# Accessibility Index to public facilities for prioritisation of community access road development

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## Declaration

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# Abstract

A number of studies have acknowledged the positive impacts that rural roads have on the social and economic development of a region. This impact is due to the increased accessibility offered by road development. The effect of the social impact, however, has proven to be difficult to quantify, with many studies opting to use ratings to define this impact. The need to quantify the social impact arises from the need to aid decision-making processes, which seek to identify or prioritise the most cost effective projects. This is more often the case in rural communities where a typical economic prioritisation method, such as a cost-benefit analysis, will likely yield unfavourable results because of the low traffic volumes present on these roads.

The method proposed for prioritisation in this research introduces an accessibility index that takes into account the accessibility provided by the road infrastructure, and by transportation modes, and by public facilities such as public schools and clinics. The data required to formulate and validate the model was collected in three villages located in the Limpopo Province of South Africa. The accessibility provided by the road infrastructure is quantified as the percentage of the length of the road link that conforms to road classification standards. The standards relate to travel speed for motorised transport and cross sectional dimensions for non-motorised transport. The probabilities of a preference to use a facility or transport mode are used as accessibility indices for the facilities and the transport modes. The probabilities are a result of stated preference experiments, which take into account the different quality attributes of public facilities, and characteristics of the transport mode. The final weighted accessibility index is obtained by considering the number of users in each observed facility in South Africa and the budget allocated to it. This enables the accessibility index to be converted further into a monetary value that is compared with the cost of successfully completing the project and the figures that arise from alternative projects. The facilities investigated were selected with the guidance of the National Development Plan (NDP) and included public schools and public healthcare facilities.

The exercise resulted in accessibility indices that were used successfully to rank seven hypothetical projects from two of the identified villages. The research showed

that, for low-volume roads, non-motorised transport modes are just as important as motorised transport modes. Other key findings were made which illustrated significant variables that influence preference for transport modes, school attendance and clinic visitation.

## Acknowledgements

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# 1 Introduction

## 1.1 Background

It has been widely accepted that roads, by providing access and transportation, are a fundamental component of the social and economic development of a country. There still is, however, no agreement as to what extent, if any at all, transport impacts development (Edmonds, 1999).

It is assumed that providing access to spatially isolated communities helps in the reduction of isolation-related poverty (Bryceson, *et al.*, 2006). This type of poverty is geographic and such areas are described as spatial poverty traps. These areas remain destitute and the residents continue to live a life that is deprived in many ways and poor over an extended period of time (Chronic Poverty Research Centre, 2004). According to The Chronic Poverty Research Centre (2004), some common characteristics associated with spatial poverty traps include:

i. Poor agro-ecology: Geological characteristics such as soil quality, topography, rainfall properties and vulnerability to natural hazards.
ii. Poor infrastructure: Poor transport infrastructure reduces access in and out. Roads, railway lines and river connections may be included.
iii. Weak institutions/organisations: e.g. weak market institutions which, in effect, lead to high costs of goods and services for the people.
iv. Political isolation: Poor delivery of local and provincial government services.

This research focuses mainly on the second and third points, although the types of institution focused on by this research are public facilities rather than markets, and the scope of infrastructure involves only low volume rural roads.

Providing access is also an important factor in reducing inequality, by providing links to equitable opportunities for rural communities (Lombard & Coetzer, 2006). When governments invest in roads, they improve education and health, as a result of an increase in the accessibility to health care and educational facilities (Bajar & Rajeev, 2015). Productivity and study prospects increase as an individual's health improves. This, in turn, increases the individual's education and makes them more aware of the importance of health care and education for themselves and their family members (Bajar & Rajeev, 2015). An increase in health care also increases an individual's life expectancy and thus increases their monetary savings over time (Bajar & Rajeev, 2015). An increase in educated individuals increases the labour force and opportunities for innovation in order to create more employment. It is evident that increasing accessibility to health care and education has a wide range of possible beneficial effects on the individual and their surrounding community.

The roles rural roads plays are relatively significant in Africa as 90% of land trade is dependent on roads (Bescq, *et al.*, 1993). Rural roads are, therefore, also a vital component of the economic well-being of African countries. Unfortunately, the majority of the African road network is in poor condition and requires substantial repair to almost 50% of paved roads and approximately 80% of unpaved roads on the continent (Bescq, et al., 1993). South Africa suffers from similar problems to those faced by the rest of the continent, as an estimated 48% of the country's provincial gravel road network is classified as being poor to very poor (National Treasury, 2011). The problems are even more evident at local municipality level where almost no available data on the condition of municipal gravel roads are available (National Treasury, 2011). Given the importance of the infrastructure, as discussed, the money invested in improving roads needs to be used efficiently and to do that, projects need to be selected to maximise returns. These returns could take many forms including funds, social development, economic development or reduction of vehicle-collision rates in the area. The inability to achieve this efficiency could possibly reduce cultural and social contacts, limit businesses and reduce employment opportunities for the rural communities concerned (Sarkar & Mashiri, 2001).

The number of trips made within and outside a rural community depends on the accessibility of the services, amenities and facilities they require (Sarkar & Mashiri, 2001). It would seem that the factors limiting the number of trips made by a community would be the number of potential destinations and the disposable income of the community. According to Edmonds (1999), the important factor limiting access is the time spent by the rural community to meet their everyday needs. These needs include water, food, fuel, school, the clinic and jobs. This time spent, or 'wasted', is the limiting factor in human development (Edmonds, 1999). Edmonds (1999) further states that rural households prioritise their time by first doing the activities necessary to sustain their lives. It is only logical that a household needs to sustain itself first before it can participate in other activities. Therefore, a minimum standard exists at which they will be content enough to be able to participate in life-enhancing activities effectively. The type of activities that these households perform to sustain life, include (Edmonds, 1999):

- Ensuring adequate shelter
- Obtaining water and food
- Obtaining fuel

Only when life-sustaining activities have been performed do rural households devote their time to life-enhancing activities such as:

- Better family care
- Health care and/or education
- Leisure
- Productive and income generating activities to improve their levels of living

Providing better access to both the life-sustaining and life-enhancing activities, could allow households to have more time to spend on the life-enhancing activities. These life-enhancing activities are crucial for poverty alleviation and human development.

It is proposed in this project to research the application of a ranking method for potential projects according to the potential gain in accessibility to these life-enhancing facilities, specifically health care and education facilities. This will depend on the quality of the road infrastructure, transportation travel time, travel cost and the quality of facilities at the destinations.

## 1.2 Problem Statement

In South Africa, unpaved roads are estimated to contribute 593 250 km of the total estimated road network of 746 978 km (Kannemeyer, 2009). This translates to approximately 79% of the total road network. Of the total unpaved roads, 24% are estimated to be un-proclaimed roads (Kannemeyer, 2009). A large number of the unpaved roads are to be found in rural areas and according to the National Treasury (2011), un-proclaimed roads are also largely found in rural areas. Various sectors of government are responsible for the management of these roads (National Treasury, 2011). These sectors are municipal, metropolitan and provincial authorities. Un-proclaimed roads are those that do not belong to any road authority. The proportioning of the unpaved roads according to the road authority responsible for them is shown in Figure 1.1. The graph shows that 51% of all unpaved roads in South Africa fall within the management of municipal road authorities. Typical management activities include maintenance, rehabilitation and upgrading of the roads.

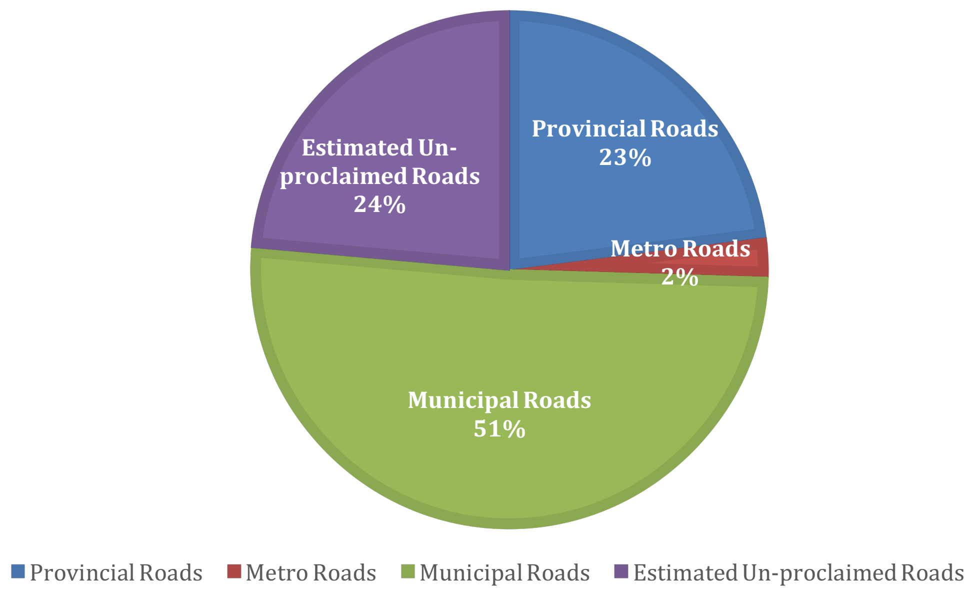


**Figure 1.1. Proportions of total unpaved roads in RSA according to different government spheres responsible for them (Kannemeyer, 2009).**

In order to manage these roads properly, it is necessary to collect data on their conditions. This data contains information on the current condition of the roads. Previously, provincial road authorities and municipalities collected road condition data annually using the visual condition index (VCI) method (National Treasury, 2011). The VCI method expresses a road's condition on a scale from 0 to 100, with 0 indicating "very poor" and "requires reconstruction" (National Treasury, 2011). A very good road will have a VCI of 100. Most authorities in the country have stopped using the method because of a lack of (National Treasury, 2011):

a) Technical capacity
b) Budget
c) Road management information
d) Decision making systems

This lack of data collection has contributed to the backlog in the refurbishment and maintenance of roads in the country and also obstructs the possibility of efficiently budgeting at local government level (National Treasury, 2011). The extent of data shortage is shown in Figure 1.2. Available data for the provincial level unpaved roads accounts for approximately 76% of the provincial network roads. Available data for the metropolitan (metro) unpaved road network comprises 12% of the unpaved metropolitan network and there is available data on the condition of only 1% of the municipal road network although they make up the bulk of the unpaved road network in the country.

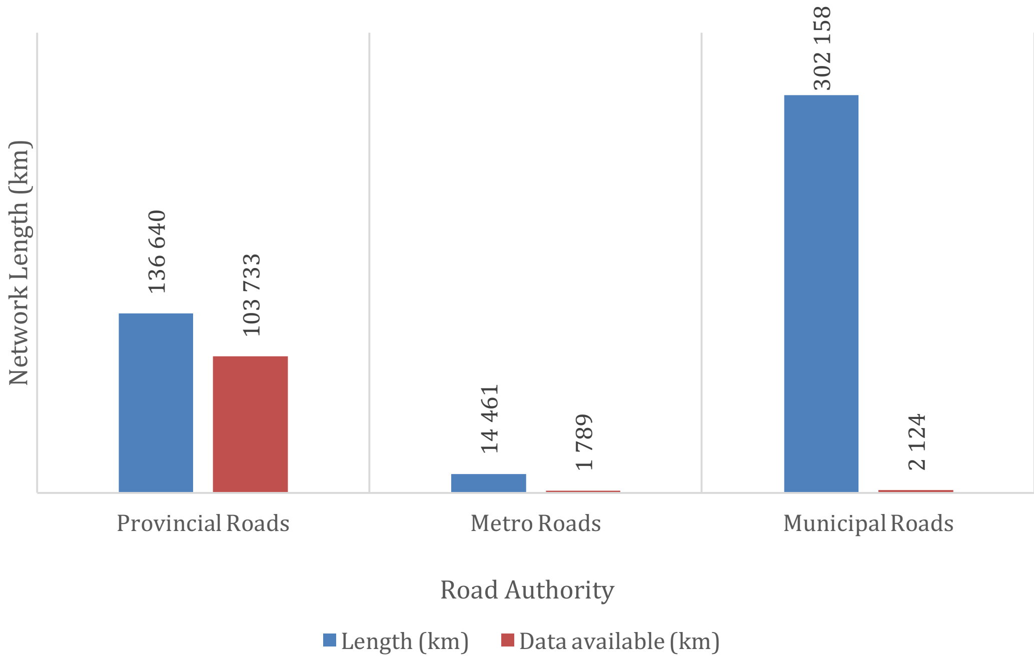


**Figure 1.2. Unpaved road network length with available condition data compared with total length according to road authority  (Kannemeyer, 2009).**

For successful collection of data on unpaved rural roads, the problems currently faced at municipal, provincial and metropolitan levels need to be addressed. The following requirements for data collection at local level have been formulated to aid in solving the challenges currently faced:

a) The method must be relatively affordable i.e. it must be free of specialised machinery and equipment.
b) The method must not require specialised skills or intensive training.

Figure 1.3 shows the known conditions of the provincial gravel roads in South Africa as presented by Kannemeyer (2009). It should be noted that these figures represent only 76% of the total provincial road network. On average 48% of the gravel roads of any province in South Africa can be classified as having conditions ranging from poor to very poor. The worst affected provinces are the Western Cape, North West, Mpumalanga, Limpopo and the Eastern Cape provinces, where more than 50% of the gravel road network in these provinces is categorised as poor to very poor.

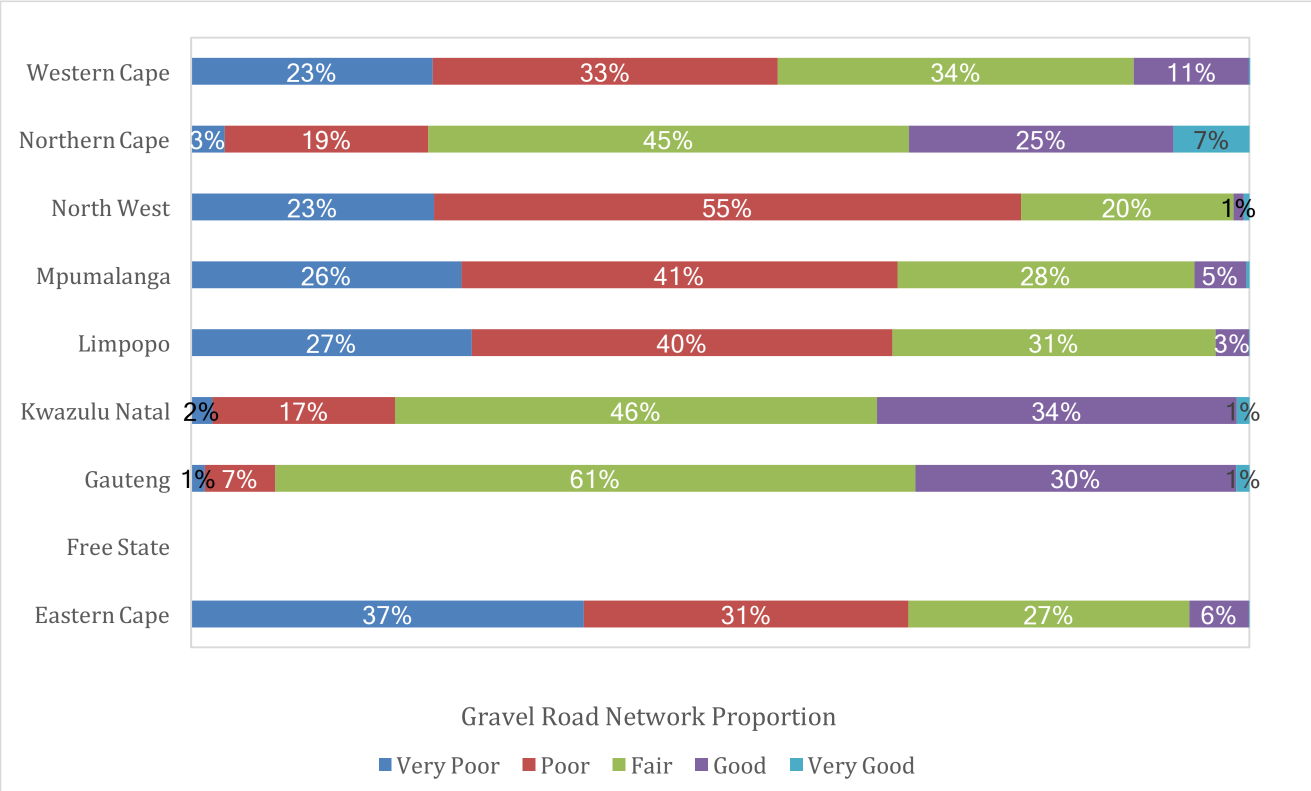


**Figure 1.3. Provincial gravel road conditions by province (Kannemeyer, 2009).**

## 1.3 Objectives

Taking into consideration the importance of rural roads and the challenges currently faced in South Africa in collecting the necessary data for road management, the following objective has been set for the research:

- To develop and test a model of ranking road infrastructure investments, with the perspective of increasing accessibility to basic public facilities necessary to provide equitable opportunities for the affected communities.

In order to achieve the objective set above, the following processes need to be completed: To

- Perform the necessary surveys in order to complete and recalibrate the developed model.
- Successfully utilise the model by performing further investigations at various villages through the application of collected data.

- Successfully analyse the collected data using the proposed model to obtain accessibility level indices.
- use the accessibility indices to rank potential or hypothetical projects at selected villages and investigate the influence of significant variables on the model's results.

The processes required to meet the objective of the research were to be conducted without the use of specialised apparatus and should not require intensive training of individuals. This requirement was set forth to address the challenges currently faced in South Africa regarding collecting road condition data.

## 1.4 Definitions

The following are as described in this research:

- Accessibility - The level or ease of access to basic needs (work, education, health care, shops etc.) and social needs (social participation within the community).
- Passability – The difficulty of travelling over a length of road.
- Unproclaimed roads – These are roads for which no authority takes responsibility.

## 1.5 Overview of Chapters

The literature review is presented in Chapter 2. The literature review will look at the common methods used in assessing unpaved roads and will also look at the ranking methods currently in use. Further, Chapter 2 will discuss life-enhancing public facilities and the key qualities needed to assess these facilities. Subsequently, some of the proposed accessibility index (AI) measures proposed by different authors will be reviewed.

Chapter 3 of the research describes the methodology used in developing and building the model, and includes the processes involved in the gathering of data for the required model.

Chapter 4 presents the results and discussions of the outcomes of the data gathering processes and model development described in Chapter 3. Chapter 5 investigates the sensitivity of the variables on the accessibility index results from Chapter 4.

Chapter 6 presents the conclusion, key findings and recommendations based on the results and objectives of the study.

# 2 Literature review

## 2.1 Introduction

The accessibility to a community of a facility is a function of mobility and the quality of the services been rendered at the facility. Mobility is dependent on the road infrastructure and properties of the mode of transport. Either one or more of the following can improve the accessibility of a facility to a particular community.

- Improving mobility:

  Mobility can be improved by decreasing the distance between the facility and the community and/or by improving transport properties, which can also be, affected by the condition of road infrastructure, in order to decrease time of travelling.

- Improving the quality of the facility:

  Increasing the quality of facilities makes the facilities more effective and decreases backlogs in human development.

Figure 2.1 illustrates the components of accessibility as described by Hajj and Pendakur (2000).

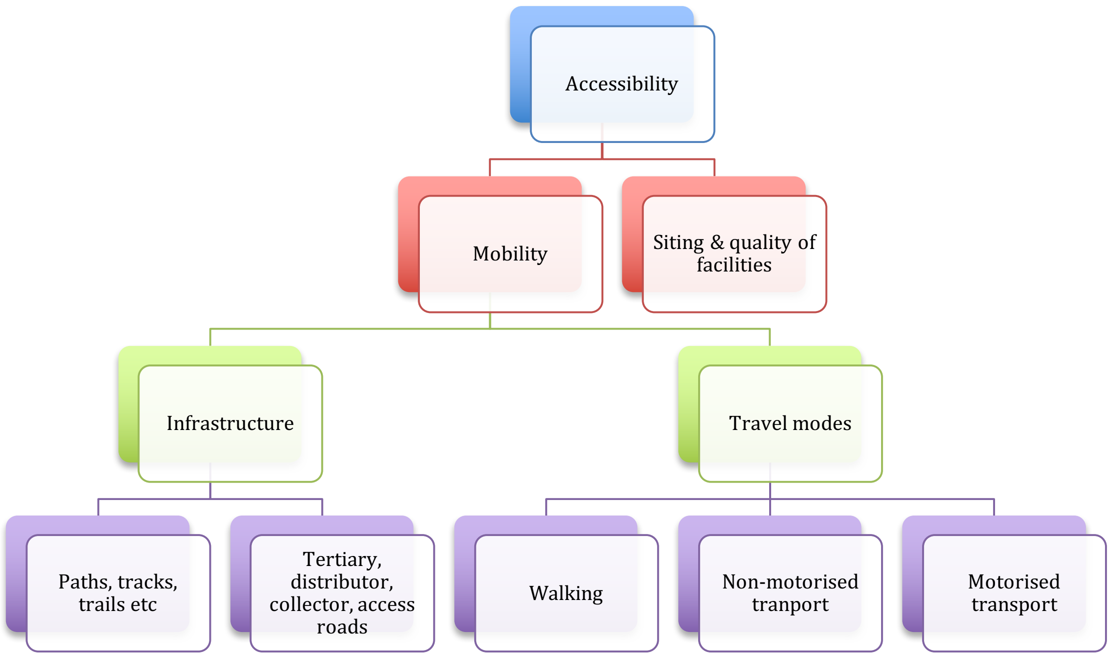


**Figure 2.1. Components of accessibility (Hajj & Pendakur, 2000).**

What is fundamental about accessibility, in the context of infrastructure and facilities, is that:

- It is essential that the communities are able to use the available or potential infrastructure through available travel modes and that the infrastructure provides an acceptable service for the particular transport modes available.
- To uise the infrastructure, appropriate transportation to and from the facilities needs to be available at a reasonable cost given the distance to the facilities and the road conditions.
- The facilities should provide efficient and fair services to the individuals to make the trip worthwhile.

The literature review in this research is presented according to the two core components of accessibility and includes:

- Siting and quality of facilities and
- Mobility
  - Infrastructure and
  - Travel modes

Each of the components is discussed in the context of assessing their respective service, quality or condition. Existing ranking methods are then discussed to assess whether the core components of accessibility can be incorporated into them. This is followed by reviews of recent studies on the topics that have presented methodologies for measuring the social aspects of communities and accessibility.

## 2.2 Quality of Facilities

The quality of facilities depends on the type of services being offered by the particular facility. The type of facility that will be investigated in this paper, are public facilities. These facilities are provided by the different spheres of government according to official standards and requirements. There are many public facilities in a country and the citizens who use them prioritise these facilities differently as regards their importance to each citizen.

To identify the key public facilities in South Africa, the National Development Plan (NDP) was consulted. The NDP was established to guide development priorities in South Africa and its primary goals are to eliminate poverty and reduce inequality by 2030 (National Planning Commission, RSA, 2013). It was decided in 2013 that the 2014-2019 Medium-Term Strategic Framework (MTSF) should form the first five-year implementation phase of the NDP. This was to align the plans of the national and provincial governments, municipalities and public entities with the visions and goals as set out in the NDP (Department of Planning, Monitoring and Evaluation, 2014). This enables all sectors in government to align their development according to the priorities listed in the NDP, work towards similar goals. The NDP identified the priorities as listed in Table 2.1 in the implementation phase (Department of Planning, Monitoring and Evaluation, 2014).

As can be seen from Table 2.1, the public facilities with the highest priorities are:

- Public schools to achieve quality basic education
- Health care facilities to achieve a long and healthy life for all
- Police stations to achieve safety for all.

The first two facilities will be discussed further to identify what characteristics about them can be used to measure their quality. Police stations are not discussed any further, as it is believed that visits to police stations in rural communities are very few.

**Table 2.1. Priorities as listed in the MTSF and corresponding rural facilities or services (Department of Planning, Monitoring and Evaluation, 2014).**

| # | Priority | Facility/Service required to provide priority |
|---|---|---|
| 1 | Quality basic education | Public schools and other educational facilities (e.g. libraries) |
| 2 | A long & healthy life for all | Health care facilities |
| 3 | Safety for all | Police station |
| 4 | Decent employment | Work opportunities |
| 5 | Skilled and capable workforce | Number of qualified people and unemployed |
| 6 | Efficient, competitive & responsive economic infrastructure network | Reliable electricity and & water supply. Condition of river crossing structures, condition of road. |
| 7 | Vibrant, equitable, sustainable rural communities | Minimal unemployment rate or households below poverty line (R443, 2011) |
| 8 | Adequate human settlements | Social housing recipients and waiting time. Current number of bedrooms to number of household members. |
| 9 | Responsive, accountable, effective & efficient local government | State of local municipality |
| 10 | Environmental sustainability | Good local regulation |
| 11 | Enhance S.A. and contribute to enhancement of Africa | - |
| 12 | Development-oriented public service | Investment of local municipality |
| 13 | Social protection system | Provision of welfare to the needy |
| 14 | Common national identity | Good community relations |

### 2.2.1 Basic Education

Section 29 (1) of the Constitution of the Republic of South Africa (1996) states that *"everyone has the right to a basic education, including adult basic education; and to further education, which the state, through reasonable measures, must make progressively available and accessible".* Basic education in South Africa consists of primary (Grades 1 to 7) and secondary education (Grades 8 to 12) and is overseen by the Department of Basic Education.

The South African basic education system achieves high enrolment in primary schools each year but the number of yearly outputs in Grade 12 is much lower than the enrolment numbers (Modisaotsile, 2012). The majority of those who do pass Grade 12 do not meet the minimum requirements to enrol at universities (Modisaotsile, 2012). Of the students who enrol in the first grade, 50% will drop out before grade 12, 40% will pass the National Senior Certificate and only 12% will qualify for university enrolment (Spaull, 2013). These figures paint an unpleasant picture of basic education in South Africa, one troubled by severe drop out numbers. The problem seems to lie in completing the education rather than entering the system and this could point to quality issues as a reason. The basic education system is divided into two different school systems in the country. These systems are divided by the socio-economic status, geographic location and language of the learners or communities, with learners in well-off communities doing much better academically than those in less well-off areas (Spaull, 2013).

Both Modisaotile (2012) and Spaull (2013) list various difficulties currently plaguing the education system in the country, such as deficient School Governing Bodies, inadequately qualified teachers, etc. In the General Household Survey of 2015 by Statistics South Africa (Stats SA), the nature of problems experienced by public school attendees were recorded. Figure 2.2 shows the results for the province with the least proportion of students reporting problems (Northern Cape), the one with the highest proportion reporting problems (North West) and the South African average. On average, the largest problem experienced by learners in South Africa is high fees (4.5%) followed closely by a lack of books (4.3%), bad facilities (3.7%) and large classes (3.6%). These problems impede the accessibility of quality education to learners. Each of the four problems will be briefly discussed.

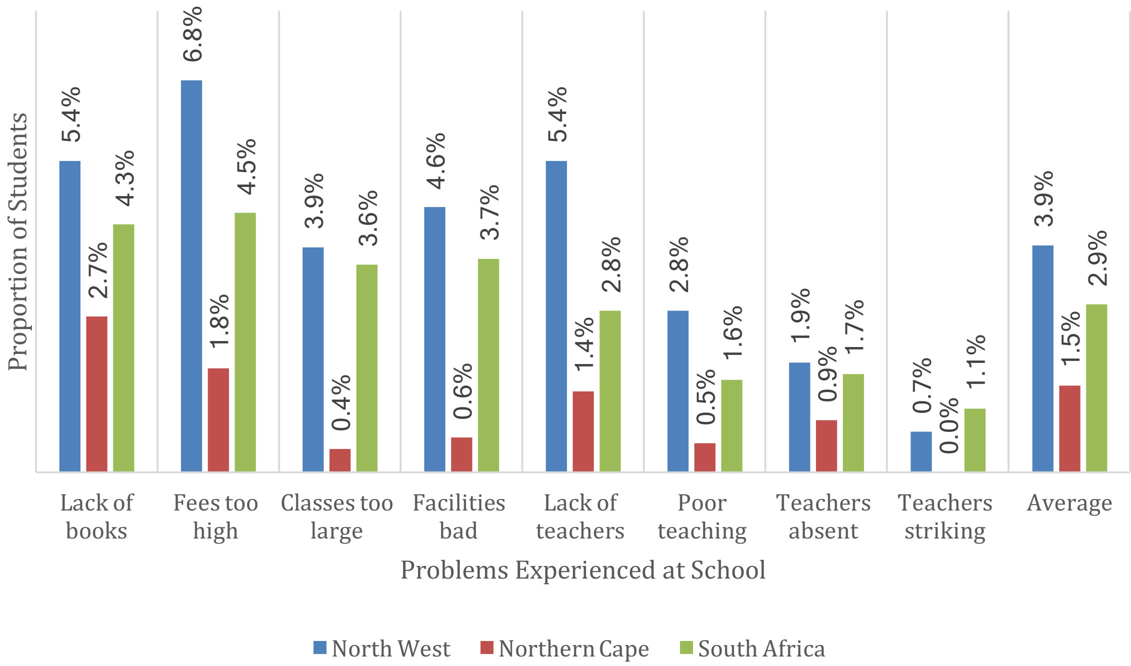


**Figure 2.2. Types of problem experienced by learners and proportion who experience them in North West Province, Northern Cape and the South African average (Statistics South Africa, 2016).**

#### *2.2.1.1 School fees in basic education*

Student fees in South African public schools are meant to supplement the school's budget from government funding (Department of Basic Education, 2016). This means that school fees cannot be used as the sole income for a public school. The Provincial Gazette provides a list of no-fee-schools, where no fees are charged for learners. These schools are selected depending on the economic characteristics of the community around the school (Department of Basic Education, 2016). Parents who cannot afford school fees can apply to the school governing body for a conditional, partial or full exemption from fees (Department of Basic Education, 2016).

#### *2.2.1.2 Availability of books in basic education*

According to the South African Human Rights Commission (2013), concerning books for learners, the state is obliged to:

> *"Provide basic learning and teaching support materials (LTSM) and equipment such as stationery and textbooks in a timely fashion to all learners, including appropriate materials for learners with disabilities"*

Each learner should have one textbook of his or her own for every subject. In the year 2012 there was significant inequality in the access to adequate books and in such situations, it was the poorer provinces that experienced the greatest shortages (SAHRC, 2013). Unfortunately, the poorer provinces of South Africa are those with the greater proportion of rural communities.

#### *2.2.1.3 Bad facilities in basic education*

Statistics South Africa (2016) did not articulate the problem of bad facilities thoroughly. This could, however, be related to poor infrastructure conditions or lack of necessary amenities such as toilets. According to the South African Human Rights Commission (2013), concerning educational facilities for learners, the state is obliged to:

> *"Ensure all schools have essential and basic services including safe structures, fencing, ventilation, lighting, safe potable water, adequate and hygienic sanitation, electricity and information communication technology"*
> and
> *"Ensure that all schools and school infrastructure comply with Universal Design standards for children with disabilities"*

#### *2.2.1.4 Large classes in basic education*

According to the South African Human Rights Commission (2013), concerning class sizes for learners, the state is obliged to:

> *"Provide sufficient schools and classrooms to accommodate all children at pre-primary, primary, & secondary levels of education in classes of a size amenable to providing an enabling learning and teaching environment"*

Tables 2.2 and 2.3 report on the maximum number of learners per teacher and minimum number of classrooms allowed for each primary and secondary school type. The maximum class size, as evident from the tables, is 40 learners for primary and secondary schools and 30 for Grade R classes.

**Table 2.2. Teacher:learner ratio and minimum classrooms for different primary school types.**

| **Basic service** | **Small Primary (135 -310)** | **Medium Primary (311 – 620)** | **Large Primary (621 – 930)** |
|---|---|---|---|
| **Teacher:learner ratio** (SAHRC, 2013) | 1: 40 and<br>1: 30 for Grade R | | |
| **Number of classrooms** (Department of Basic Education, 2012) | 7 | 14 | 21 |

**Table 2.3. Teacher:learner ratio and minimum classrooms for different secondary school types.**

| Basic service | Small Secondary (200 - 400) | Medium Secondary (401 – 600) | Large Secondary (601–1000) |
|---|---|---|---|
| **Teacher:learner ratio** (SAHRC, 2013) | 1: 40 | | |
| **Number of classrooms** (Department of Basic Education, 2012) | 10 | 15 | 25 |

In conclusion, there exist various guidelines and regulations concerning the quality of public schools. These guidelines can be used to assess the quality of the facility to determine the overall accessibility of the facility.

### 2.2.2 Health Care

Since 1994, although South African policies governing the health care system have been good and the investment into the system has been high, the health care system has been poor (South African Government, 2012). This suggests that the deeper problem is in implementing the policies and/or utilising the financing adequately. The health system in South Africa is divided into two sectors, the public and private sector. The public sector provides services to approximately 83% of the country's population and the private sector provides services to approximately 17% of the population (South African Government, 2012). There is an explicit difference in the amount of investment into each of the two sectors, with the private sector spending more than the public sector, which has led to cost escalations (South African Government, 2012). This imbalance increases the consequences of inequality, where the well-off population receives much better health care than the poorer population.

The South African government has included long-term goals for the South African health care system in its National Development Plan. It lists six priority areas for the improvement of healthcare facilities. These priority areas are based on concerns expressed by the patients during surveys, through complaints and media reports (Department of Health, 2011). The six priorities are incorporated in the core standards and are:

- Improving staff values and attitudes towards patients
- Reduction of waiting times
- Cleanliness
- Patient safety and security
- Infection prevention and control
- Availability of medicine

In the case of villages, the following four types of public health care facilities should be available:

- Clinics: A fixed facility that provides primary health care services and is normally operational for at least eight hours a day for a minimum of four days a week (Cullinan, 2006).
- Satellite clinics: This facility is a fixed building, with one or two rooms permanently equipped for primary health care (PHC) services (Health Systems Trust, 2012). This facility is normally open for eight hours a day and, at most, four days a week.
- Mobile clinics: This is a temporary service by a mobile unit/bus/car, offering a range of PHC services. The service is usually provided on a fixed route at numerous points at periodic times (Health Systems Trust, 2012).
- Community Health Centre (CHC): This is a facility that, in addition to providing PHC services, normally provides 24-hour maternity and accident emergency services (Cullinan, 2006). This type of facility can have up to 30 beds whereby patients can be observed by staff for up to 48 hours (Cullinan, 2006).

Some of the consequences of poor access to primary health care (PHC) include detrimental pregnancy outcomes, infant mortality, decreased vaccination coverage and decreased use of contraceptives (Masango-Makgobela, *et al.*, 2013). Health care facilities must be strategically placed to allow adequate accessibility to as many community members as possible. Providing access is, however, only one part of the solution as has been mentioned before. Quality service is also required from the facility to treat patients adequately and efficiently and lead to a better relationship between the medical staff and patients. Masango-Makgobela *et al.* (2013) state the following as the leading causes of patients not returning to a particular clinic:

- long waiting times
- long queues
- unavailability of medicines
- bad service (quality perception).

When patients do not return to a specific clinic, they might choose to travel further to reach another clinic in the hope of finding better service.

Only two quality attributes are discussed further in this research, namely doctor visitation frequencies and waiting times. The reasons for this are explained as follows:

- Waiting time and long queues are linked.
- The type of medicines which should be available are difficult to assess except by a competent individual.
- The experience of the service is based on the perception of the patients, and is also difficult to assess impartially.
- It is believed that adequate doctor visitations are paramount to adequate health care.

**Doctor visitation at clinics**

Nurses run PHC services, although doctors make periodic visits (Cullinan, 2006). In the case of villages, health care is predominantly provided by clinics. The clinics can be either be permanent building structures or mobile clinics. This is dependent on the size of the population.

No explicit indications on the frequency or purpose of doctor visitations were found. Furthermore, in the National Health Facilities Baseline audit of 2012, it was reported that approximately 47% of South African clinics had no doctor visitations.

Ideally, doctor visitation frequencies should be tailored to the clinic's characteristics and to the needs of its surrounding community (Couper, 2002). Table 2.4 shows the principle of frequency of visits used by most provinces in the country (Couper, 2002).

**Table 2.4. Ideal doctor visitation frequencies per health care facility type (Couper, 2002).**

| Health Care Facility Type | Frequency of Doctor Visits |
|---|---|
| Fixed clinic | Once a week |
| Mobile clinic | Possibly once a month |

As can be seen from Table 2.4, a typical clinic should ideally have at least one visitation by a doctor every week and mobile clinics, one every month.

**Waiting times**

According to Operation Phakisa (2015), approximately 75% of patients wait for more than two hours in a clinic, with 7% of them waiting more than seven hours. It would not be surprising that a patient was reluctant to revisit the clinic after waiting for such long hours. A consequence of this is that patients could opt to visit another clinic that would probably be located even further away. This could then lead to an increased catchment area for that particular clinic, therefore overloading the available resources, and increasing the waiting times, as a result of the increased influx.

Long queues also mean that patients need to spend time in the clinic that could have been spent on an income generating activity, amongst other many activities important to them. Operation Phakisa names the following as their targets to be met by the year 2018:

- Two hours maximum waiting time
- Three hours maximum spent at the clinic
- 90% patient satisfaction with clinic waiting time

## 2.3 Mobility

Mobility in the context of this research is defined as the ability of individuals to move freely and easily to their respective destinations (the destinations being public facilities). Mobility constitutes two components, namely the travel infrastructure and the transport mode. The two components need to be favourable to ensure good mobility.

Favourable conditions for transport modes differ according to the mode of transport. Two basic modes of transport exist, namely motorised and non-motorised modes. Non-motorised travel modes include amongst others:

- Walking
- Animal-drawn carts
- Bicycles

Mobility in the case of non-motorised transport is largely dictated by the distance and the topography of the path. Large distances and steep paths are not favourable conditions for non-motorised transport modes. Geographical conditions also play a role in which non-motorised transport is favoured. Starkey (2007) found that donkey carts are usually found in semi-arid regions and water based modes of transport require coasts, rivers, lakes or canals.

Motorised transport modes include, amongst others:

- Public transport such as buses and mini bus taxis
- Cars
- Motorcycles

Mobility in the case of motorised transport modes is largely dictated by road conditions. Bad road conditions for unpaved roads include corrugations, potholes, rutting, stoniness and any other condition that renders the travel path difficult to navigate comfortably. Bad road conditions increase the operating costs of motorised vehicles such as the maintenance costs of the vehicle and the time lost whilst travelling on difficult terrain. These costs are experienced directly by the user if they own the vehicle and indirectly in the case of public transport. In the case of public transport, the operating costs are passed down to the user through fares. In other cases, road conditions can be so bad that some transport modes cannot gain access through the road, e.g. roads that can only be navigated by four-wheel drive vehicles.

Road infrastructure and transport modes will be discussed in more detail in order to assess their conditions and rate their quality in the sections below.

### 2.3.1 Infrastructure

The infrastructure of concern in this report is low-volume unpaved rural roads. As mentioned in Chapter 1, these roads make up the bulk of the road network in South Africa. Local municipalities manage the majority (51%) of these roads and alarmingly, 24% of the gravel road network is estimated to be un-proclaimed. Unpaved rural roads can be divided into classes as those shown in Table 2.5 and typical lengths of these unpaved roads are reported in Table 2.6.

**Table 2.5. Unpaved road classes and their respective descriptions (COTO, 2012).**

| RCAM | Description | Linkage |
|---|---|---|
| R1 | Rural principal arterial | Carry traffic between metropolitan areas and large cities |
| R2 | Rural major arterial | Carry traffic between smaller cities and medium to large towns (population > 25000) |
| R3 | Rural minor arterial | Carry traffic between small towns, villages and larger rural settlements (population < 25000) |
| R4 | Rural collector road | Carry traffic to local destinations, smaller rural settlements, tourist areas, mines, game and nature parks |
| R5 | Rural local road | Carry traffic to private properties such as households within rural communities |
| R6 | Rural walkway | Typically, informal paths essential for pedestrians |

**Table 2.6. Unpaved road classes and their typical lengths and average annual daily traffic (AADT) (COTO, 2012).**

| RCAM | Class | Typical length | Typical AADT |
|---|---|---|---|
| R1 | Class 1 | > 50 km | > 1000 vehicles |
| R2 | Class 2 | > 25 km | > 500 vehicles |
| R3 | Class 3 | 10 km < length < 100 km | 100 < AADT < 2000 vehicles |
| R4 | Class 4 | < 10 km | < 1000 vehicles |
| R5 | Class 5 | < 5 km | < 500 vehicles |

#### *2.3.1.1 Present condition survey methods*

Condition surveys are used to assess the condition of a road link or network. At present, a standardized method to assess and rate the conditions of unpaved roads does not exist (Nkomo, *et al*., 2016). However, as previously discussed, condition surveys of unpaved rural roads have mostly been conducted through a visual assessment of the road and concern the functional performance of the road. Instrument surveys, which assess the functional and structural properties of the road, are often conducted to supplement the visual surveys (Committee of State Road Authorities, 1995). Figure 2.3 shows the different condition surveys used.

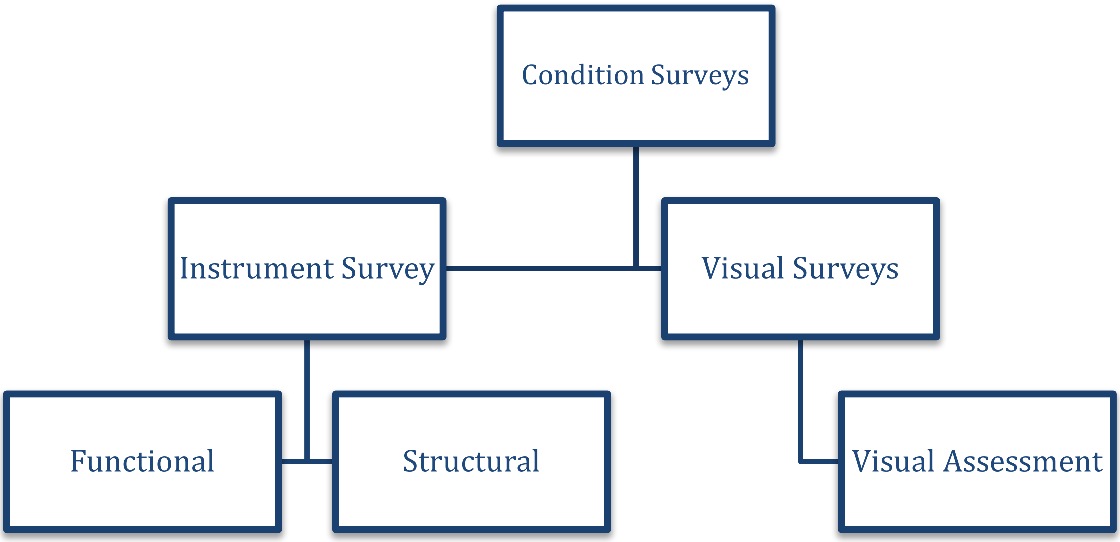


**Figure 2.3. Different forms of condition survey for any road (Committee of State Road Authorities, 1995).**

2.3.1.1.1 Visual assessments

TMH12 is the commonly used manual for visual assessment of unsealed roads in South Africa. Results from visual assessments can be used to determine the following (Jones & Paige-Green, 2000):

- Condition indices
- Maintenance and rehabilitation type, extent and scheduling
- Prioritisation at network level.

The assessment is usually conducted from a vehicle travelling at a slow pace through a "windshield" survey (Committee of State Road Authorities, 1995). It is accepted that this method can have an element of subjectivity, if not done properly, as it requires subjective judgements from those conducting the survey. These assessors require training to ensure consistent and repeatable reporting. The training then minimises the risk of subjectivity.

Jones and Paige-Green (2000) suggest that visual assessment is most applicable for determining the following:

- Regravelling needs
- Blading frequencies
- Suitability of road to given traffic and environment
- Typical distresses of the road. The type, degree and extent of distresses are recorded during the surveys. Guidance on how to do this is given in TMH12.

The condition of the road is indicated as a visual condition index (VCI). The VCI can be classified into condition categories ranked from 1 -5 as shown in Table 2.7. It is recommended that a visual assessment be conducted at least every year and at most every two years (Committee of State Road Authorities, 1995). As discussed in Chapter 1.2, the visual assessment method using VCI was the method of choice for collecting road condition data for provincial and municipal authorities. The reasons to why road authorities were not conducting condition surveys were listed as a lack of:

a) Technical capacity
b) Budget
c) Road management information
d) Decision making systems

**Table 2.7. VCI condition categories (Committee of State Road Authorities, 1995).**

| **Condition category** | **VCI Range** |
|---|---|
| Very Good | $85 \leq VCI \leq 100$ |
| Good | $70 \leq VCI \leq 85$ |
| Fair | $50 \leq VCI \leq 70$ |
| Poor | $30 \leq VCI \leq 50$ |
| Very Poor | $0 \leq VCI \leq 30$ |

VCI is a good indicator of a road's condition. It also allows for budgeting according to the required remedial actions. Remedial actions can be determined from the recorded distresses and the extent at which they are present. It is because of such benefits that this has been the preferred method for condition assessment.

##### 2.3.1.1.2 Instrument surveys

Instrument conducted by using equipment specially developed for condition surveying. As shown in Figure 2.3, instrument surveys are may be divided into two groups. These are, namely, functional and structural assessments, which are discussed below.

*Functional assessment*

*Road roughness*

Pavement roughness is the most widely used measure for a pavement's functional condition (Committee of State Road Authorities, 1995). It is a representation of the distortions on a road's surface and thus can be viewed as a measure of ride comfort (Committee of State Road Authorities, 1995). It is measured by two types of systems, namely the Response Type Roughness Measuring System (RTRMS) and the Profilometer Roughness Measuring System (Committee of State Road Authorities, 1995).

The roughness scale, International Roughness Index (IRI), was selected to encourage a common unit (usually m/km, in/mi, etc.) of measure for roughness around the world (Sayers, *et al.*, 1986). Sayers, *et al*. states that the IRI is appropriate for relating the roughness to the following:

- Vehicle operating costs (VOC)
- Overall ride quality
- Dynamic wheel loads (relates road damage to wheel loads from heavy trucks. Safe braking and cornering limits for passenger cars)
- Overall surface condition

IRI is a component of the longitudinal profile on a road, which is experienced in the wheel path of the traveling vehicle (Archondo-Callao, 1999). There is a direct relationship between speed and roughness (Sayers, *et al.*, 1986). This would imply that speed is also a measure of several road conditions just as roughness is. The relationship is shown in Table 2.8 (van Zyl, 2016).

**Table 2.8. Road classes, typical speeds and IRI equivalent (van Zyl, 2016).**

| Road class | Passability (impassable days/ year) | Mobility average speed (km/hr) | IRI average |
|---|---|---|---|
| R1 | 2 | 80 – 100 | < 5 |
| R2 | 2 | 80 – 100 | 7.5 – 5 |
| R3 | 3.5 | 60 – 80 | 10 – 7.5 |
| R4 | 3.5 | 45 – 60 | 13 – 10 |
| R5 | 3.5 | < 35 | 15 – 13 |

Methods for the measurement of IRI are given according to different classes as reported by Sayers, *et al.* (1986). These classes are differentiated by their level of accuracy in determining the IRI. They are as follows:

i. Class 1 – Precision Profiles.

This represents the most accurate standard in measuring IRI and is performed using profilometric methods (Sayers, *et al.*, 1986). A method is deemed to be a Class 1 method if measurement error is negligible in comparison to the uncertainty associated with locating exactly the same wheel track twice (Sayers, *et al.*, 1986). This class type requires specialised profilometric vehicles that could be costly for small municipalities. They are also not suitable for profiling gravel roads (COTO, 2007).

ii. Class 2 – Other profilometric methods.

This class encompasses all other methods by which a profile is measured for direct correlation to IRI but which is incapable of the Class 1 accuracy (Sayers, *et al.*, 1986). High-speed profilometers and static methods are used to compute the IRI in this class (Sayers, *et al.*, 1986). This type of method requires other profilometric type vehicles, albeit of less accuracy. It therefore has similar disadvantages.

iii. Class 3 – IRI estimates from correlation equations.

This class represents the method most widely used in determining the IRI and is collected with a Response Type Road Roughness Measuring System (RTRRMS) (Sayers, *et al.*, 1986). A RTRRMS comprises of a measurement vehicle and a unit called a Roadmeter that measures the response of the measurement vehicle to the road surface (COTO, 2007). Output from RTRRMS vehicles depends on the vehicle characteristics, particularly the suspension and calibration is important to obtain reputable IRI results (Sayers, *et al.*, 1986). Because vehicular properties change easily over time in operation, maintenance and operating procedures, as well as control testing need to be strictly adhered to for these vehicles (Sayers, *et al.*, 1986).

COTO (2007) state that the maintenance, operation and calibration of the vehicle and device is relatively simple and inexpensive compared to profilers in South Africa. This type of devices appears to be more successful on gravel roads than profiling devices (Class 1 and 2) in South Africa (COTO, 2007). The advantage of this type of device makes it extremely suitable for use on municipal and provincial gravel roads. These devices are, however, not in use nationwide.

iv. Class 4 – Subjective ratings and uncalibrated measures.

This class encompasses roughness measurements that do not require high accuracy or where higher accuracy is not affordable (Sayers, *et al.*, 1986). In such a case, a subjective evaluation is conducted by either a ride experience on the subject road or a visual inspection of the road (Sayers, *et al.*, 1986).

The method provides for qualitative, and in some cases quantitative, description of the road surface condition and ride quality (Sayers, *et al.*, 1986). Photographs along the road can be used as evidence to supplement this method (Sayers, *et al.*, 1986). These photographs, however, place emphasis on the road defects and therefore can be misleading in thier severity (Sayers, *et al.*, 1986).

A rigorous and robust Class 4 method is yet to be developed and verified but successes have been reported which suggest that IRI values can be estimated with limited accuracy that does give an indication of the true road condition (Sayers, *et al.*, 1986). This method can be used for low budget projects where expensive investigations cannot be justified.

*Skid resistance*

This measure does not have a direct relationship to the condition of the pavement but significantly affects the rate of accidents (Committee of State Road Authorities, 1995). This measure will not be discussed further in this paper.

*Structural assessment*

Structural assessment is conducted to determine the structural integrity of the road or road network. This assessment is done by investigating the surface deflection and rut depth measurements of the network. The structural integrity of the road is highly important for roads of high traffic volume or those that are used by heavy vehicles. The subject roads in this paper are low volume unpaved roads. The types of measurements most popular for structural assessments will be discussed only briefly.

*Surface deflection*

All current non-destructive evaluations of a pavement's structural capacity are conducted by equipment that measures deflections (Committee of State Road Authorities, 1995). Three types of device are commonly used in South Africa to measure these deflections. These are the Benkelman Beam, the Travelling Deflectograph and the Falling Weight Deflectometer (Committee of State Road Authorities, 1995)

*Rut depth*

The information gathered from measuring the rut depth gives an indication of the structural deterioration and the potential safety complications (Committee of State Road Authorities, 1995). Measurements for rut depths are conducted by using a 2 m long straight edge and measuring the maximum deviation from a line parallel to the surface of the pavement.

### 2.3.2 Transport

In this section, the types of transport typically used to access health care and educational facilities will be discussed.

For comparison of travel patterns between rural and urban settlements, results in the National Household Travel Survey of 2013 showed that 85% of individuals in urban areas, compared to 75.4% in rural areas, had travelled in their seven-day reference period before the survey date. This shows that rural dwellers are less likely to travel. There are a number of possible reasons for this outcome, which can include poor road infrastructure, lack of public transport, high costs of public transport and few potential destination points amongst others. In the 10 years since the first National Household Survey, it was found that access to public transport in rural households had increased and that travel times had decreased (Statistics South Africa, 2014). This can be translated to mean an increase in accessibility for rural households in the country during the 10-year period between the surveys. The survey was conducted for three types of travel patterns, namely education, work and other related travel patterns (includes day and overnight trips). Figure 2.4 illustrates the differences between metropolitan, urban and rural settlements in accessing public facilities. The graph shows the percentage of households who travel for more than 60 minutes to reach the selected services. The information was obtained from the National Household Travel Survey of 2013 by Statistics South Africa (Stats SA).

The chart shows a significant difference between the three settlement types, which demonstrates the inequality faced by rural settlements in accessing public facilities. On average, 78% of rural households, compared to 13% for metropolitan and 9% for urban households, travel for more than 60 minutes to reach the destinations listed in Figure 2.4.

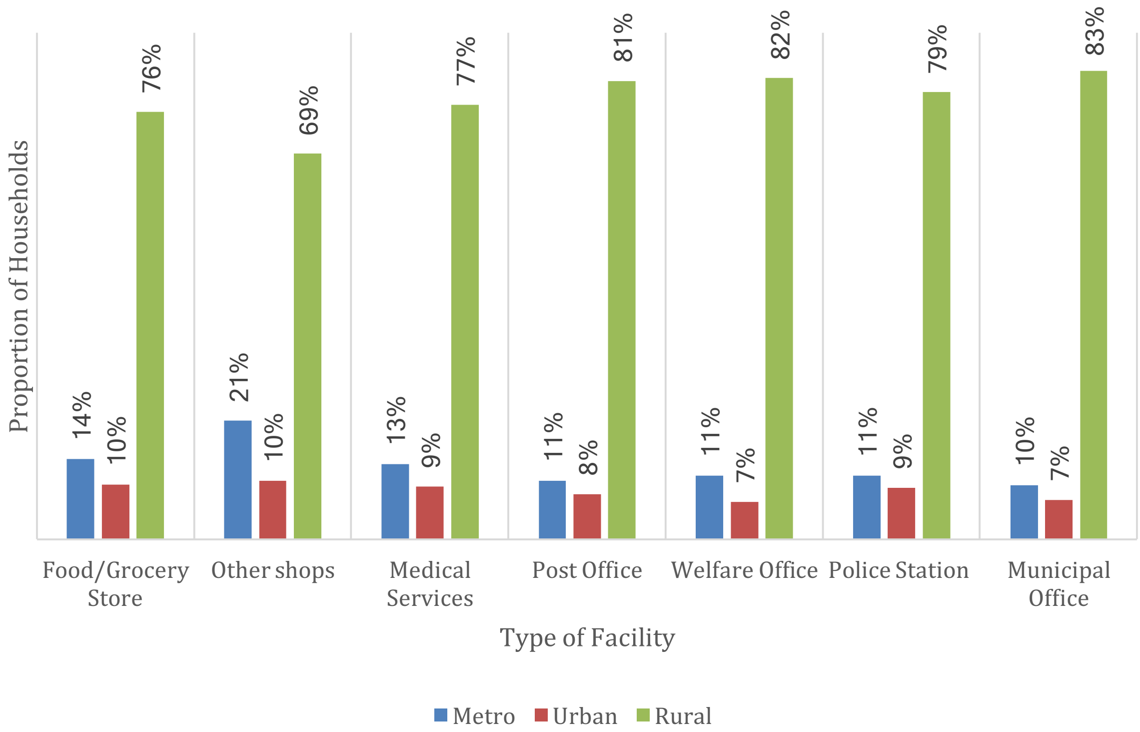


**Figure 2.4. Percentage of households who travel for more than 60 minutes to selected services according to settlement type (Statistics South Africa, 2014).**

#### *2.3.2.1 Educational transport*

The anticipated walking distance necessary for the locals to reach them generally determines the location of primary and secondary schools. Tables 2.9 and 2.10 show the acceptable walking distance, according to source, for primary and secondary schools respectively.

Of the pupils who walk to school, 81% take 30 minutes or less to reach the school (Department of Basic Education, 2011). This shows that on average, students have good access to schools. However, 19% of rural students take more than 30 minutes to reach their schools (Department of Basic Education, 2011). Assuming an average walking speed of 5 km/h, a 30-minute journey would be 2.5 km long.

**Table 2.9. Acceptable walking distances to primary schools in South Africa.**

| Source | Population Threshold: | Acceptable Travel Distance and/or Time |
|---|---|---|
| (Green & Argue, 2012) Villages | 7 000 | 5 km |
| (Green & Argue, 2012) Remote villages | 1 000 | 10 km |
| (CSIR, 2000a) | 3 000 – 4 000 minimum | 1.5 km (20 minutes) |
| (Department of Education, 2003) | | 1 hour |

**Table 2.10. Acceptable walking distances to secondary schools in South Africa.**

| Source: | Population Threshold: | Acceptable Travel Distance and/or Time |
|---|---|---|
| (Green & Argue, 2012) Villages | 12 500 | 5 km |
| (Green & Argue, 2012) Remote villages | 2 500 | 10 km |
| (CSIR, 2000a) | 6 000-10 000 minimum | 2.25 km (30 minutes) |
| (Department of Education, 2003) | - | 1 hour |
| (Department of Basic Education, 2012) | - | 5km |

The Department of Basic Education (2012) defines feeder zone for schools to aid in the planning stages of new schools. The feeder zone for every school is required to have a radius of 5 km and the total walking distance to and from school should not exceed 10 km (Department of Basic Education, 2012). In the SAHRC's Charter of Children's Basic Education Rights (2013), it is given that, for the state to meet the obligation of addressing the access barrier resulting from excessive physical distance to schools, all learners who reside more than 5km away from the school and cannot afford motorised transport, be provided with free transport to and from the school.

Figure 2.5 shows the attendance distribution, per settlement type, of schools. It is evident from the chart that rural attendee numbers are highest amongst the three settlement types. This is because rural areas tend to have a higher proportion of school-going children in the population, compared to urban and metropolitan settlements (Statistics South Africa, 2014). This was evident in Limpopo, Mpumalanga, North West, KwaZulu-Natal and the Eastern Cape.

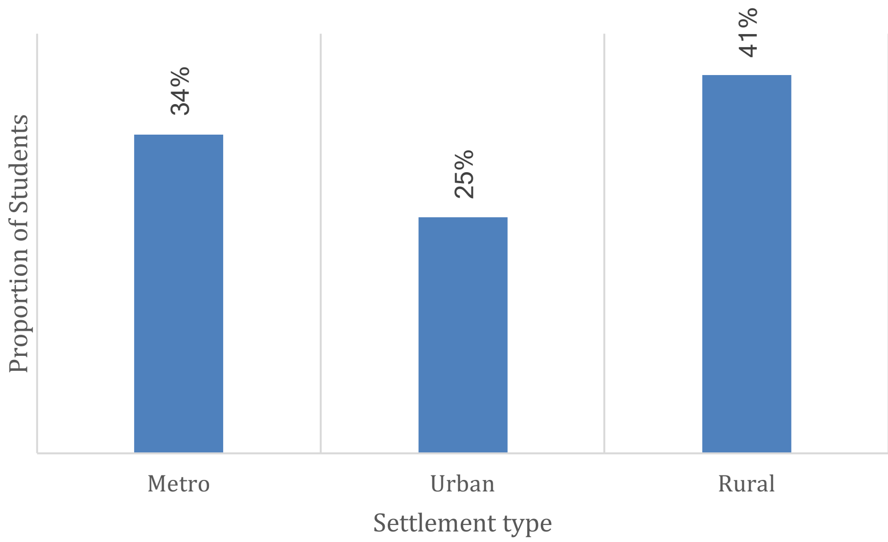


**Figure 2.5. Attendance distribution of basic education according to settlement type (Statistics South Africa, 2014).**

Figure 2.6 shows the distribution of mode of transport for educational travel. It was found in the survey performed by Statistics South Africa that the most widely used mode of transport for educational travels across all settlement types was walking followed by taxis in rural and urban settlements, whilst travelling as a car or truck passenger was the second most widely mode in metropolitan areas (Statistics South Africa, 2014). Of the individuals who used public transport, 69% used taxis, followed by buses at 28%, and the remaining few used trains (Statistics South Africa, 2014). The provinces in which most of the learners walk to school, are KwaZulu-Natal, Limpopo and Eastern Cape provinces.

Of the number of learners who walked all the way to their educational institute in rural areas, 8.1% were found to walk for more than an hour (Statistics South Africa, 2014). Learners who walked for more than an hour in metropolitan and urban areas, contributed 2.7% and 3%, respectively, to the total walking population.

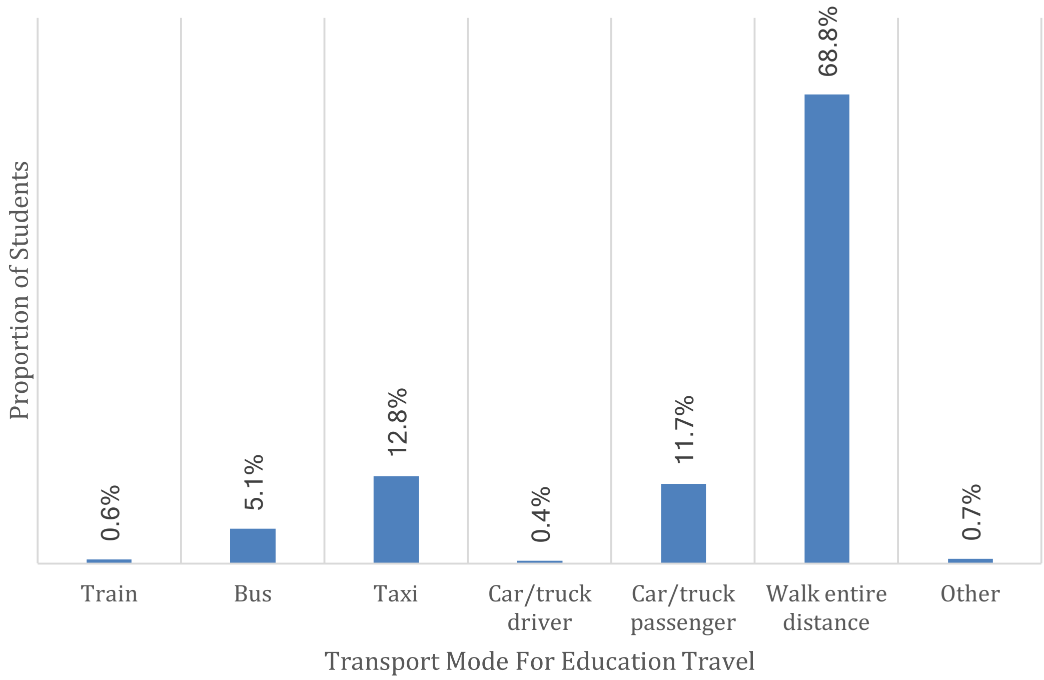


**Figure 2.6. Mode of transport for education travel for school-going learners (Statistics South Africa, 2014).**

#### *2.3.2.2 Health care transportation*

In a study by McLaren *et al*. (2013), sample data was obtained from the National Income Dynamics Study of 2012, which included information on income, expenditure, household composition, fertility, mortality, human capital formation, health and social capital. This information was used to study the effect of clinic locations (distances to household) on the equality of South Africans. Distances from the respondent's clinic of choice to the respondent's household were determined using geographic positioning system coordinates (McLaren, *et al.*, 2013). It was determined in the study, that on average urban households are located less than 2km away from the nearest clinic while the average distance to the nearest clinic for African rural households was determined to be 4km (McLaren, *et al.*, 2013). The average distance determined for rural households satisfies the recommendation set by the CSIR (2012) of 5km. It was further discovered that 10% of the rural households are located at a distance of more than 10 km from the nearest clinic (McLaren, *et al.*, 2013). Table 2.11 shows recommended travel distances.

**Table 2.11. Acceptable travel distance to clinics by source.**

| Source | Population Threshold | Acceptable Travel Distance and/or Time |
|---|---|---|
| (Green & Argue, 2012) Villages | 5 000 – 7 000 | 90% of population served within 5 km |
| (Green & Argue, 2012) Remote villages | 5 000 – 7 000 | 90% of population served within 5 km |
| (CSIR, 2000a) | > 5 000 | • 2 km max distance<br>• 5 minutes max to public transport stop<br>• 30 minutes maximum travel time |

Very little information was obtained from the National Household Travel Survey of 2013 regarding health care journeys. There is a lack of literature describing the travel times and travel costs associated with traveling to health care facilities. Figure 2.7 shows trip proportions to various types of destinations.

As can be seen from Figure 2.7, medical constituted only 3% of the total trips in the seven days before the survey. Of rural households, 77.2% reported taking longer than 60 minutes to travel for medical services. The majority of trips in Figure 2.7 were undertaken for shopping purposes, for both personal and business reasons.

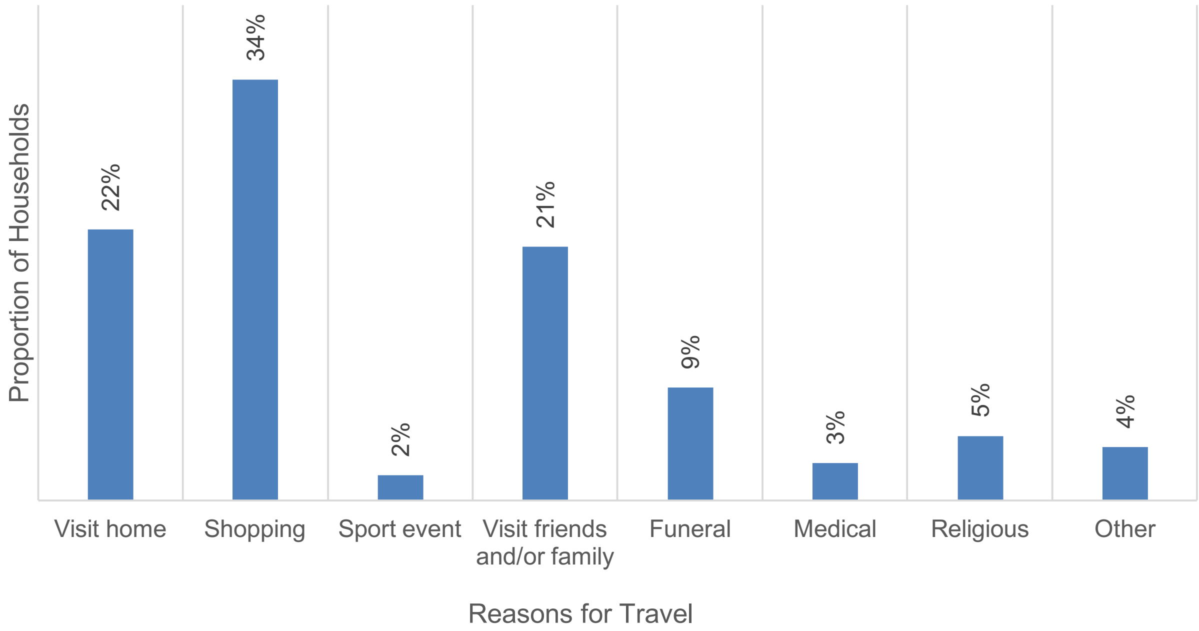


**Figure 2.7. Percentage of households by destination who travelled in the 7 days before survey (Statistics South Africa, 2014).**

#### *2.3.2.3 General transport perceptions*

Respondents in the National Household Travel Survey were asked to give their perceptions of transport related problems. The results for problems related to bus and taxi journeys are presented in Figures 2.8 and 2.9. Only these two were considered, as they are the most likely modes of motorised transport to be found in rural South Africa.

From Figure 2.8, the biggest problem associated with taxi journeys for households in South Africa is that they are perceived to be too expensive. This perception is shared by 10.2% of all households. Reckless driving is the second biggest problem associated with taxis, with 7.4% of all households sharing that perception.

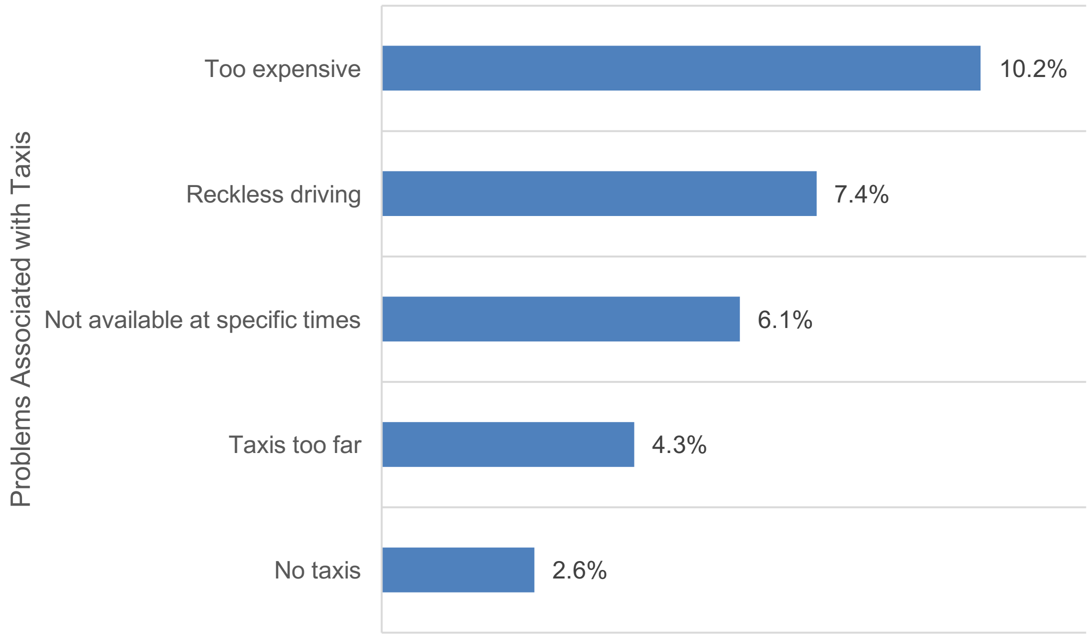


**Figure 2.8. Transport problems associated with taxi travel for South African households (Statistics South Africa, 2014).**

From Figure 2.9, bus availability is by far the biggest problem associated with bus transportation for South African households (10.5%). The expense of buses is perceived to be much lower than that of taxis, with only 1.6% reporting the bus fare as expensive compared to 10.2% for taxis. Bus drivers are also perceived to be less reckless than taxi drivers.

Figure 2.10 shows the most important attributes when selecting a mode of transport. From Figure 2.10 we can see that travel time is the perceived as the most influential factor in deciding which transport mode to use (32.6% consensus amongst households). Travel cost is ranked second at 26.1%. The third most important attribute is flexibility at 9.2%. It is worth noting that the travel cost and travel time are the most important transport attribute for 58.7% of households in South Africa.

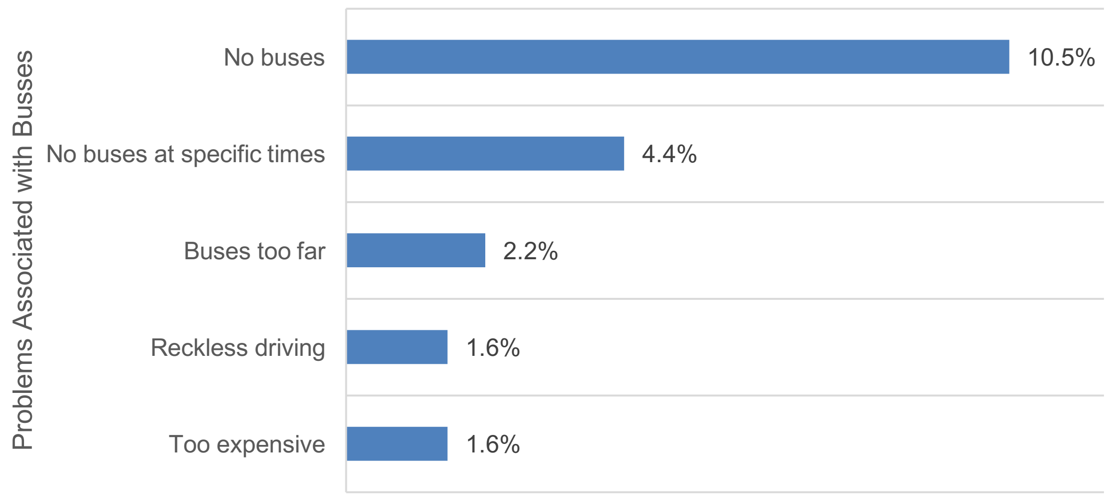


**Figure 2.9. Transport problems associated with bus travel for South African households (Statistics South Africa, 2014).**

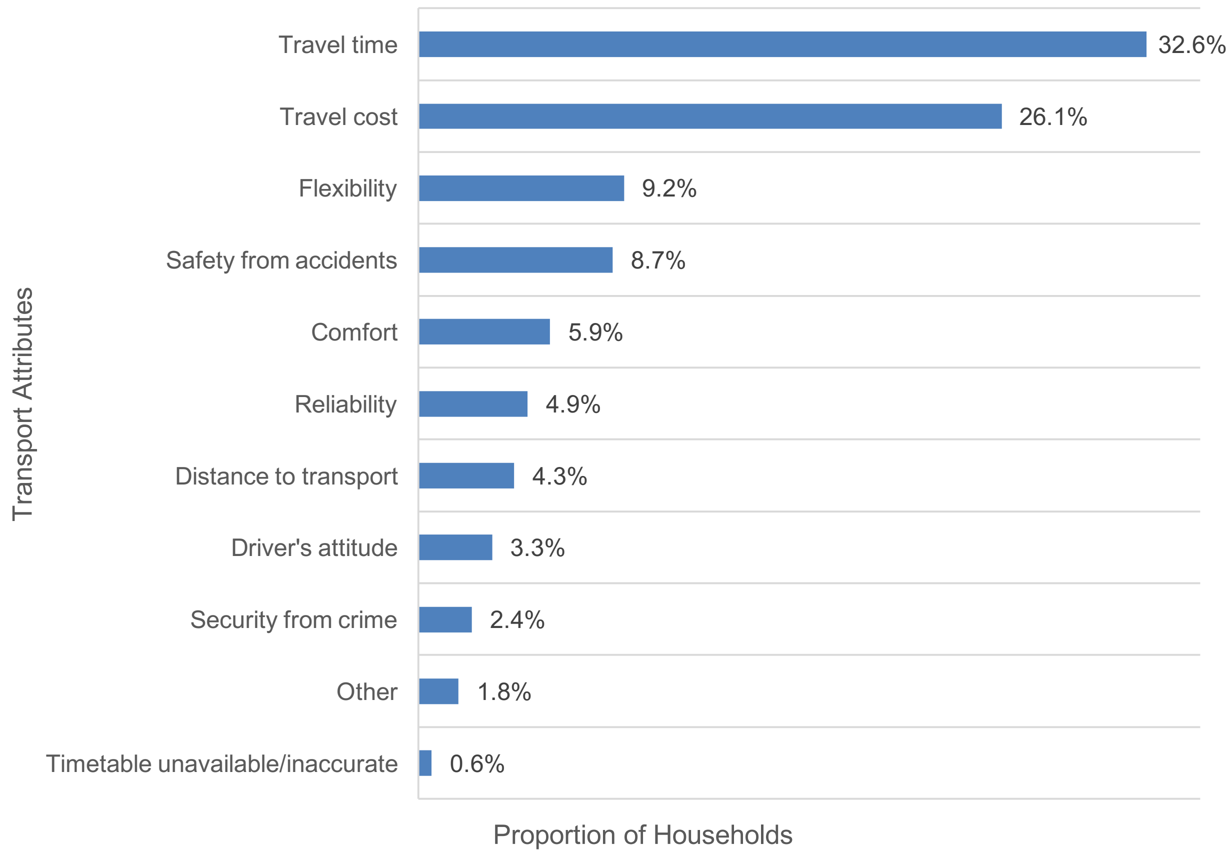


**Figure 2.10. Attributes influencing a household's choice of mode of transport in South Africa (Statistics South Africa, 2014).**

## 2.4 Current Ranking Methods

Ranking is the process of compiling a priority list of potential projects (Committee of State Road Authorities, 1995). Ranking is vital when agencies find themselves with a limited budget and cannot advance the full list of projects they intend doing. It has been found that ranking projects can provide an agency with 20 to 40% more benefit than if they were using simple subjective project selection methods (Zimmerman, 1995). Various methods of ranking exist, and the most widely used methods of deciding the order of priority of road maintenance projects will be discussed in this chapter.

### 2.4.1 Condition Ranking

This is a non-economic method based on the road's condition (e.g. VCI). Generally, the current condition level is used to rank projects by this method, although it can be refined by developing pavement performance prediction models or remaining life estimates (Zimmerman, 1995). Condition ranking can lead to a worst-first approach unless other factors are considered. This method does not take into account the importance of a road link. It can therefore lead to the least used roads being maintained or rehabilitated ahead of more economically or socially important routes.

### 2.4.2 Life-Cycle Cost Analysis Ranking

Life-Cycle Cost Analysis (LCCA) is an assessment tool of Life-Cycle Analysis (LCA) used to assess the economic viability of an investment option. It typically involves evaluating the cost (in monetary terms) of various investment alternatives over a certain time period. LCCA, like any other tool of LCA, requires that the analyst clearly identifies the activities throughout the phases of a pavement's life-cycle for all alternatives. The pavement's life-cycle usually comprises of the materials, construction, use, maintenance and end-of-life phases. The activities associated with each phase can be evaluated, with the costs of completing them, throughout the analysis period. The costs are then converted into net present value (NPV) or net present cost (NPC) by using the economic technique of ‘discounting’ (Federal Highway Administration, 2015). Using these present values, NPV or NPC, alternatives can be compared and then ranked according to which is most cost effective.

Other tools of LCA, are the Environmental Life-Cycle Assessment (E-LCA) and the Social Life-Cycle Assessment (SLCA). E-LCA is an assessment tool used to analyse and quantify environmental impacts of a product, system or process throughout its life-cycle phases (Federal Highway Administration, 2015). The impact categories analysed by an E-LCA include, amongst others, the following (Enironmental Protection Agency, 2000):

- Global warming
- Stratospheric ozone depletion
- Acidification
- Human health
- Ecological health

The importance of each category is determined by its assigned weighing factor. Jenkins and Rudman (2016) found that the weight aggregation of the impact categories Global Warming Potential (GWP) and Ozone Depletion, using methods from the United States of America and Europe, make up at least 20% of the total value. The same impact categories make up only 12% as proposed for South Africa (Brent, 2004). Although the proposed values from Brent (2004) are yet to be formally accepted by the South African government into a LCA method, it does illustrate a difference in importance. Problems facing E-LCA in South Africa, and low volume roads in particular, include:

- No current LCA framework exists in the South African context and priorities within South Africa are expected to be different from those of first-world countries with developed LCA frameworks (Jenkins & Rudman, 2016). Unlike developed countries, South Africa is still trying to alleviate poverty and its priorities could very well lean more toward socio-economic factors.
- Developing countries contribute relatively small amounts of $CO_2$ emissions. In 2013, South Africa contributed only 1.3% of the world $CO_2$ emissions

compared with 14.5% and 28.6% for the USA and China respectively (The World Bank, 2016).

- Potential fuel consumption benefits in the use phase, from a newly rehabilitated low volume road take much longer to materialise and a break-even on the production of materials and construction phase may never occur (Wang, *et al.*, 2012).

SLCA is a social impact (and potential impact) assessment tool of LCA that is developed to assess the social and socio-economic aspects of products/processes and their impacts along their life-cycle (UNEP, 2009). The aspects assessed by SLCA, are those that directly (depending on the scope) affect the stakeholders positively or negatively during the life cycle of a product (UNEP, 2009). These aspects may be linked to the behaviour of enterprises, socio-economic processes or effects on social capital (UNEP, 2009). Jenkins and Rudman (2016) identify socio-economic aspects as being a greater challenge than environmental aspects to integrate into a LCA method because of the prevalence of uncertainties.

There are many stakeholders involved in work pertaining to pavement engineering. This includes individuals involved in the materials phase who extract the raw materials and those involved in production lines such as for cement and bitumen. In the construction phase, it involves the construction workers and those who work with the machinery and product supplies. In the use phase, the stakeholders could be those directly using the road and those affected indirectly by those using the road. The end-of-life and maintenance phase can include stakeholders similar to those in the materials, construction and use phases. It can be an extensive exercise to estimate all those benefits and such an exercise cannot be justified for low-volume unpaved rural roads.  A study review on using social benefits to rank investments is discussed in Chapter 2.4.3.

Methods of LCCA will be discussed in more detail because these are the most widely used in South Africa. Their applicability to low-volume unpaved rural roads will be assessed.

#### *2.4.2.1 Methods of Life-Cycle Cost Analysis*

The most extensively used method of LCCA, when benefits between alternatives differ, is the Cost-Benefit Appraisal (CBA) (Federal Highway Administration , 2015). This method considers the costs and benefits either directly or, indirectly linked to the project in monetary terms. It is used as a tool for comparing different project alternatives.  The costs and benefits in this method also need to be discounted to allow comparisons to be made. The types of benefit measured are generally based on savings when the road has been improved, and these include (Committee of State Road Authorities, 1995):

- Travelling time
- Vehicle operating cost
- Accident costs
- User comfort cost

The commonly used benefit type is the estimated saving to users in vehicle operating costs (Committee of State Road Authorities, 1995).

The Highway Development and Management Model (HDM) developed by the World Bank is the most commonly used software to execute cost-benefit appraisals of roads (Lombard & Coetzer, 2006). Its characteristics as listed by Lombard and Coetzer (2006) are:

- An economic evaluation of roads with a traffic flow of 200 vehicles per day or greater.
- Detailed input data with respect to the road network, vehicle fleet, traffic components and work standards.
- Benefits estimated in terms of user savings of vehicle operating costs, travel time and accident costs.

Because roads have a relatively long life-span, depending on the class of the road, costs and benefits are estimated until the road’s estimated terminal point (AASHTO, 2010). The costs thus include not only the construction costs, but also rehabilitation, upgrades and routine maintenance costs. The user benefits will vary depending on the road's condition. User benefits will decrease as the road's condition decreases (AASHTO, 2010). This trend is attributed to the adverse effects of a road in poor condition such as the increase in vehicle operating costs, accidents, travel time and decrease in comfort.

This type of appraisal is not suitable for low-volume rural roads as most of them serve less than 200 vehicles per day. This makes it unlikely that the savings in vehicle operating costs will ever give a good return to the costs of implementing the project. It also does not allow for ranking of projects based on non-economic benefits, which arise from an increase in accessibility and mobility. It is limited due to its lack of consideration of sensitivity to economic inequality, distributional impacts on vulnerable groups and inter-generational impacts (Weisbrod, 2011). This makes Cost-Benefit Appraisals (CBA) biased towards urban projects as it ignores market access and connectivity benefits to rural areas (Weisbrod, 2011).

The consumer surplus and/or produce surplus can be included as benefits when analysing rural roads. Robinson and Thagesen (2004) have suggested that the CBA can further be enhanced for minor rural roads by including the following:

- Better assessment of the costs of interrupted access or conversely, benefits from improved trafficability
- Estimating the operating costs of NMT (non-motorised transport)
- Savings due to mode changes (NMT to MT)
- Improved valuation of time savings, including those of pedestrians
- Valuation of social benefits resulting from access to schools and health centres

##### 2.4.2.1.1 Consumer surplus

CBA can be used in minor rural roads through the willingness-to-pay approach. Economists have demonstrated that people express how much well-being they derive from something by demonstrating a willingness to pay (AASHTO, 2010). The difference between what users would have been willing to pay and what they are actually asked to pay is captured by the consumer as surplus well-being, and is called consumer surplus. There is, however, only a consumer surplus if cost savings are passed on to consumers through fares and freight charges, otherwise the vehicle operators retains the surplus as increased profit (Robinson & Thagesen, 2004). This method is appropriate for traffic above 50-100vpd. The consumer surplus may work for motorised transport, where costs are tangible. It will, however, not be practical for non-motorised transport. This is especially critical for rural commuters, as most commutes are expected to be undertaken by non-motorised transport modes.

#### 2.4.2.1.2 Producer surplus

Benefits attributed to producer surplus are calculated directly based on the increase in farm-gate prices received by producers of agricultural goods (Robinson & Thagesen, 2004). This benefit is equal to the product of the reduction in unit price of the produce and the volume of production. There have been several difficulties identified with the application of this method by Bovill (1978). Robinson and Thagesen (2004) state firstly that the net increase in agricultural production is unlikely because of the road investment alone. Other variables such as irrigation or fertilisers may have an impact on the increase. Secondly, double counting can be a problem. A reduction in transport costs for normal traffic can be associated with the reduction in product prices or increase in agricultural output. Thirdly, other benefits apart from agricultural benefits may be present in the community such as school attendance, medical services and market sales. This approach is generally not recommended (Robinson & Thagesen, 2004).

### 2.4.3 Social Benefits Ranking – Study Review

One such social ranking method in terms of social benefit is the Van de Walle Method. The objective of the method is to provide a ranking amongst projects by defining a selection formula that identifies areas stricken with poverty and inaccessibility, but which possess a high economic potential. It is assumed that each road link has a set of encompassing communities (EC) and that benefits are confined to those specific communities. The latter assumption is not necessarily true but it has the advantage that data at community level is easily collectable. Equality within a specific EC is assumed the same throughout the different households. The benefit to a typical user of a proposed link is estimated from data on the existing infrastructure, human development, economic potential of the region and other factors that are deemed influential to the marginal gains from the road investment. The total benefit arising from the EC would then be the total population of the EC multiplied by the individual benefit and thus the cost-benefit ratio of the EC can be calculated. To address equity concerns, a social weight is applied to each EC, which reflects how poor the residents are on average. This then creates a social weighted benefit-cost ratio.

$$Social\ welfare = SW = \sum S_i B_i N_i \qquad \text{(Equation 2.1)}$$

where

$S_i$ = social equity value attached to a typical user of the i-th link

$B_i$ = efficiency gain per person for the i-th link

$N_i$ = the number of people living in EC relevant to the i-th link.

The aim is to maximise SW within the cost constraint *C.* All potential road links should first be ranked by the benefit-cost ratio:

$$BC\ Ratio = \frac{S_i B_i N_i}{C_i} \qquad \text{(Equation 2.2)}$$

A minimum rate of return can also be stipulated and thus form another constraint that must be satisfied.

Equation 2.3 gives the social equity.

$$S_i = \sum_k v_k Y_{ik} \qquad \text{(Equation 2.3)}$$

Where $Y_{ik}$ is the *k*-th measurable variable with relevance to road link *i* describing the socio-economic conditions in the relevant EC. $v_k$ is the weight attached to the $k_{th}$ variable deemed relevant to the overall social weight, where $\sum v_k = 1$. The ideal variables included in this equation are based on the poverty data collected and can also include welfare indicators.

Similarly

$$B_i = \sum_j w_j X_{ij} \qquad \text{(Equation 2.3)}$$

where $X_{ij}$ is *j*-th measurable variable of an average benefit relevant to EC of the *i*-th road link. $w_j$ is the weight attached to the *j*-th variable deemed relevant to the overall social weight, where $\sum w_j = 1$. Examples of variables may include road density data, local human resource development (e.g percentage of children completing primary school), development projects in the area, accessibility to social service facilities, accessibility to other forms of transport, agricultural development potential, current road conditions, linkages with the existing road network (Van de Walle, 2002). Weights for both the social and beneficial variables need to be determined by a multidisciplinary group of government and non-government experts (Van de Walle, 2002).

The benefits of this method include:

- The method identifies specific roads for improvement. This is because marginal gains are estimated at encompassing all communities along the length of the road. The method is applicable to road authorities.
- The social equity value takes into account poverty stricken communities. This is good for countries with high inequalities.

The disadvantages of the method include the following:

- A multidisciplinary group of government officials determines weights for both social and beneficial variables. The lack of public participation at this stage means that communities are not able to choose what is more important to them.
- All benefits, including social, need to be expressed in monetary terms.
- There are no standardised steps and benefits can change geographically. This would imply that the government group employed to determine the

beneficial variables would need to assess many communities independently, which can be time consuming.

### 2.4.4 Accessibility Ranking – Study Review

One of the most appropriate social ranking methods in terms of social benefit ranking is the method proposed by Sarkar and Dash (2011). The concepts highlighted here are also used as underlying principles in the development of the proposed method of using accessibility measures for ranking and are therefore discussed in detail.

The most significant advancement in this method was the development of a new modified quantification technique. This technique quantifies accessibility by using population, travel time, travel cost and quality of service, as measurable parameters (Sarkar & Dash, 2011). The parameters measured were for three different sectors, namely; primary education, primary healthcare and drinking water. The resulting index is referred to as the accessibility index and is presented in Equation 2.4.

The following equations are applicable to the method:

$$AI_m = (w_1)FT + (w_2)FCT + (w_3)\sum_{i=1}^{n}\{(w_3)FQS_i\}$$ (Equation 2.4)

$$WI_m = (W_m)AI_m$$ (Equation 2.5)

$$PI_m = (FP)WI_m$$ (Equation 2.6)

where

$AI_m$ = Accessibility Index for sector m

$WI_m$ = Sector-Weighted Accessibility Index for sector m

$PI_m$ = Priority Index of a village for sector m

$W_m$ = Relative weight assigned to a particular sector m

FP = Score based on the number of people using the sector

FT = Score based on the average travel time to facility or service

FCT = Score based on the cost of transportation to a service

$FQS_i$ = Score based on the quality sub-factors. Sector can have more than one sub-factor for quality
$w_1$ = Relative weight assigned to travel time considering all other factors in the sector
$w_2$ = Relative weight assigned to cost of transportation considering all other factors in the sector
$w_3$ = Relative weight assigned to quality of service considering all other factors in a sector
$w_{3i}$ = weights assigned to sub-factors of quality of service, so as to have $\sum_{i=1}^{n} w_{3i} = 1$
n = Total number of sub-factors used in defining quality of service.

The scores for FP, FT, FCT and the sub parameters of FQS are all given scores on a scale between 0 and 4. The use of the scale is subjective in that some parameters can be scored from 0 to 4, others 1 to 4 and in the example of the sub parameter of availability of doctor and medicine, can be scored either 0, 2 or 4 (Sarkar & Dash, 2011).

Weights on the parameters are used to determine the importance of each parameter. These weights were obtained from the villagers by asking them to rate each parameter in a scale between 1 (low importance) and 4 (high importance) (Sarkar & Dash, 2011). Multiplying the weights by their relevant parameter score gives Equation 2.4.

Villagers were also asked to rate the three sectors. This rating was on a scale of 1 to 5 (Sarkar & Dash, 2011). Multiplying the different sector indices by the weight, gives Equation 2.5.

The number of people using each sector is taken into account in Equation 2.6. This essentially prioritises a sector according to how many persons will benefit from its improvement (Sarkar & Dash, 2011).

The Accessibility Index in this method aids in the comparison of villages with respect to the different sectors. The Weighted-Sector Accessibility Index assists in the comparison between accessibility levels of different sectors within a village and amongst villages. The Priority Index helps prioritise the sector, as a sector with a larger populace of users will receive a higher priority.

The approach defined by Sarkar and Dash (2011) has the following benefits:

- The inclusion of villagers in determining the importance of each sector helps in prioritising the sectors that the villagers actually want the most.
- The number of sectors and parameters that can be included in the model has no limit.
- The approach does not make use of any specialised apparatus or specialised training.

The approach however has the following shortcomings:

- The condition of the roads receives no consideration and the sectors therefore cannot be ranked on a technical basis that is helpful to a road authority.
- Having respondents assign scores results in very subjective results. The reason for this is that there is no consistency as different people assign scores using their own terms of reference for measuring severity.
- The resulting values from Equations 2.4, 2.5 and 2.6 are used to rank sectors but do not give any indication of the potential benefits that may arise from improving a specific sector.

## 2.5 Conclusions

The literature review presented in this chapter introduced the concept of accessibility and its components in the context of road development. Public facilities identified by the National Development Plan are key to reducing poverty and inequality and were identified and discussed here. The discussion of the facilities focused on the quality of their attributes, requirements with respect to locality and transportation trends. Infrastructure requirements were also discussed. Methods of assessing the condition of roads were presented and discussed, according to the shortfalls with regard to rural unpaved roads and, specifically, in the South African context. These methods included economic, functional (condition) and social methods. The last section of this chapter presented different ranking methods. Four proposed methods which can be used for ranking were discussed. The methods discussed were as follows:

- Condition Ranking
- Life-Cycle Cost Analysis
- Van de Walle (2002) method
- Sarkar & Dash (2011) method

The methodology proposed in this research considers the condition ranking, Van de Walle (2002) and Sarkar & Dash (2011) methods. This is done by:

- Considering the present condition of the road and the condition the road will be in once improved, as in condition ranking.
- Weights on variables are determined through participation by villagers in filling questionnaires as, was done by Sarkar & Dash (2011).
- Different sectors are investigated. These include, healthcare and educational facilities, as was done by Sarkar & Dash (2011).
- Benefits for communities are determined from the improvement of the road links under investigation, as was proposed by Van de Walle (2002).

# 3 Methodology

## 3.1 Introduction

There is a need for the development of a model that can successfully rank road infrastructure investments, from the perspective of increasing accessibility to the basic public facilities necessary to provide equitable opportunities for the communities in need of them. Such a model must avoid point ratings. The proposed model is one that incorporates the three core elements of accessibility as described by Hajj and Pendakur (2000). These core elements are:

- Infrastructure
- Travel modes
- Location and quality of facilities

With respect to the travel modes, and location and quality of facilities, it is only the perception of the facility users that can assess the accessibility level of a facility to that community. This is done by using stated preference surveys to build models that are used to determine which of certain possible properties of a facility or transport mode are preferred. The surveys involved asking participants whether they would use a particular facility or transport mode given different attributes of the facility or transport mode. A model is then built from the responses received in the survey by using a binary logit regression. The regression analysis also takes into account the socio-economic conditions of the households (gathered during the survey). The stated preference survey is required to be conducted at a location with similar characteristics to the subject communities. Once the model has been built, information is collected int the subject communities through another door-to-door survey. Information is also gathered from the facilities that are subject to the investigation. This information is then input into the model and a preference probability of using a facility, or a particular mode of transport to reach the subject facility is than obtained. This value is than taken as the accessibility index of the community to the transport mode and to quality service at the facility.

Current conditions of the subject road links are measured using a commercial handheld GPS unit. It is argued in Section 3.5.2 that a correlation exists between travel speed and road surface condition. The road widths of the links are also measured to assess conformity with recommended class widths. The current speed of travel is compared with the minimum travel speed that a road of similar class is supposed to provide. The conformity of the road to class standards is taken as the percentage of the road length that conforms to the standards. This value is used as a factor in the overall calculation of the accessibility index of the community to facility.

To obtain a weighted and priced accessibility index, the following is done:

- The number of people who use the facility is estimated from the door-to-door survey. This is also done for the different modes of transport.
- The investment made by government in education and healthcare is estimated per capita.
- The number of persons accessing a facility by means of a particular mode of transport and the corresponding per capita investment, is than multiplied by the accessibility indices of the community to the mode of transport to the facility and to the quality of service at the facility.
- The resulting values are obtained in monetary terms, and represent the amount of investment not used efficiently by the government.

Equation 3.1 shows the proposed model below.

$$AI_{ij}(k) = AI_{TR,j} \times AI_{Q,k} \times Q_{L_{i,j}} \qquad \text{(Equation 3.1)}$$

Where

$AI_{ij}(k)$ =Accessibility index of subject community to a facility k using road link *i* and transport mode *j*

$AI_{TR,j}$ = Accessibility index of community to travel mode *j*

$AI_{Q,k}$ = Accessibility index of community to quality service at facility *k*

$Q_{L_{i,j}}$ = Quality of link *i* using travel mode *j*

It is proposed to use probabilities for $AI_{TR,j}$ and $AI_{Q,k}$ values. This is done to avoid the need for ratings, which are subjective. As an illustration of the subjectivity of ratings, consider the following example:

If a quality of service is to be rated it could be rated as follows (though this is also subjective): Very Poor, Poor, Fine, Good and Very Good. One can choose very poor to be 0 or 1 or even 10. The units between the levels of quality of service can be 1, 2 or any other number. The subjectivity is in that it is very easy for the next person to consider something very different from the previous scale. Another concern of subjectivity comes with how 'fine' or any other description, is defined and measured.

That being said, the model proposed in this research is a product of the probability of using a particular travel mode and the probability of using a facility. The two probabilities are obtained from using models built from the stated preference (SP) experiments. The probabilities represent a percentage preference of a user to a particular facility or transport mode. A 100% preference, given certain attributes of the facility or transport, means that the user is perfectly satisfied with the transport mode or quality of service at the facility. This implies a satisfactory level of accessibility to an adequate transport mode and to a perfect quality of service at a facility. The product between the preference probability of a particular transport mode and a facility is then factored by the quality of the infrastructure. The quality of the infrastructure is the percentage of the length of the road that conforms to class standards. The infrastructure itself is seen as a link between the user, the facility and the chosen travel mode. Such a link can impede the accessibility of the community to the transport mode and to quality service if the road infrastructure is in bad condition or non-existent (where upon, it would be zero).

$$AI_{TR,j} = P(j) \quad \text{(Equation 3.1a)}$$

$$AI_{Q,k} = P(k) \quad \text{(Equation 3.1b)}$$

where

$P(j)$ = Probability of using travel mode *j* given specific properties of the travel mode, such as travel time and costs.

$P(k) =$ Probability of using facility $k$ given specific conditions of the facility such as time spent waiting and availability of doctors in the case of a public clinic.

This model was inspired by that used by Sarkar & Dash (2011). In their model, accessibility is quantified by using three factors namely travel time, travel cost and quality of service (Sarkar & Dash, 2011). The travel time and cost, in the instance of the proposed model, is incorporated into the probability of using a travel mode. Once characteristics of a facility or a transport mode become unattractive (expensive, long travel times, long waiting times, etc.) the probability of preference for the facility or transport mode decreases. If a person is still subjected to the necessity of using the facility or transport mode, this then translates to a low accessibility level. Therefore, this probability is assumed to be linearly related to accessibility.

The *quality of infrastructure* (or level of service) factor was incorporated because it is assumed in this method that impaired infrastructure impedes accessibility. Although two communities might have the same accessibility index to a travel mode and quality of service at a facility, the community with the poorest infrastructure has an adversely ‘factored’ level of accessibility compared to the community with the better infrastructure, although their facilities and transport modes are identical.

The method was verified using two villages in Limpopo. The villages are located in the Makhado Municipal Region. The chart shown in Figure 3.1. illustrates the steps necessary to obtain the terms illustrated in Equation 3.1 for each of the subject villages. The methodology can be divided into two main subdivisions, namely model development and data capturing. This is discussed in more detail below.

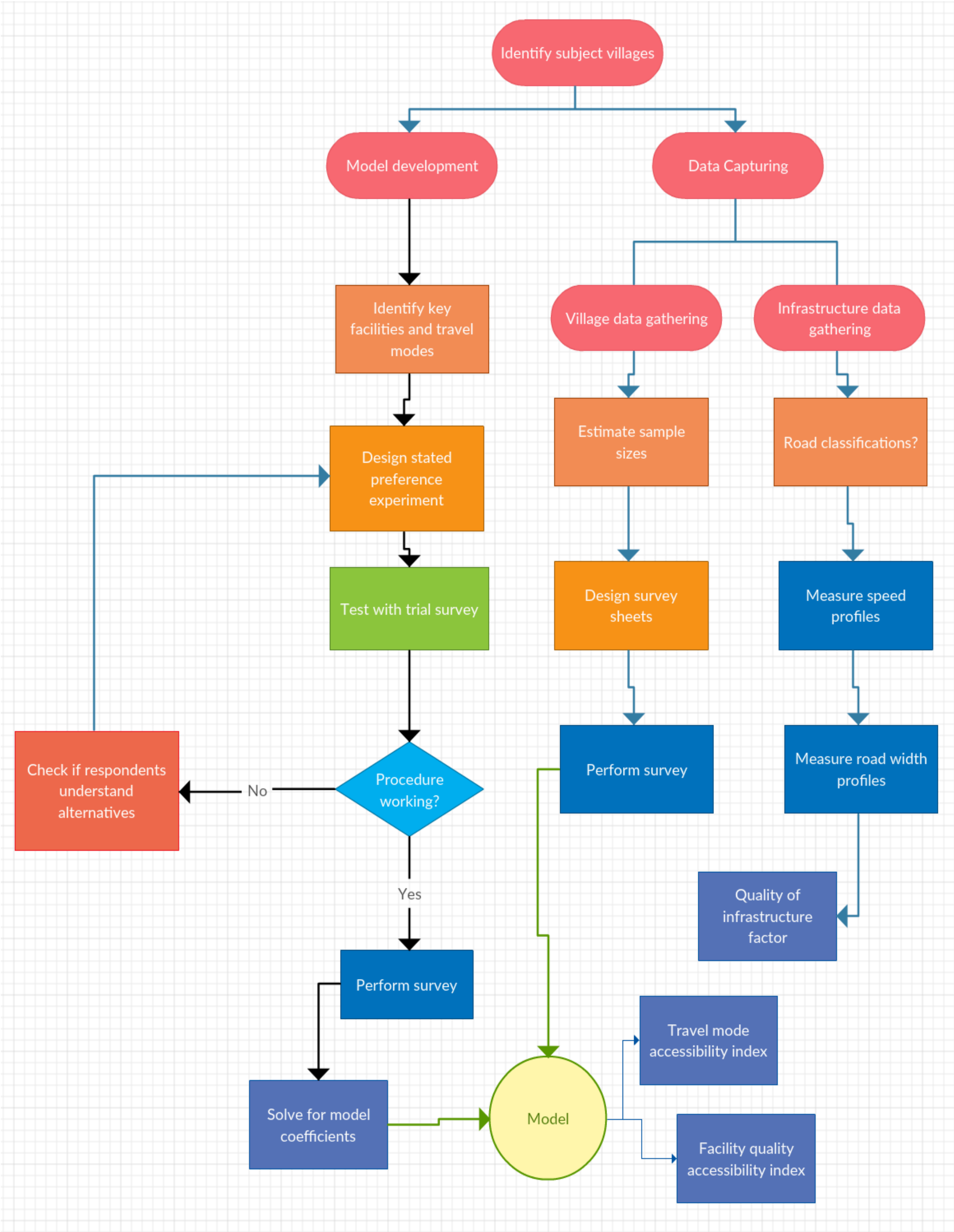


**Figure 3.1. Flow diagram to obtain the proposed accessibility indices for transport mode and facility.**

## 3.2 Village Identification

The criteria used for village selection are the following:

- Location and proximity of facilities
- Population
- Distance to market

The selection criteria are explained individually in the following sub-sections. The method itself is independent of the *identification of a subject village* step but is shown in the following sub-sections, as this was the proces followed during the build and validation of the method.

### 3.2.1 Location

The area of VhaVenda in Limpopo was selected simply because of the numerous rural villages present there and the background knowledge of the area obtained from the initial interviews. At least two villages are required for comparison. A shortlist of villages was compiled, using Google Maps. Table 3.1 shows a list of villages which were identified as suitable to be used for the collection of data.

**Table 3.1. Shortlist of subject villages.**

| Number | Village |
|---|---|
| 1 | Mangwele |
| 2 | Sane |
| 3 | Tshitwi |
| 4 | Khakhu |
| 5 | Ha-Lambani |
| 6 | Tshikalani |
| 7 | Mutale-Masisi |

It was finally decided, after a site visit, that the first three villages in Table 3.1, namely **Mangwele, Sane and Tshitwi** would be the subject villages. These villages lie along the gravel main road and this would allow a comparison of how road length and populations affect the model. In the end, Tshitwi was eliminated as a subject village because of time constraints.

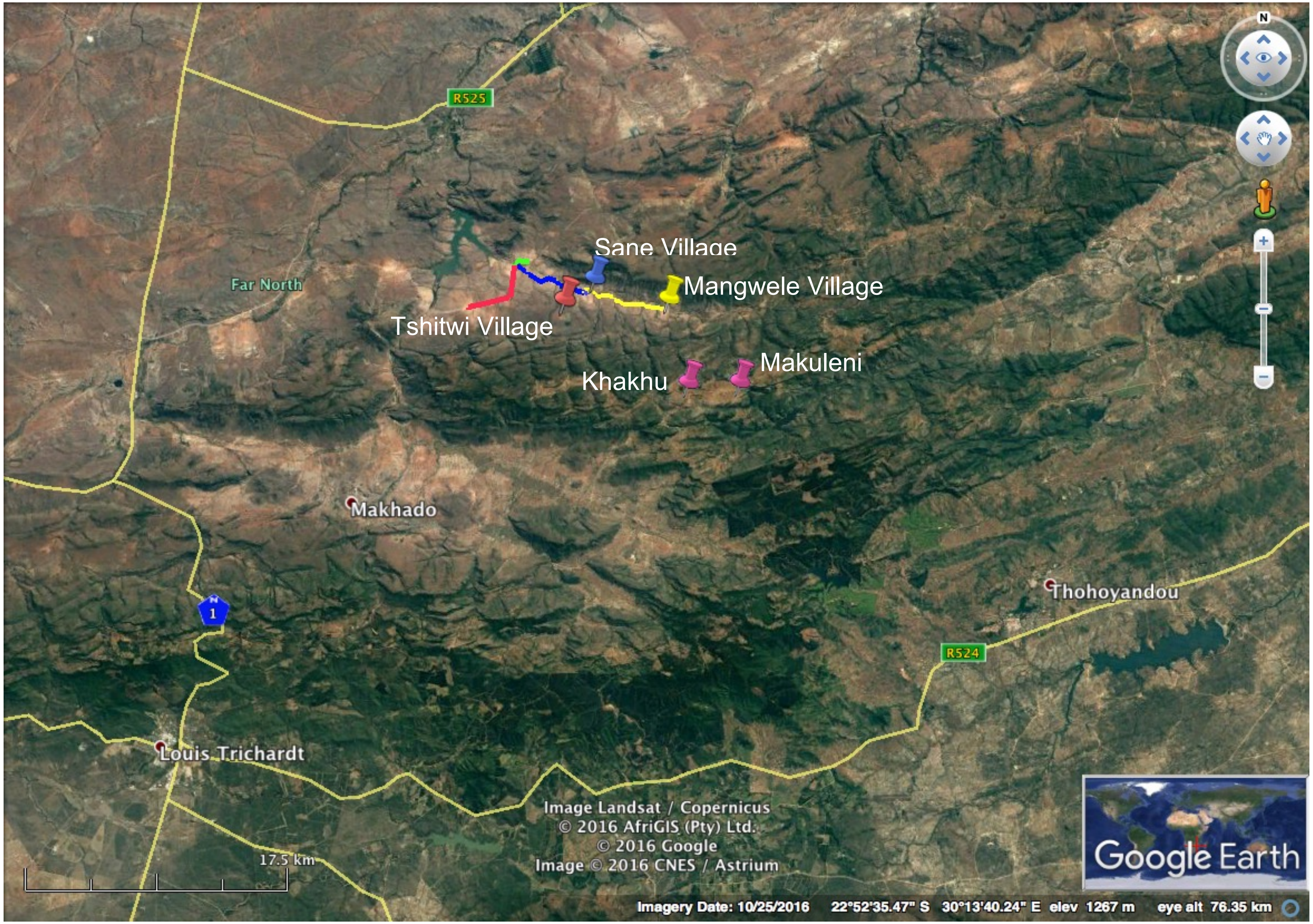


**Figure 3.2. Subject villages and road links.**

**Table 3.2. Legend for Figure 3.2.**

| Road Link Segment Colour Code | | | Description | Length |
|---|---|---|---|---|
| Segment 1 | Segment 2 | Segment 3 | | |
| | None | None | Mangwele (East) to Sane (West) and Sane Combined School | 6 km |
| | | | Mangwele (East) to Ramabulana Secondary School and Straight Hardt Clinic (West) | 12.5 km |
| | | | Mangwele (East) to Tshianane Secondary School (West) | 16.3 km |
| | | None | Sane (East) to Ramabulana Secondary School and Straight Hardt Clinic (West) | 6.4 km |
| | | None | Sane (East) to Tshianane Secondary School (South West) | 10.3 km |

Figure 3.2 shows the location of the villages relative to each other. The road links connecting the villages are also shown in different colours in Figure 3.2. Table 3.2 gives the descriptions and length of the road links shown in Figure 3.2.

Whilst performing the stated preference (SP) survey during the initial site visit, it became evident that another village apart from Mangwele, Sane, and Tshitwi was necessary to construct the model. The reasons for this were as follows:

- Participants were willing to accept any quality of school or SP alternatives because the biggest concern in the subject villages was distance.
- Because these villages have a small number of households, the same houses would inevitably be asked to participate in both surveys. Thus, the values of variables in the data collection survey would be very similar to the values used to build the model (therefore, the answer would already be known).

A third village was selected that would be used to perform the SP experiment for the model development subdivision in Figure 3.1. Such a village was required to:

- Be close to the subject villages to ensure similar living conditions.

- Have facilities in close proximity. This will make respondents more critical of the quality of the facilities.

The selected village for SP experiments was Makuleni in Khakhu, which is 7.4km from Mangwele. This is shown in Figure 3.3.

Two criteria were used to distinguish what constitutes a village. These criteria are the population of the area and the distance they are from the nearest market. Both are discussed in the forthcoming chapter.


**Figure 3.3. Location of Makuleni relative to Mangwele.**

### 3.2.2 Population

Population boundaries were taken from the Council for Scientific and Industrial Research's (CSIR, 2012) Guidelines for the Provision of Social Facilities in South African Settlements. These are shown in Table 3.3.

**Table 3.3. Population characteristics of villages and remote villages (CSIR, 2012).**

| No. | Type of Settlement | Population Size (number of people) |
|---|---|---|
| 1 | Village | 5000 – 25000 |
| 2 | Remote Villages | 500 – 5000 |

The population of Sane was estimated to be 447 in the 2011 census with an average household size of four (Statistics South Africa, 2011a). No information could be found for Mangwele on the Stats SA website. The populations in Table 3.4 were estimated by counting the number of households on Google Maps and using an average household size of 4 people.

**Table 3.4. Estimated population sizes of subject villages**

| Village | Households | Estimated Population |
|---|---|---|
| **Mangwele** | 73 | 292 |
| **Sane** | 167 | 668 |

Sane can be described as a remote village and Mangwele has a population less than that of a remote village.

### 3.2.3 Distance to Nearest Market Town

To identify 'remote areas', the distance to market areas will be used to distinguish the extent of remoteness. This methodology was used by Starkey (2007) and comprised five degrees of remoteness, as shown in Table 3.5.

**Table 3.5. Degree of remoteness of high and low density villages Starkey (2007).**

| Degree of Remoteness | Distance to Nearest Market Town | |
|---|---|---|
| | High Density Village | Low Density Village |
| 1 | 0 – 10 km | 0 – 20 km |
| 2 | 10 – 20 km | 20 – 40 km |
| 3 | 20 – 30 km | 40 – 60 km |
| 4 | 30 – 40 km | 60 – 80 km |
| 5 | 40 – 50 km | 80 – 100 km |

Table 3.6 shows the distances of the subject villages to Dzanani, which is the nearest market town.

**Table 3.6. Degree of remoteness of subject villages.**

| Description | Length | Degree of remoteness |
|---|---|---|
| Mangwele to Makhado/Dzanani | 35.3 km | 2 |
| Sane to Makhado/Dzanani | 29.3 km | 2 |

## 3.3 Model development

### 3.3.1 The Basic Model

A binary logit model was used to estimate the preferences of users to utilise a particular transport mode and a particular facility.

The model has the following form

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \epsilon_i \quad \text{(Equation 3.2)}$$

where

$y_i$ = utility of *i*th facility (can be either 1 or 0)

$\beta_0$ = Intercept of utility model

$\beta_k$ = Coefficient of *k*th attribute

$x_k$ = *k*th attribute variable

Since the model is binary, 1 and 0 are used to describe "using the facility" and "not using the facility" respectively.

The probability that event E occurs is given by Equation 3.3.

$$P(E) = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_k x_k)}} \qquad \text{(Equation 3.3)}$$

To determine the coefficients in Equations 3.2 and Equation 3.3 above, a logit regression was carried out on StatPlus together with Microsoft Excel. The variables depend on the type of facility and transport mode and will be discussed later.

### 3.3.2 Identifying Key Facilities and Transport Modes

It was decided that the National Development Plan would form the basis for the selection of key facilities against which to measure accessibility. Three public facilities were identified from the NDP's fourteen priority list:

1. Educational facilities – identified in the priority of "Quality basic education"
2. Health care facilities – Identified in the priority "A long and healthy life for all"
3. Police service facilities – Identified in the priority "Safety for all"

Only the first two types of facility were selected in the case study performed using the proposed model. The reason for this, was that trips to police stations were expected to be relatively scarce compared to those for educational and medical services. Information on the proportion of the population that uses police stations could not be obtained. It is expected that there would be a division between police stations and tribal authorities as upholders of the law, and this is something that should be considered for future research.

### 3.3.3 Designing the Stated Preference Experiments

A stated-preference (SP) experiment was used to estimate the probability of an individual or household using a facility or particular transport mode. In an SP experiment, individuals are asked about what they would choose to do given several hypothetical alternatives with varying attributes (Ortuzar & Willumsen, 1994). Their choices being limited, in this case, to “utilise” or to “not utilise”. The attributes concerning facilities, will be the selected quality variables (e.g. class size, waiting times, etc.). For the transport modes, the attributes will be the mode’s characteristics (e.g. travel time, cost, etc.). Each attribute will have varying levels, which ideally should include levels that can be described as ranging from good to bad.

It should be noted that the choice model built from the SP data will not necessarily be observable but is what the participants would prefer as an ideal situation and thus provides a basis for acceptability. In designing the experiment, the attributes (a) and the number of levels each attribute can take (n) are used to determine the factorial design ($n^a$) of the experiment. The number of hypothetical alternatives participants will have to respond to is dependent on the factorial design.

In these experiments, respondents react to a different number of observations at a time and, because of this, successful models have been built with as few as 30 respondents (Kocur, *et al.*, 1982). The factorial design of these experiments makes an experiment susceptible to having too many hypothetical alternatives or options for participants to respond to. Tables given by Kocur, *et al.*, (1982) can be used to limit the number of options to mitigate the problem.

When conducting the experiments at Makuleni, it was discovered that people responded better to alternatives when there were only two attributes, i.e. a binary selection. This makes it easier for them to judge the attractiveness of the alternatives, especially if the attributes are in strong contrast. Thus, it was decided to redesign the survey with only two attributes for each alternative. The number of levels does not add to any confusion on site but it does add to the length of the survey, as it will increase the number of hypothetical alternatives required.

#### *3.3.3.1 Attributes and levels*

##### 3.3.3.1.1 Education

Table 3.7 shows the reported quality issues related to schools. Stats SA reported these figures in the General Household Survey of 2015. Only three of the problems in this list are measurable. These are the lack of books, unaffordable fees and large classes. Only the class size and lack of books were investigated in this research. The total number of school days in South Africa was 199 days in 2016, 197 in 2017 and 199 in 2018 (http://www.gov.za/about-sa/school-calendar)

**Table 3.7. Reported school related problems from The General Household Survey of 2015 by Stats SA.**

| Problem Experienced | Percentage of Total Learners in Limpopo | Rank |
| --- | --- | --- |
| Lack of books | 2.5% | 2 |
| Unaffordable Fees | 2.7% | 1 |
| Large classes | 1.1% | 5/6 |
| Bad facilities | 1.2% | 4 |
| Lack of teachers | 1.1% | 5/6 |
| Poor teaching | 1.0% | 7 |
| Teacher absenteeism | 0.8% | 8 |
| Teacher strikes | 1.6% | 3 |

Each attribute was taken to three levels. The attributes and levels are summarised in Table 3.8.

**Table 3.8. Selected attributes and levels for the education quality SP experiment.**

| Attribute | Levels | Standard |
|---|---|---|
| Class size | 30 | 40 maximum |
| | 45 | |
| | 60 | |
| Textbook availability | All text books | 100% |
| | Most text books (67%) | |
| | Some textbooks (33%) | |

This design has two attributes with three levels each. This then gives a factorial design of $3^2 = 9$ options. The options or alternatives are shown below in Table 3.9.

**Table 3.9. Hypothetical alternatives for the education quality stated preference experiment.**

| Option | Number of learners in class (CLASS) | Subjects with textbooks (TXTBKS) | Attend? (yes or no) |
|---|---|---|---|
| 1 | 30 | All subjects | |
| 2 | 60 | Some subjects | |
| 3 | 30 | Some subjects | |
| 4 | 45 | Most subjects | |
| 5 | 45 | Some subjects | |
| 6 | 60 | Most subjects | |
| 7 | 45 | All Subjects | |
| 8 | 60 | All subjects | |
| 9 | 30 | Most subjects | |

The options shown in Table 3.9 will be the same as those that were used in the survey conducted on site to build the SP model. The actual designs used on-site are shown in Appendix A1.

#### 3.3.3.1.2 Health care

Three attributes were initially chosen for the health care SP experiment design. Two attributes were taken from the Department of Health's (2011) six-priority list from Chapter 2.2. These attributes are waiting times and availability of medicines. The third attribute chosen is the frequency of doctor visit. Because of the two-attribute-limit that was self-imposed after the initial site visit for SP survey, availability of medicines was removed as an attribute. The remaining attributes were taken to two and three levels, as shown in Table 3.10.

**Table 3.10. Selected attributes and levels for the health care quality SP experiment.**

| Attribute | Levels | Standard |
|---|---|---|
| Waiting times | More than 2 hours | 2 hours maximum[1] |
| | Less than 2 hours | |
| Doctor visitation | Once a month | Once a week[2] |
| | Once a week | |
| | Twice a week | |

[1] Operation Phakisa (2011)

[2] Couper (2002)

The choices of attributes and levels led to a factorial design of $3^1$ X $2^1$ = 6 options, as shown in Table 3.11. The actual designs used on-site are shown in Appendix A2.

**Table 3.11. Hypothetical alternatives for the health care quality stated preference experiment.**

| Option | Doctor Visitation (DOC) | Waiting Time (WAITt) |
|---|---|---|
| 1 | Once a month | Less than 2 hours |
| 2 | Twice a week | More than 2 hours |
| 3 | Once a week | More than 2 hours |
| 4 | Twice a week | Less than 2 hours |
| 5 | Once a month | More than 2 hours |
| 6 | Once a week | Less than 2 hours |

###### 3.3.3.1.3 Travel modes

An SP experiment for modes of travel will make it possible to determine whether a particular transport mode has the preferred characteristics for journeys to a health care or educational facility.

To establish which attributes to use, factors influencing a household’s choice of mode of travel were identified. These were found in the National Household Travel Survey of 2013 and are shown in the Figure 3.4.

The expected types of travel modes were taxis, buses, private cars and walking. After the initial survey, it was discovered that vehicle ownership was minimal. Households with vehicles seem to use the vehicle as their only mode of transport. This could have been a consequence of unattractive transport alternatives.

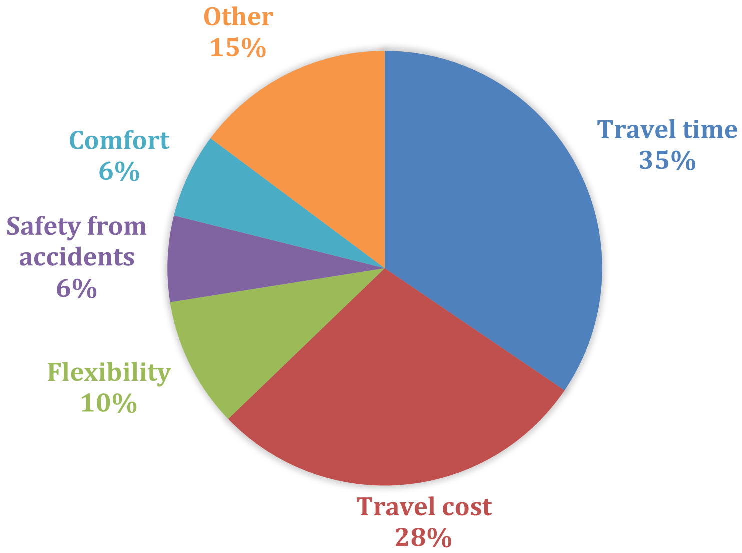


**Figure 3.4. Factors influencing travel mode choice in the Limpopo province (Statistics South Africa, 2014).**

It was then decided to remove private transportation from the model. This left two travel modes, namely public transport and walking for non-motorised transport. The chosen attributes were walking time and public transport cost, as shown in Table 3.12. This was done to limit the number of attributes to two. It was decided that it would be logical to have a separate SP experiment to assess preferences between public transport cost and travel time. This, however, was not done in this research. The attributes and levels are shown in Table 3.12.

**Table 3.12. Selected Attributes and levels for transport mode stated preference experiment.**

| Attribute | Levels |
|---|---|
| **Walking time** | 30 minutes |
| | 1 hour |
| | 2 hours |
| **Public transport cost** | R5 |
| | R10 |
| | R15 |

The choices of attributes and levels led to a factorial design of $3^2 = 9$ alternatives, as shown in Table 3.13.

**Table 3.13. Hypothetical alternatives for the transport mode stated preference experiment.**

| Option | Walking time (WAITt) | Transport cost (PTCST) |
|---|---|---|
| 1 | 30 minutes | R5 |
| 2 | 2 hours | R10 |
| 3 | 30 minutes | R10 |
| 4 | 1 hour | R15 |
| 5 | 1 hour | R10 |
| 6 | 2 hours | R15 |
| 7 | 1 hour | R5 |
| 8 | 2 hours | R5 |
| 9 | 30 minutes | R15 |

The experiment design is presented Appendices A3 and A4. Respondents were asked to select their choice of transport mode to the clinic, given the above attributes and levels. The same was done for travel to school. Thus, it was important to place the travel in the context of its purpose, to assess whether it were worth the cost or it the participants were willing to walk in that context.

### 3.3.4 Sample Size Estimation

Makuleni in Khakhu was identified as the village where the SP experiment would be performed, after a failed attempt in Mangwele, as explained in Chapter 3.2.1. The sample size for all the experiments was chosen to be 30. This was done because, in these experiments, respondents react to various situations. Successful models have been built with as few as 30 respondents (Kocur, *et al.*, 1982).

### 3.3.5 Performing the Surveys

The SP experiments were performed in two pairs. The first pair included:

- Educational quality SP experiment
- Transport mode to educational facility SP experiment

The second pair included:

- Health care quality SP experiment
- Transport mode to educational facility SP experiment

Both pairs of surveys also included other variables that were believed to influence the participant's preference. The educational quality and transport to educational facility SP experiments required the following information to be gathered from the participants of the SP experiments:

a) The number of students in the household (STU HH)
b) The gender of each student in the household
c) The grade or age (if grade unknown) of each student in the household
d) Whether each student attends primary or secondary school. This, together with items b) and c) gives the following:
    i. Number of household females in secondary school (SEC FEM)
    ii. Number of household females in primary school (PRI FEM)
    iii. Number of household males in secondary school (SEC MAL)
    iv. Number of household males in primary school (PRI MAL)
e) Household income per month. The household incomes were placed in income groups as shown in Table 3.14 (INC GRP).

The health care quality SP and transport to health care facility SP experiments required the following information to be given:

a) The household size (HHS)
b) The household monthly income. The household incomes were also placed in income groups as shown in Table 3.14 (INC GRP).

These sheets are attached in Appendix A1 to Appendix A4.

Income information for households in Makuleni, Khakhu was periodically missing with eight household's income data missing from the 29 households surveyed. The population distribution according to the income categories from Stats SA is shown in Table 3.14 for Khakhu. Looking at Table 3.14, the average household income is Category 2. Furthermore, any missing income data was consequently assumed to be Category 2 income.

**Table 3.14. Income categories (Statistics South Africa, 2014) and population proportions according to the income categories for Khakhu.**

| Income category | Lower boundary | Upper boundary | Proportion of Population |
|---|---|---|---|
| 0 | R- | | 10.0% |
| 1 | R1.00 | R800.00 | 7.5% |
| 2 | R801.00 | R1 633.33 | 52.5% |
| 3 | R1 633.42 | R3 183.33 | 25.0% |
| 4 | R3 183.42 | R6 366.67 | 0.0% |
| 5 | R6 366.75 | R12 816.67 | 5.0% |
| 6 | R12 816.75 | R25 633.33 | 0.0% |
| 7 | R25 633.42 | | 0.0% |

### 3.3.6 Analysis

The data from the SP experiments were then copied into an Excel spreadsheet and were analysed using StatPlus. The objectives of the analysis were to determine the values of the coefficients and to determine the significance of each variable. Four models were developed for each SP experiment in the manner listed below:

- Model 1 – Preference regarding quality of educational facilities
- Model 2 – Preference regarding quality of health care facilities
- Model 3 – Preference regarding mode of transport to educational facilities
- Model 4 – Preference regarding mode of transport to health care facilities

Table 3.15 shows a list of variables that were assumed significant for each model. Calculating and evaluating the P-value for each variable made it possible to identify which of the variables was significant. The criterion for significance is a P-value less than 0.05.

**Table 3.15. Assumed variables for SP experiment models.**

| **Variables ($x_k$)** | | | |
|---|---|---|---|
| **Model 1 – Educational Facilities** | **Model 2 – Health Care Facilities** | **Model 3 – Education Transport Mode** | **Model 4 – Health care Transport Mode** |
| STU HH | HHS | STU HH | HH |
| SEC FEM | INC GRP | SEC FEM | INC GRP |
| PRI FEM | DOC | PRI FEM | WT |
| PRI MAL | WAITt | PRI MAL | PTCST |
| SEC MAL | | SEC MAL | |
| INC GRP | | INC GRP | |
| CLASS | | WT | |
| TXTBKS | | PTCST | |

## 3.4 Village Data Collection

Collection of village data is part of the data capturing division shown on Figure 3.1 on page 54. The collected data was intended to be used in the equations derived from the SP experiments. The type of data to be collected included all the significant variables in the SP experiments. The data was collected at the villages of Mangwele and Sane. Data on school characteristics was gathered at the individual schools.

### 3.4.1 Sampling

Because it was unrealistically time-consuming and expensive to capture data from all households, samples were determined which would represent the villages. The sample sizes were determined using the equation for calculating sample sizes for population proportions as described by the United Nations: Department of Economics and Social Affairs. The equation is based on the equation for calculating sample sizes for population proportions (Cochran, 1963). The equations are as follows:

$$n_o = \frac{Z_{\propto/2}{}^2 (r)(1-r)(f)(k)}{\varepsilon^2 (p)(\tilde{n})} \qquad \text{(United Nations: Statistical Division, 2008)}$$

$$n = \frac{n_o}{1+\left({n_o - 1}/{N}\right)} \qquad \text{(Cochran, 1963)}$$

where

$n_o = initial\ approximation$

$n = final\ approximation\ of\ sample\ size$

$Z_{\propto/2} = critical\ value\ of\ normal\ distribution$

$\varepsilon = margin\ of\ error$

$N = population\ size$

$r = is\ an\ estimator\ of\ the\ key\ indicator\ in\ the\ survey$

$f = sample\ design\ effect\ factor, deff$

$k = factor\ to\ account\ for\ non-response$

$\tilde{n} = average\ household\ size$

$p = proportion\ of\ total\ population\ on\ which\ r\ is\ based$

Assumptions:

The United Nations: Statistical Division recommends the following:

- A value of 1.2 for the sample design effect factor *f*.
- A value of 1.1 for the non-response factor *k*. This was changed to 1 after it was realized that there were no non-responses in SP experiments.
- A 95% level of confidence (LOC), therefore giving a Z statistic value of 1.96
- A margin of error of 10% of r.
- The average household size in Makhado Municipality of South Africa, from census 2011, was reported to be 3.7 (Statistics South Africa, 2011b).
- The value for the product r (1 – r) will be taken as 0.5. This gives a conservative result (Cochran, 1963).

- The proportion of the population between the ages of 5 and 19 was estimated to be 34.2% (Statistics South Africa, 2011b). This will be used for p.

The number of households in each village was estimated using Google Maps and the sample sizes were estimated as shown in Table 3.16. for a 95% and 90% level of confidence.

**Table 3.16. Sample sizes for different levels of confidence.**

| Village (*v*) | Households (*HHv*) | n (95% LOC) | n (90% LOC) |
|---|---|---|---|
| Mangwele | 73 | 41.0 | 34.0 |
| Sane | 167 | 59.0 | 47.0 |

### 3.4.2 Conducting the Survey

When conducting the survey at Mangwele, there were numerous houses where no persons were present, which made it problematic to obtain enough samples (only 33 households were surveyed). This problem, however, did not occur at Sane.

The initial intention was to have a randomly picked sample from each village. The households were numbered on a map and a random sample was generated using Excel. This proved to be impractical on site as one would have had to visit a household much further away from the previous one and then have to return somewhere close to the initial one. The problem of having no one present in some houses also enlarged the problem of using a random sample. The survey was conducted by going from door to door per street.

#### *3.4.2.1 Variables for data collection*

Below is a list of the variables collected at each household.

- Household size (*HHS*)
- Grade of each student
- Name of school of each student (*l*)

- Mode of transport (*j*)for each student (walk or public transport) with cost for public transport (PTCST) and travel time for walking (WT)
- Gender of each student. This, together with the school grade information gives the following variables:
  - Number of secondary females (SEC FEM)
  - Number of primary females (PRI FEM)
  - Number of secondary males (SEC MAL)
  - Number of primary males (PRI MAL)

- Household income per month (INC GRP). Income group obtained from using Table 3.14 on page 69
- Clinic which each household visits (*k*)
- Mode of transport to clinic (walk or public transport) (*j*)
- Travel cost for public transport to clinic (PTCST)
- Travel time for walking to clinic (WT)
- Waiting time at clinic before attendance (WAITt)
- Frequency of doctor visitation (DOC). This was not included in the survey paper but was asked on numerous occasions

Below is a list of the variables collected at schools

- Grades offered
- Number of students
- Number of classes in each grade or overall (CLASS)
- An estimate of the number of textbooks made available to students (e.g. 90% of all students have the required textbooks) (TXTBKS)

The survey design is shown in Appendix B.

Some households did not declare their monthly income; this was than estimated using the average income of Sane available at the Stats SA website. Mangwele could not be found in the Stats SA website and it was decided to use the same average monthly income as listed for Sane. This was done because the villages are and very similar. The average was found to be in the same income category as that of Khakhu.

### 3.4.3 Analysis

The analysis of the data involved substituting the variables in the SP models with the variables obtained from the data collection survey. This was done as discussed in Chapter 3.3.1. using Equation 3.3 to determine the probability of an individual household using a particular facility or travel mode. Ideally, the probability of using a facility or travel mode should decrease as the conditions become unattractive (expensive, far to walk, long waiting times, etc.) and increase when they become attractive.

#### *3.4.3.1 Education facilities analysis*

The probability of a household making use of a particular school and transport mode to reach it was estimated for each school. This probability depends on the significant variables identified in the logit regression, as shown in Equations 3.5 and 3.6.

$$P(j)_{h,l} = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_k x_k)}} \qquad \text{(Equation 3.5)}$$

$$P(l)_h = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_k x_k)}} \qquad \text{(Equation 3.6)}$$

where

*P(j)* = Probability of household *h* using transport mode *j* to go to school *l*

*P(l)* = Probability of household *h* using school *l*

These probabilities were then aggregated according to the schools, using the number of households making use of the school as shown in Equation 3.7.

$$P(j)_{v,l} = \sum_{h=0}^{n} \left(P(j)_{l,v,h}\right) / HH(j)_{l,v} \qquad \text{(Equation 3.7)}$$

where

$P(j)_{v,l}$ = Probability of average household from village *v* using transport *j* to travel to school *l*

$P(j)_{v,l,h}$ = Probability of household *h* from village *v* using transport mode *j* to travel to school *l*

$HH(j)_{l,v}$ = Number of households from village *v* using transport mode *j* to travel to school *l*

This probability was also aggregated according to the number households using that school as shown in the Equation 3.8.

$$P(l)_v = \sum_{h=0}^{n} \left(P(l)_{v,h}\right) / HH(l)_v \qquad \text{(Equation 3.8)}$$

where

$P(l)_v$ = The probability of an average household in village *v* using school *l*

$P(l)_{v,h}$ = The probability of household *h* from village *v* using school *l*

$HH(l)_v$ = The number of households in village *v* using school *l*

#### *3.4.3.2 Health care facility analysis*

For health care, the two villages were identified as using the same clinic facility. The probability of using the facility was estimated just as it was for educational facilities using Equations 3.9 and 3.10.

$$P(j)_{h,c} = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_k x_k)}} \qquad \text{(Equation 3.9)}$$

$$P(c)_h = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_k x_k)}} \qquad \text{(Equation 3.10)}$$

Where

$P(j)_{h,k}$ = Probability of household *h* using transport mode *j* to go to clinic *c*

$P(c)_h$ = Probability of household *h* using clinic *c.*

The probability of an average household using the facility and/or transport was calculated similarly to that of the educational facilities as shown in Equations 3.11 and 3.12.

$$P(j)_{v,c} = \sum_{h=0}^{n} \left(P(j)_{c,v,h}\right) / HH(j)_{l,v} \qquad \text{(Equation 3.11)}$$

Where

$P(j)_{v,c}$ = Probability of average household from village *v* using transport *j* to travel to clinic *c*

$P(j)_{v,c,h}$ = Probability of household *h* from village *v* using transport mode *j* to travel to clinic *c*

$HH(j)_{c,v}$ = Number of households from village *v* using transport mode *j* to travel to clinic *c*

This probability was also aggregated according to the number of households using that particular school as shown in the Equation 3.12.

$$P(c)_v = \sum_{h=0}^{n} \left(P(c)_{v,h}\right) / HH(c)_v \qquad \text{(Equation 3.12)}$$

Where

$P(c)_v$ = The probability of an average household in village *v* using clinic *c*

$P(c)_{v,h}$ = The probability of household *h* from village *v* using clinic *c*

## 3.5 Infrastructure Data Collection

The term $Q_L$ in Equation 3.1 on page 51 is dependent on the observed conditions of the road used by transport mode *j* to clinic *c* or school *l*. $Q_L$ is assumed to be a measure of the efficiency of the road link after assessment of the observed operating conditions to the specified capacity of the link, which depends on the road's class.

$Q_L$ in the proposed model is perceived as an efficiency factor between the transport mode and the facility. Given that both the mode of transport and the facility can have an accessibility measure, because walking time is always present and a facility can be operational, the overall accessibility measure must be zero if there is no link between the community and the facility. In addition, a perfect $Q_L$ must mean that the overall accessibility measure is the product of the accessibility measures of the facility and the transport mode.

The statement above therefore implies that:

- $Q_L$ cannot have a value lower than zero
- $Q_L$ cannot have a value greater than one

The quality of link, QL, for motorised vehicles is the lesser of Equations 3.13 and 3.14.

$$Q_{L,MT} = \sum_{s=0}^{n}\left(\left(V_{s,avg}/V_{s,cl}\right)\times L_S\right)/L_R \qquad \text{(Equation 3.13)}$$

$$Q_{L,MT} = \sum_{s=0}^{n}\left(\left(W_{s,avg}/W_{s,cl}\right)\times L_S\right)/L_R \qquad \text{(Equation 3.14)}$$

Where

$Q_{L,MT}$ = Quality of link using motorised transport mode

$V_{s,avg}$ = Average measured speed over road link segment *s*

$V_{s,cl}$ = Average classification speed of road link segment *s*

$L_S$ =Length of segment *s*

$L_R$ = Length of road link *R*

$W_{s,avg}$ = Measured cross-sectional width of road link segment *s*

$W_{s,cl}$ =Average classification width of road link segment *s*

Equation 3.15 gives the quality of link, QL, for non-motorised vehicles.

$$Q_{L,NMT} = \sum_{s=0}^{n}\left(\left(SW_{s,avg}/SW_{s,cl}\right)\times L_S\right)/L_R \qquad \text{(Equation 3.15)}$$

where

$Q_{L,NMT}$ = Quality of link using non-motorised transport modes

$SW_{s,avg}$ = Average measured shoulder width of road link segment *s*

$SW_{s,cl}$ = Average classification shoulder width of road link segment *s* for relevant transport mode.

$L_S$ =Length of segment *s*

$L_R$ = Length of road link *R*

The criteria for the method required for measuring $Q_L$ are that:

- The method has to be low cost
- The method should not require specialists or specialised machinery
- The method should be relatively quick to perform

### 3.5.1 Road Classification

The $Q_L$ value is required to give an indication of the condition of the link and the level of service provided by the link. To understand what is required of a road link, the specification performance of the road link must be clearly defined. This is done by defining the road classification of the particular link. Once the classification of the road link is known, the terms $SW_{s,cl}$, $W_{s,cl}$ and $V_{s,cl}$ can be defined.

The classification is done using TRH26 by COTO (2012). The summary of the classifications as given by COTO (2012) is given in Tables 3.17 and 3.18. The roads in the study have all been identified as R4 roads. This was done by considering the type of linkage provided by the road and the route numbering of the road. The road link from Intersection 1 to Mangwele was also identified as a R4 road. This is because the road link gives access to smaller rural settlements.

**Table 3.17. Descriptions of different road classes (COTO, 2012).**

| RCAM | Description | Linkage |
|---|---|---|
| R1 | Rural principal arterial | Carries traffic between metropolitan areas and large cities |
| R2 | Rural major arterial | Carries traffic between smaller cities and medium to large towns (population > 25000) |
| R3 | Rural minor arterial | Carries traffic between small towns, villages and larger rural settlements (population < 25000) |
| R4 | Rural collector road | Carries traffic to local destinations, smaller rural settlements, tourist areas, mines, game & nature parks |
| R5 | Rural local road | Carries traffic to private properties such as households within rural communities |
| R6 | Rural walkway | Typically, informal paths essential for pedestrians |

**Table 3.18. Typical length and AADT of different road classifications (COTO, 2012).**

| RCAM | Class | Typical length | Typical AADT |
|---|---|---|---|
| R1 | Class 1 | > 50 km | > 1000 vehicles |
| R2 | Class 2 | > 25 km | > 500 vehicles |
| R3 | Class 3 | 10 km < length < 100 km | 100 < AADT < 2000 vehicles |
| R4 | Class 4 | < 10 km | < 1000 vehicles |
| R5 | Class 5 | < 5 km | < 500 vehicles |

The road link between Tshianane and Ramabulana Secondary Schools was also identified as an R4 road. The nomenclature of the road was considered when classifying this road link. The road link (Road link 4 in Figure 3.5) extends further to the west and is for some distance officially named Road D3671. According to COTO (2012), Class 4 road numbers generally start with a 'D'. Table 3.19 gives the lengths and classification of the road links in Figure 3.5.

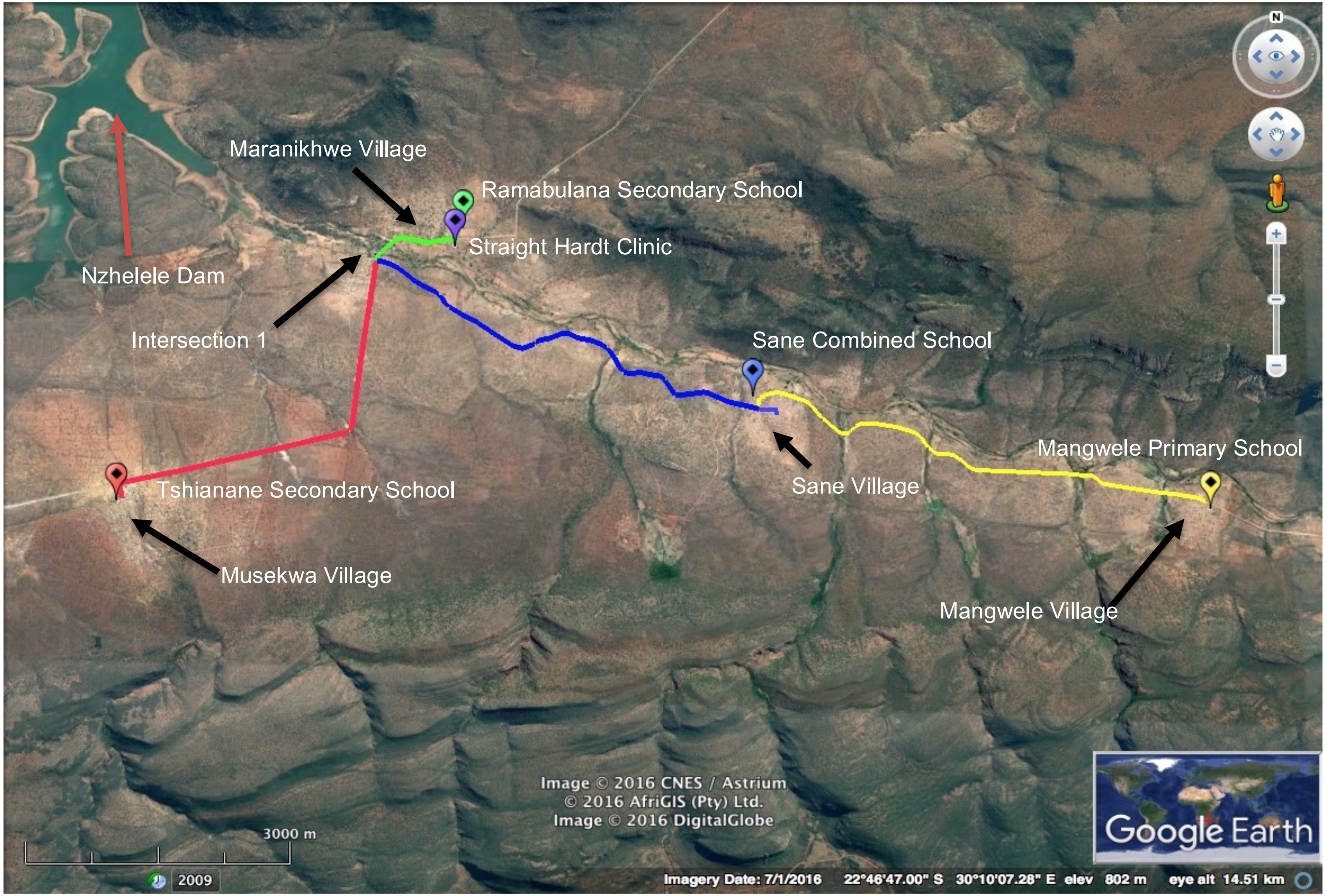


**Figure 3.5. Map showing road links to facilities and villages.**

**Table 3.19. Road links map legend.**

| Link | Description | Length | RCAM |
|---|---|---|---|
| 1 | Mangwele (East) to Sane (West) | 6 km | R4 |
| 2 | Sane (East) to intersection 1 (West) | 5.4 km | R4 |
| 3 | Intersection 1 (South) to Ramabulana Secondary school (North) | 1.14 km | R4 |
| 4 | Intersection 1 (North) to Tshianane (South) | 5.21 km | R4 |

### 3.5.2 Road Link Speed Profiling

Road roughness is a term used to quantify the relative user comfort on a road link (COTO, 2007). Roughness is seen as a holistic measure of several road conditions such as rutting, cracking, potholes and undulations (COTO, 2007). The international roughness index (IRI) is used to measure roughness. IRI is a component of the longitudinal profile on a road, which is experienced in the wheel path of the travelling vehicle (Archondo-Callao, 1999).

A direct relationship exists between speed and roughness (Sayers, *et al.*, 1986). This would imply that speed is also a measure of several road conditions just as roughness is. In the guideline from Sayers *et al.* (1986), four different classes of roughness measurement methods are described. Each measurement method varies in accuracy, expense and the required measurement instruments. Class 4 was selected as the method of choice for the proposed accessibility measure. The method is labelled as "*subjective ratings and uncalibrated measures*". A class 4 roughness measurement is achieved by either a ride experience or a visual inspection of the road (Sayers, *et al.*, 1986). Measurements from an uncalibrated instrument can also be used in this class. This class differs from the other classes as it does not require specialised personnel or measuring equipment but this also implies that there is a much greater margin of error. Table 3.20 shows the correlation between average speed and average IRI by road class as given Van Zyl (2016).

**Table 3.20. Passability classification, average road speeds and IRI for gravel roads (van Zyl, 2016).**

| Road class | Passability (impassable days/ year) | Mobility Average Speed (km/hr) | IRI Average (mm/m) |
|---|---|---|---|
| R1 | 2 | 80-100 | < 5 |
| R2 | 2 | 80-100 | 7.5 – 5 |
| R3 | 3.5 | 60-80 | 10 – 7.5 |
| R4 | 3.5 | 45-60 | 13 – 10 |
| R5 | 3.5 | < 35 | 15 – 13 |

Using Table 3.20, it was concluded that for all road links, the average classification speed be given as that of road class 4 which is a mobility speed of 45 km/h to 60 km/h.

#### *3.5.2.1 Measuring the speed profiles*

The method of ride experience was used to measure the change in speed along the longitudinal path of the roadway. The method was supplemented with a Garmin Nuvi 2597LMT handheld GPS receiver. The receiver was used to obtain a profile of speed along the distance travelled.

Garmin GPS receivers are accurate to within 15 m 95% of the time with a clear view of the sky (Garmin International, 2016). Generally, users receive signal at an accuracy of 5 – 10 metres under normal conditions (Garmin International, 2016). At the investigation locations from Mangwele to Tshianane Secondary School, the GPS could have had accuracy closer to 5 metres given the clear sky, which was present, and the absence of any obstruction in the sky as well.

The car used was a double cab 2014 4X2 Ford Ranger with an automatic gearbox. The vehicle started at Mangwele. driving in the direction of the schools. The car was driven to a maximum comfortable speed at all times. This measurement was carried out in three phases. The first phase consisted of driving from Mangwele to

Intersection 1. The second phase, from intersection 1 to Ramabulana Secondary School and Straight Hardt Clinic. The third phase consisted of driving from intersection 1 to Tshianane Secondary school. The vehicle was brought to a complete stop at the beginning and at the end of each driving phase.

The vehicle used had a coil-over-strut wishbone front suspension and a leaf rear suspension, which has been reported to give a compliant ride (Motoring, 2014). The type of rear suspension in the vehicle is known to allow for a more comfortable ride when laden (not to capacity). The test vehicle used in the research was unladen. The test vehicle also had wider aftermarket tyres that also could have affected the ride quality. The exercise was conducted with all this in knowledge.

The handheld receiver could not be set up to record the speeds at set intervals and recorded the speed at what seems to be random time intervals called legs. Table 3.21 shows leg summaries of the three phases recorded. Phase 1 consisted of measurements take from Mangwele to intersection 1 as shown in Figure 3.5. Phase 2 was measurements from Intersection 1 to the end of road link 3. Phase 3 was measurements from Intersection 1 to the end of road link 4.

**Table 3.21. Recorded leg characteristics from GPS Receiver for subject road links in phases.**

| Phase | Number of legs | Average Leg length (m) | Average Leg time interval (seconds) | Maximum Leg time interval (seconds) | Minimum Leg time interval (seconds) |
|---|---|---|---|---|---|
| Phase 1 | 257 | 44.11 | 6 | 16 | 1 |
| Phase 2 | 24 | 46.63 | 7 | 13 | 1 |
| Phase 3 | 43 | 116.37 | 9 | 16 | 1 |

Depending on the road class, the minimum mobility average speed should be achieved comfortably.

#### *3.5.2.2 Segmentation according to speed profiles*

To identify road sections that require maintenance and rehabilitation, road administrations use homogenous sections (Thomas, 2004). It is important to analyse the data from the speed profiles in order to identify these homogenous sections, for which a mean speed value can be defined which presents significant differences compared to the averages of other adjacent sections (Cafiso & Di Graziano, 2012).

The method of cumulative differences was used to identify these homogenous sections. The method used is recommended in the AASHTO guide for design of pavement structures (1993). It compares the sequence of the actual sums of the measured speed data with the sums that would result from simply adding the averages (Thomas, 2004). The cumulative difference value is given by Equation 3.15 (Thomas, 2004).

$$z_k = \sum_{i=1}^{k} x_i - k\bar{x} \qquad \text{(Equation 3.15)}$$

where

***k*** = represents the data sequence ***(k =1,…,n)***

$$\boldsymbol{\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i}$$

When the series, $\boldsymbol{z_1, z_2, \ldots, z_n}$, is plotted as a function of the distance along the road, unit boundaries occur where the gradient of the function changes signs between being positive and negative (AASHTO, 1993). It is up to the individual performing the analysis to assess the plot and determine which units should be combined for practical reasons of construction and economics (AASHTO, 1993).

In the case study, segments were made wherever the gradient changed signs. This was done because the speed profile was not recorded at constant distances or time as discussed above in Chapter 3.5.3. Table 3.22 summarises some of the segmentation results.

**Table 3.22. Homogenous segment properties resulting from speed profiles.**

| Property | Value |
|---|---|
| Number of segments | 87 |
| Average segment length | 200.7 m |
| Minimum segment length | 5 m at 19 km/h |
| Maximum segment length | 1936 m at 58 km/h |

The least number of segments was identified in Road Link 3. This link is also the shortest of the four links.

### 3.5.3 Road Link Widths

The recommendations shown in the *Unsealed Roads Manual* by the Australian Road Research Board are shown in Table 3.23 (Department of Transport and Public Works, 2006).

**Table 3.23. Recommended road widths (Department of Transport and Public Works, 2006).**

| AADT | Road width |
|---|---|
| Less than 50 vehicles | 6 m |
| Between 50 & 200 vehicles | 7.5 m |
| More than 200 vehicles | 8.6 m |

For a Road Class 4, a road width of 4m or less requires turnouts to be provided at predetermined locations to allow vehicles passing (Department of Transport and Public Works, 2006). A minimum road width of 5 m was taken as the required width necessary for two-way uninterrupted traffic flow for a Class 4 road. Table 3.24 summarises the recommended roadway width for a Class 4 road on flat and rolling terrain, according to a count of the existing vehicles per day (Department of Transport and Public Works, 2006).

**Table 3.24. Recommended road widths for Class 4 roads (Department of Transport and Public Works, 2006).**

<table>
<tr><th>Existing Traffic (VPD)</th><th>Minor Roads & Tracks</th><th>Formed minor roads</th><th>Divisional roads</th><th>Main roads</th><th>Trunk Roads</th></tr>
<tr><td>< 20</td><td>3 m[1]</td><td>4 m[1]</td><td rowspan="2">6 m</td><td rowspan="2">6 m</td><td rowspan="4">8.6 m</td></tr>
<tr><td>20 - 50</td><td>5 m</td><td>5 m</td></tr>
<tr><td>50 – 200</td><td></td><td>6 m</td><td>7.5 m</td><td>7.5 m</td></tr>
<tr><td>> 200</td><td></td><td>6 m</td><td>8.6 m</td><td>8.6 m</td></tr>
<tr><td colspan="6">[1] Turnouts should be provided to allow vehicle passing</td></tr>
</table>

No traffic counts were performed for the study roads. To estimate the amount of traffic, the Stats SA website was used to investigate vehicle ownership percentages in the area.

In the 2011 census, 12.5% of households in Sane owned at least one vehicle. This translates to 21 houses with at least one vehicle, established by using the recent Google Maps count of households. The percentage of households in Mangwele that owned at least one vehicle was assumed to be the same as in Sane. This translated to nine households with at least one vehicle. It is assumed that the existing traffic on Road Link 1 is less than 20 vehicles per day (VPD), while for road link 2 it is between 20 and 50 (VPD).

In the 2011 census, 6.1% of households in Maranikhwe owned at least one vehicle. The total number of households counted on Google Earth was 371. it was thus estimated that about 23 households in Maranikwe owned at least one vehicle. It is assumed that for Road Link 3, the number of vehicles per day (VPD) was between 20 and 50. The assumed VPD for road link 4 is 50–200 vehicles.

Such assumptions can be made to make a more informed classification of the road. It was, however, decided to suggest a minimum road width of 6 m to allow for uninterrupted traffic flow, this was decided when considering that a bus and car need a minimum lane width of 3.1 m and 2.7 m each respectively (CSIR, 2000a). The combined width then adds up to 5.8 m. The types of vehicles observed in the road links are shown in Table 3.25.

There is another village, called Aftoni, approximately 2 km from Maranikwe. Aftoni is much smaller in comparison to Maranikwe and its vehicle ownership was therefore considered negligible. The closest village west of Mangwele is Tsakani, approximately 4.3 km from Mangwele. The west side of Mangwele consists of numerous villages, and therefore of other schools as well. The vehicle ownership of these villages was not considered because the traffic distribution from the village and the locations of key facilities is unknown.

Non-motorised transport modes in rural areas normally travels on the shoulder of the road (COTO, 2012). The shoulder width available on an unpaved road can be estimated by considering the types of vehicle which travel on the specific road and subtracting that width from the total width of the road.

I.T. Transport Ltd (2002) recommends a minimum pathway width of 1.2 m for a two-way footpath. Further recommendations are listed in Table 3.26 (I.T. Transport Ltd, 2002).

**Table 3.25. Observed traffic in subject road links.**

| Road Link 1 | Road Link 2 | Road Link 3 | Road Link 4 |
|---|---|---|---|
| Passenger cars | Passenger cars | Passenger cars | Passenger cars |
| Bus (twice a day) | Bus (twice a day) | Taxis | Taxis |
| Pedestrians | Pedestrians | Bus (twice a day) | Bus (twice a day) |
| | | Pedestrians | Pedestrians |

If all transport modes are present on the study road, the road's cross section would need to accommodate the following transport modes:

- One bus, because only two services are made per day
- One passenger car or minibus taxi (same width)
- Two pedestrians (opposing directions)

The total width required would be 7 m with the roadway being a minimum of 5.8 m and the remaining 1.2 m dedicated to the shoulder width for pedestrians.

**Table 3.26. Recommended path widths for non-motorised transport modes (I.T. Transport Ltd, 2002).**

| Path type | User | Traffic volume/day | Path width (m) |
|---|---|---|---|
| One-way footpath | Pedestrians | < 50 | 1.0 |
| Two-way footpath | Pedestrians | > 500 | 1.2 |
| One-way bicycle track | Bicycles | < 50 | 1.2 |
| One-way track | Pedestrians Pack- animals | < 500 | 1.4 |
| Two-way track | Pedestrian Pack- animals | > 500 | 2.0 |
| Two-way bicycle track | Bicycles | > 500 | 2.0 |

#### *3.5.3.1 Measuring road link widths*

The equipment used to measure the road width was a standard measuring wheel. The procedure involved driving along the road and stopping to take the cross sectional length measurement at intervals, at places where the cross section seemed to change. The start and end points of the cross section were visibly clear, as vehicles had travelled on the road and a grader was evidently used on the road for maintenance purposes (see Figure 3.6).

Due to the relatively large expenses required to adjust vertical and horizontal alignments of unsurfaced roads, it is proposed that geometric improvements be limited to the widening cross sections only. Horizontal and vertical curves, which require a slower driving speed, should have appropriate traffic signs assigned to them. A traffic sign log was, however, not completed


**Figure 3.6. Illustration of cross section measured line.**

#### *3.5.3.2 Segmentation according to widths*

A separate exercise for identifying homogenous segments according to measured road widths was not conducted. The measured road widths were fitted into the already identified speed segments.

### 3.6 Costs of Infrastructure Works

Infrastructure costs depend on a number of variables, such as time, location, subgrade conditions and topographical characteristics like waterways. The cost of infrastructure in this model is taken as a unit cost. This is to allow for future changes in the figure to allow for the influence of the above-mentioned variables to be taken into account.

### 3.6.1 Upgrading & Rehabilitation

The types of work proposed for each road link took into account the following current conditions of the links:

- Road Link 1 have been categorised as an earth road.
- Road Link 2 consisted of approximately 1.1 km of earth road and the rest was surfaced. The surfacing was in a dire state.
- Road Link 3 was categorised as a surfaced road and had numerous pot-holes.
- Road Link 4 was categorised as a gravel road. The road was generally in a good condition, but some portions show signs of corrugation.

The proposed works are as shown in Table 3.27 for Road Links 1 and 4. Work for Road Links 2 and 3 is shown in Table 3.28. The costs presented in Tables 3.27 and 3.28 were not necessarily those used for the entire portion of each respective road link as some road links had a combination of earth and paved surfaces. Therefore, the cost of the work was assigned to each homogenous section individually.

Extending the shoulder width was assumed to cost the same as upgrading the road from earth to gravel. The costs were rounded off for convenience and are as presented in Table 3.29.

**Table 3.27. Estimated unit costs of upgrading earth road to gravel road for links 1 and 4.**

| Description | Unit | Unit Cost |
|---|---|---|
| Earthworks | $m^2$ | R 6.00 |
| Clearing | $m^2$ | R 1.00 |
| Regravelling layer (200mm deep) | $m^2$ | R 12.00 |
| Overhaul (extra 2km) | $m^2$.km | R 0.70 |
| Roadbed preparation | $m^2$ | R 5.00 |
| Ps & Gs | @10% | R 2.47 |
| Professional fees | @15% | R 2.96 |
| VAT | @14% | R 3.46 |
| Total Cost | $m^2$ | R 33.58 |

**Table 3.28. Estimated unit costs for breaking paved surfacing and regravelling for links 2 and 3.**

| | | |
|---|---|---|
| **Breaking of surfacing (labour intensive) @ R190/worker/day** | $m^2$ | R21.38 |
| **Earthworks** | $m^2$ | R 10.00 |
| **Clearing** | $m^2$ | R 1.00 |
| **Regravelling layer (200mm deep)** | $m^2$ | R 12.00 |
| **Overhaul (extra 2km)** | $m^2$.km | R 0.70 |
| **Roadbed preparation** | $m^2$ | R 5.00 |
| **Ps &Gs** | 10% | R 5.01 |
| **Professional fees** | 15% | R 7.51 |
| **VAT** | 14% | R 7.01 |
| **Cost per $m^2$** | | R 48.23 |

**Table 3.29. Rounded off unit costs according to type of work.**

| Works | Cost per $m^2$ |
|---|---|
| **Earth to gravel** | R35.00 |
| **Surfacing to gravel** | R50.00 |
| **Extend shoulder width (SW)** | R35.00 |

## 3.7 Weighted Accessibility Index

In this research, ranking and optimisation were done by weighing the accessibility index of each school and clinic from the different villages. The weight factors need to be applied to these accessibility indices to take into account the different population groups affected, as well as the importance of the facilities to the community.

Equation 3.17 gives the weighted accessibility index of a village.

$$AI_w(k) = \left(1 - AI_j(k)\right) \times POPG_j(k) \times INVST_{POPG} \quad \text{(Equation 3.17)}$$

where

$AI_w(k)$ =Weighted accessibility index in Rands

$POPG_j(k)$ = The number of persons who go to facility *k* using transport mode *j* from the subject village

$INVST_{POPG}$ = Average investment per capita made by the government department responsible for the relevant facility, *k,* in the financial year concerned.

The equation can be loosely translated as 'The amount of investment which is not used efficiently because of imperfect accessibility'. When we have a perfect accessibility index (i.e. $AI_j(k) = 1$), the investment not used efficiently will equate to zero, because the accessibility is 'perfect'. If we have a non-existent accessibility index ($AI_j(k) = 0$), the investment not used efficiently will be the average investment per person using that facility (health care or basic education in this case).

### 3.7.1 Population Group (POPG) Estimate Per Facility

POPG is estimated from the proportions obtained in the village data collection surveys. This was done for both the health care facility and the educational facility.

For the educational facility:

$$POPG(l)_j = \frac{STU(l)_j}{STU(v)} \times \overline{STU(v)}$$ (Equation 3.18)

where

$POPG(l)_j$ =The population group attending school *l* by using transport mode *j* from a village

$STU(l)_j$ =Number of students from survey attending school *l* using transport *j*

$STU(v)$ =Number of students from village *v* from survey

$\overline{STU(v)} = \frac{STU(v)}{HH(v)} \times \overline{HH(v)}$

$HH(v)$ =Total number of households interviewed in survey from village *v*

$\overline{HH(v)}$ = Total number of households in village *v*, estimated from Google Earth count

**Table 3.30. Size of population (POPG) attending the different schools from the subject villages.**

| From/To | POPG | | |
|---|---|---|---|
| | **Sane Combined** | **Ramabulana** | **Tshianane** |
| Mangwele (Walking) | 4.7 | 0 | 4.7 |
| Mangwele (Public Transport) | - | 7.1 | 18.8 |
| Sane (walking) | - | 71.2 | 11.0 |
| Sane (Public Transport) | - | 0 | 2.7 |

For the health care facility:

The health care facility is viewed differently from the educational facilities, which have a registered number of users for each year. A public clinic is a facility that can be used by anyone. Sixty one percent of households reported using a public clinic as the type of health care facility they consulted first when they fall ill or are injured (Statistics South Africa, 2016). It was assumed that only 61%, as reported by Statistics South Africa (2016), of all households in the villages would make use of the public clinics. All households interviewed in the village data collection survey reported using Straight Hardt Clinic. The frequency with which they use it, however, was not reported, e.g. whether they use it at least once a year or if they have only consulted the clinic a handful of times in their entire lives. This was also one of the reasons why only 61% of all households are assumed to use the clinic. This is specifically because the investment per capita, which will be discussed in the next chapter, is reported with regard to one financial year only. The number of people using the public clinic facility is calculated as shown in Equation 3.19.

$$POPG(c)_j = \frac{HH(c)_j}{HH(v)} \times \overline{HH(v)} \times HHS_{avg} \times 0.61 \qquad \text{(Equation 3.19)}$$

where

$POPG(c)_j$ = The population of persons in the subject village who use clinic *c* by travelling to it by transport mode *j*

$HH(c)_j$ = The number of households reported to be using clinic *c* and transport mode *j*

$HHS_{avg}$ = The average household size of those interviewed.

**Table 3.31. Size of population (POPG) using Straight Hardt Clinic.**

| From/To | Straight Hardt Clinc POPG |
|---|---|
| Mangwele (Walking) | 13.4 |
| Mangwele (Public Transport) | 207.1 |
| Sane (Walking) | 316.7 |
| Sane (Public Transport) | 228.8 |

### 3.7.2 Investments in Facilities

$INSVT_{POPG}$ is estimated by considering the amount of investment made in basic education and public health care. The amounts obtained are shown in Table 3.32.

To estimate the number of people using a public health care facility, the following assumptions were made:

- 61% of households in South Africa were reported to use public clinics as their first consultation facility (Statistics South Africa, 2016).
- 61% of the total population in the country was estimated to be 32 757 610.

The number of users could be more accurately estimated by obtaining information from the district departments. Consulting the district departments would also allow for a better estimation of the investment made per user.

The $INSVT_{POPG}$ as shown from Table 3.32 show that Basic Education had a higher per capita investment than Public Health Care. The $INSVT_{POPG}$ values are used as weights for the accessibility index. This avoids rating systems which can be biased towards a particular facility. The $INVST_{POPG}$ is determined by Government priority, as perceived from the budget they allocate to the respective department.

**Table 3.32. Per capita investment in facilities from the 2014 budget.**

| Facility | 2014 Budget and Source | Users in South Africa | Average Investment Per Capita ($INSVT_{POPG}$) |
|---|---|---|---|
| Basic education | R177 billion (Times Live, 2014) | 12 117 015 students | R14 607.56 |
| Public health care | R77 billion (South Africa Info, 2014) | 32 757 610 people | R2 350.60 |

## 3.8 Ranking

After potential projects have been identified for upgrading/rehabilitation, the next step would be to create a priority list of those projects. The priority list is a ranking of the potential projects, as usually not all projects are able to be implemented, because of certain resource constraints such as funding (Committee of State Road Authorities, 1995). The prioritisation is defined as a process of ranking potential projects according to a given set of rules or guidelines (Committee of State Road Authorities, 1995).

To rank the projects, the current weighted accessibility index $AI_{w,0}(k)$ and the anticipated $AI_{w,1}(k)$ after upgrading were calculated. The only change between the two values will be the value of $Q_L$. The value of $Q_L$ after an upgrade must be 100% if it is assumed to fully conform to road class standards. The accessibility index of either the facility or the travel mode can change only if their properties change.

Ranking is done by comparing the savings in the weighted accessibility index and the cost of the upgrade. This is called the accessibility benefit: cost ratio and is shown by Equation 3.20.

$$Accessibility\ benefit: cost\ ratio = \frac{AI_{w,0}(k) - AI_{w,1}(k)}{CONCST} \quad \text{(Equation 3.20)}$$

where
CONCST = construct cost of upgrade.

## 3.9 Optimisation

Where funding is not available for a full upgrade i.e. there is an even more constrained budget to complete a single project, an exercise of optimisation can be performed. An important attribute of pavement management is the ability to compare the maintenance and rehabilitation alternatives for each project within some funding constraints (Committee of State Road Authorities, 1995). The optimisation can be made to fund rehabilitation and/or maintenance operations of various road links.

The optimisation exercise involves the options of either spot regravelling, which will decrease the roughness of the road and therefore increase the average mobility speed and widening of the cross section, which will provide a safe pathway for pedestrians. It was, however, assumed in this exercise that if a section required either spot regravelling or widening then the section would include the other if necessary.

The optimisation exercise was performed on Microsoft Excel using the solver add-in. The solver add-in in Excel was used to maximise Equation 3.21.

$$y = \sum_{n=0}^{i} (AI_{w,0}(k) - AI_{w,1}(k)) \quad \text{(Equation 3.21)}$$

where

*y* = Accessibility benefit from rehabilitation/maintenance/widening operations.

$AI_{w,0}(k)$ =Current weighted accessibility index of road link

$AI_{w,1}(k)$ =Alternative weighted accessibility index

The equation is maximised by changing which segments are worked on and which left in their current state given the budget constraint.

## 3.10 Conclusions

The methodology was developed to be practical, cheap and easy to perform. The difficulties are in the data gathering section of the method. Gathering data would require the most resources, but this type of data does not require the type of training that is required for visual assessment surveys. The limitations on the number of variables that can be included in an SP experiment can lead to multiple surveys for modelling the transport mode preference, if there are more options in the village.

# 4 Results and Discussions

In this chapter, the results of the research done by methods discussed in Chapter 3 will be presented.

## 4.1 Model Development Results

The stated preference surveys included four different quality surveys that were conducted in two pairs. These were education quality, education transport mode, health care quality and health care transport mode. The raw data and full results from the binary logit regression are given in the CD attached under filename: *Appendix C – Data and Regression.xlsx.*

The village of Makuleni was used to build the models necessary to estimate the preference probabilities of Mangwele. Table 4.1 summarises some of the sample data from Makhuleni.

**Table 4.1 Summary of sample data from Makuleni, Khakhu.**

| Property per household | Value |
|---|---|
| Average students | 2.48 |
| Average number of female secondary students | 0.66 |
| Average number of female primary students | 0.52 |
| Average number of male primary students | 0.97 |
| Average number of male secondary students | 0.34 |
| Number of total students | 72 |
| Average students per house | 2.48 |
| Average income group | 2 |
| Average household size | 6.07 |

### 4.1.1 Education Stated Preference Experiment Results from Makuleni

#### *4.1.1.1 Education quality stated preference results*

A summary of the results from the stated preference (SP) experiment conducted at Makuleni is shown in Table 4.2, which shows the attributes included in the experiment and their different levels. The table also shows the number of respondents who reported that they would use the facility, given the respective attributes, and those who would not use the facility.

**Table 4.2 Results summary of education quality stated preference experiment (Makuleni Village – Model Development Stage).**

| Option | CLASS[1] | TEXTBKS[2] | Use[3] | Not use[4] | Total respondents |
|---|---|---|---|---|---|
| 1 | 30 | 1.00 | 28 | 0 | 28 |
| 2 | 60 | 0.33 | 3 | 25 | 28 |
| 3 | 30 | 0.33 | 6 | 22 | 28 |
| 4 | 45 | 0.67 | 19 | 9 | 28 |
| 5 | 45 | 0.33 | 7 | 21 | 28 |
| 6 | 60 | 0.67 | 13 | 15 | 28 |
| 7 | 45 | 1.00 | 27 | 1 | 28 |
| 8 | 60 | 1.00 | 24 | 4 | 28 |
| 9 | 30 | 0.67 | 22 | 6 | 28 |

[1]Average number of students in classroom
[2]Average available textbooks per student
[3]Number of respondents who would attend the school
[4]Number of respondents who would look for an alternative

Twenty eight respondents were recorded for the experiment testing stated preference regarding education quality. This was two short of the targeted number of respondents. The SP experiment was done by asking respondents at Makuleni if they would use (attend) the school facility, given the attributes shown in Table 4.2. The options most favoured when choosing whether to attend the schools were options 1, 7, and 8. These options included the attribute 'all books available at the school'.

Using the SP data from the survey, the coefficients for Equation 3.2 on page 60 were estimated, using Microsoft Excel and StatPlus. The resulting coefficients for education quality are shown in Table 4.3. The only significant variables in the model are those shown in the table, and the rest were found to be insignificant. The insignificant variables were:

- STU HH – Number of students in household
- SEC FEM – Number of female secondary students in household
- PRI FEM – Number of female primary students in household
- PRI MAL – Number of male primary students in household
- SEC MAL – Number of male secondary students in households

**Table 4.3 Estimated coefficients for education quality utility function.**

| ***$X_i$*** | ***Variable*** | ***coefficients $\beta_k$*** | ***p-value*** | ***lower*** | ***Upper*** |
|---|---|---|---|---|---|
| - | Intercept | -0.62 | 0.46 | 0.10 | 2.80 |
| 1 | INCGRP[1] | -0.49 | 0.02 | 0.41 | 0.92 |
| 2 | CLASS[2] | -0.05 | 0.00 | 0.93 | 0.98 |
| 3 | TEXTBKS[3] | 6.80 | 0.00 | 180.58 | 4474.18 |

[1] Household income group
[2] Average classroom size at school
[3] Availability of textbooks at school

The utility function is given by Equation 4.1 and equates to 1 when preference is given to using the school and 0 when preference is to use another school.

$$y = -0.62 - 0.49(INCGRP) - 0.05(CLASS) + 6.80(TEXTBKS) \qquad \text{(Equation 4.1)}$$

From Equation 4.1, the following can be concluded:

- Larger classes are not preferred
- The proportion of textbooks available makes the biggest impact, with more textbooks being preferred.

- Surprisingly, a school is less preferred with increasing household income.

Equation 4.2 gives the probability that a household would use a school.

$$P(Use\ School) = \frac{1}{1+e^{-(-0.62-0.49INCGRP-0.05CLASS+6.80TEXTBKS)}} \qquad \text{(Equation 4.2)}$$

This probability function will be used further as the accessibility index of schools for the subject villages.

#### *4.1.1.2 Education transport: stated preference results*

A summary of the results from the SP survey conducted at Makuleni for transport to educational facilities is shown in Table 4.4. Twenty nine households participated in the experiment. This was one short of the targeted number of 30. The most favoured options towards public transport were options 2, 6, 7 and 8. Three of the four options included a two-hour walking time as an alternative. One of the four options displayed a preference toward using public transport, given a fare of R5.00, and a walking time of one hour. The estimated coefficients for the education transport SP model are shown in Table 4.5.

**Table 4.4 Results summary of transport to education stated preference experiment (Makuleni Village - Model Development Stage).**

| Option | WT[1] (mins) | PTCST[2] | "Use Public transport" | "Walk" | Total respondent |
|---|---|---|---|---|---|
| 1 | 30 | R5.00 | 10 | 19 | 29 |
| 2 | 120 | R10.00 | 26 | 3 | 29 |
| 3 | 30 | R10.00 | 7 | 22 | 29 |
| 4 | 60 | R15.00 | 15 | 14 | 29 |
| 5 | 60 | R10.00 | 16 | 13 | 29 |
| 6 | 120 | R15.00 | 25 | 4 | 29 |
| 7 | 60 | R5.00 | 24 | 5 | 29 |
| 8 | 120 | R5.00 | 26 | 3 | 29 |
| 9 | 30 | R15.00 | 4 | 25 | 29 |

[1] Walking time

[2] Public transport cost (one-way)

**Table 4.5 Estimated coefficients for education transport utility function.**

| *Variable* | *coefficients* $\beta_k$ | *p-value* | *lower* | *upper* |
|---|---|---|---|---|
| Intercept | 0.92 | 0.34 | 0.39 | 16.08 |
| STU HH | -4.68 | 0.00 | 0.00 | 0.10 |
| SEC FEM | 5.19 | 0.00 | 15.05 | 2158.42 |
| PRI FEM | 4.55 | 0.00 | 7.17 | 1238.24 |
| PRI MAL | 3.93 | 0.00 | 4.90 | 530.52 |
| SEC MAL | 3.60 | 0.01 | 2.88 | 463.45 |
| INC GRP | -0.56 | 0.02 | 0.36 | 0.91 |
| WT | 0.05 | 0.00 | 1.04 | 1.06 |
| PTCST | -0.13 | 0.00 | 0.81 | 0.95 |

When the utility function in Equation 4.3 equates to 1 then a preference to public transport is absolute. 0 translates to a preference to walk.

$$y = 0.92 - 4.68(STU\ HH) + 5.19(SEC\ FEM) + 4.55(PRI\ FEM) + 3.93(PRI\ MAL) + 3.60(SEC\ MAL) - 0.56(INC\ GRP) + 0.05WT - 0.13PTCST$$ (Equation 4.3)

From Equation 4.3, the following can be concluded:

- The more students there are in a household, the less likely they are to use public transport.
- Female students (secondary and primary students) prefer public transport more often than their male counterparts.
- An increase in household income translates to a negative preference to public transport.
- An increase in walking time also increases the preference to use public transport.
- An increase in public transport cost gives preference to walking.

Equation 4.4 gives the probability of using public transport.

$$P(Public\ transport) = 1/\left(1 + e^{-(0.92-4.68(STU\ HH)+5.19(SEC\ FEM)+4.55(PRI\ FEM)+3.93(PRI\ MAL)+3.60(SEC\ MAL)-0.56(INC\ GRP)+0.05WT-0.13PTCST)}\right)$$

(Equation 4.4)

$$P(walk) = 1 - P(Public\ transport)$$

This probability function will be used further as the accessibility index of transport mode for the subject villages.

### 4.1.2 Health Care Stated Preference Experiment Results from Makuleni

#### *4.1.2.1 Health care quality stated preference results*

A summary of the responses to the SP experiment is shown in Table 4.6. The options which most favoured use of a public clinic were options 4 and 6. The options both had a waiting time of less than 2 hours and a doctor visitation frequency of once and twice a week. Four variables were recorded for each respondent in the health care SP experiment. These were:

- Household size (HHS)
- Income group (INC GRP)
- Doctor visitation frequency (DOC)
- Waiting time at clinic before consultation (WAITt)

Only the variables in Table 4.7 were found to be significant in deciding preference for a particular clinic.

**Table 4.6 Summary of health care quality SP experiment (Makuleni Village - Model Development Stage).**

| Option | DOC[1] | WAITt[2] | Utilise[3] | Not Utilise[4] |
|---|---|---|---|---|
| 1 | Once a month | Less than 2 hours | 11 | 18 |
| 2 | Twice a week | More than 2 hours | 13 | 16 |
| 3 | Once a week | More than 2 hours | 11 | 18 |
| 4 | Twice a week | Less than 2 hours | 29 | 0 |
| 5 | Once a month | More than 2 hours | 8 | 21 |
| 6 | Once a week | Less than 2 hours | 28 | 1 |

[1]Doctor visitation

[2]Waiting time before consultation

[3]Number of respondents who would use the clinic

[4]Number of respondents who would seek an alternative

**Table 4.7 Estimated coefficients for health care quality preference.**

| $X_i$ | *Variable* | *coefficients* $\beta_k$ | *p-value* | *lower* | *upper* |
|---|---|---|---|---|---|
| 1 | Intercept | 2.63 | 2.39E-09 | | |
| 2 | DOC | -0.08 | 1.68E-06 | 0.89 | 0.95 |
| 3 | WAITt | -2.24 | 6.20E-08 | 0.05 | 0.24 |

Using the coefficients in Table 4.7, the utility function for clinic quality becomes as shown by Equation 4.5

$$y = 2.63 - 0.08DOC - 2.24WAITt \quad \text{(Equation 4.5)}$$

From Equation 4.5, the following can be concluded:

- A clinic is less preferred when the number of days between doctor visitations increases.
- A clinic is more preferred when the waiting time before consultation decreases.

Equation 4.6 gives the probability that a household prefers a clinic.

$$P(School) = \frac{1}{1+e^{-(2.63-0.08DOC-2.24WAITt)}} \quad \text{(Equation 4.6)}$$

#### *4.1.2.2 Health care transport stated preference results*

A summary of responses in the SP experiment for transport to public clinics is shown in Table 4.8. The most favoured options for using public transport are options 2, 6 and 8. These options all consist of a walking time of 2 hours. Four variables were recorded for each respondent in the health care SP experiment. These were:

- Household size (HHS)
- Income group (INC GRP)
- Walking time (WT)
- Public transport cost (PTCST)
-

Only the variables shown in Table 4.9 were found to be significant in preferring public transport over walking to clinic.

Using the coefficients in Table 4.9, the utility function for preference of transport mode to clinic becomes as shown by Equation 4.7.

$$y = -1.67 + 0.05WT - 0.13PTCST \quad \text{(Equation 4.7)}$$

From Equation 4.7, the following can be concluded:

- Preference for using public transport increases when the walking time to the clinic increases,
- The preference for using public transport to a clinic increases with decreasing fare cost.

Equation 4.8 gives the probability that a household prefers to use public transport.

$$P(Public\ transport) = \frac{1}{1+e^{-(-1.67+0.05WT-0.13PTCST)}}$$ (Equation 4.8)

**Table 4.8 Results summary of transport health care facility stated preference experiment (Makuleni Village - Model Development Stage).**

| Option | WT[1] | PTCST[2] | Utilise[3] | Not utilise[4] |
|---|---|---|---|---|
| 1 | 30 | R5.00 | 7 | 22 |
| 2 | 120 | R10.00 | 27 | 2 |
| 3 | 30 | R10.00 | 5 | 24 |
| 4 | 60 | R15.00 | 14 | 15 |
| 5 | 60 | R10.00 | 16 | 13 |
| 6 | 120 | R15.00 | 26 | 3 |
| 7 | 60 | R5.00 | 23 | 6 |
| 8 | 120 | R5.00 | 28 | 1 |
| 9 | 30 | R15.00 | 2 | 27 |

[1]Walking time

[2]Public transport cost

[3]Number of respondents who would use public transport

[4]Number of respondents who would rather walk

**Table 4.9 Estimated coefficients for health care transport utility function.**

| $X_i$ | *Variable* | *coefficients* $\beta_k$ | *p-value* | *lower* | *upper* |
|---|---|---|---|---|---|
| 1 | Intercept | -1.67 | 9.51E-04 | 0.07 | 0.51 |
| 2 | WT | 0.05 | 7.17E-15 | 1.04 | 1.07 |
| 3 | PTCST | -0.13 | 2.29E-03 | 0.81 | 0.96 |

## 4.2 Data Capturing Results

This section presents the results from the data capturing exercise at the villages of Sane and Mangwele. It also presents the results from the data capturing of the condition of road links.

### 4.2.1 Village Data Gathering

The results of data gathering are presented separately, according to the village. The surveys were conducted on two separate days at Mangwele and Sane. The surveys involved obtaining information on the significant variables required in the utility functions determined in Chapter 4.1. The raw data from the survey is contained in the attached CD under the filename: *Appendix D – Village Data.xlsx.*

#### *4.2.1.1 Mangwele results for method testing*

The results for Mangwele will be presented according to the type of facility.

##### 4.2.1.1.1 Education model testing – Mangwele

Table 4.10 gives a statistical summary of Mangwele from the data gathered during the data capturing surveys.

**Table 4.10 Sample results summary from Mangwele data capturing survey for educational facilities.**

| | |
|---|---|
| **Average household size** | 5.1 |
| **Average number of female primary students per household** | 0.4 |
| **Average number of female secondary students per household** | 0.4 |
| **Average number of male primary students per household** | 0.5 |
| **Average number of male secondary students per household** | 0.2 |
| **Number of total students** | 43 |
| **Average students per household** | 1.4 |
| **Average household income group** | 1.9 |

The results in Table 4.10 show that there are marginally more female students than males. There are, also, more than twice as many females in secondary schools than there are males. The average income group as defined by Table 3.14 on page 69 is approximately 2, as reported by the respondents. This implies that, on average, each household receives a monthly income ranging between R801.00 and R1 633.33 (see table 3.14).

Table 4.11 shows the distances to the school attended by pupils from Mangwele. The furthest subject school attended from Mangwele is Tshianane Secondary School, which is 16.93 km. The table also shows the average class size and average textbook availability at each school. This information was gathered at the respective schools. The schools Mangwele Primary School and Gogogo are not located on the subject roads and were thus not visited.

**Table 4.11. Subject school properties from Mangwele according to school.**

| Property | Mangwele Primary School | Ramabulana Secondary School | Tshianane Secondary School | Sane Combined School | Gogogo |
|---|---|---|---|---|---|
| Travel distance (km) | 0.3 | 12.86 | 16.93 | 6.32 | 12.9 |
| Estimated walking time (minutes) | 4 | 154 | 203 | 76 | 155 |
| Average class size (learners) | - | 36.6 | 28.9 | 24 | - |
| Average textbook availability | - | 100% | 85% | 50% | - |

The accessibility indices were calculated for only those schools affected by the selected road links. The indices calculated are shown in Table 4.12. The indices were calculated using Equation 4.2 for education quality, together with the survey information and data from Table 4.11. Equation 4.4 was used to estimate the accessibility index for transport modes, together with the survey data.

**Table 4.12. Estimated accessibility indices of Mangwele households to subject schools.**

| Index | Ramabulana Secondary school | Tshianane Secondary school | Sane Combined School |
|---|---|---|---|
| P(public transport) = $AI_{TR}$ Public transport | 100% | 100% | - |
| P(walking) = $AI_{TR}$ Walking | - | 0.1% | 20% |
| *P(enrolling at school) =* $AI_{QT}$ | 97% | 94% | 72% |

The probability of preferring to walk to Tshianane gives the lowest accessibility index with an estimated $AI_{TR}$ of 0.10%. This is because of the very long walking distance of 16.9 km. The proportion of students walking to Tshianane is 5% of the sample.

Those who use public transport to travel to Ramabulana and Tshianane are using the most preferred transport mode. This would suggest that the price is thought to be reasonable given the distance.

$AI_{QT}$ is higher at schools with the highest average number of textbooks available. The school with the highest percentage of textbooks available (100%) is Ramabulana Secondary School, with an average $AI_{QT}$ of 97% per household.

The proportions of students from the total of those in the sample, according to the school, are shown in Figure 4.1.

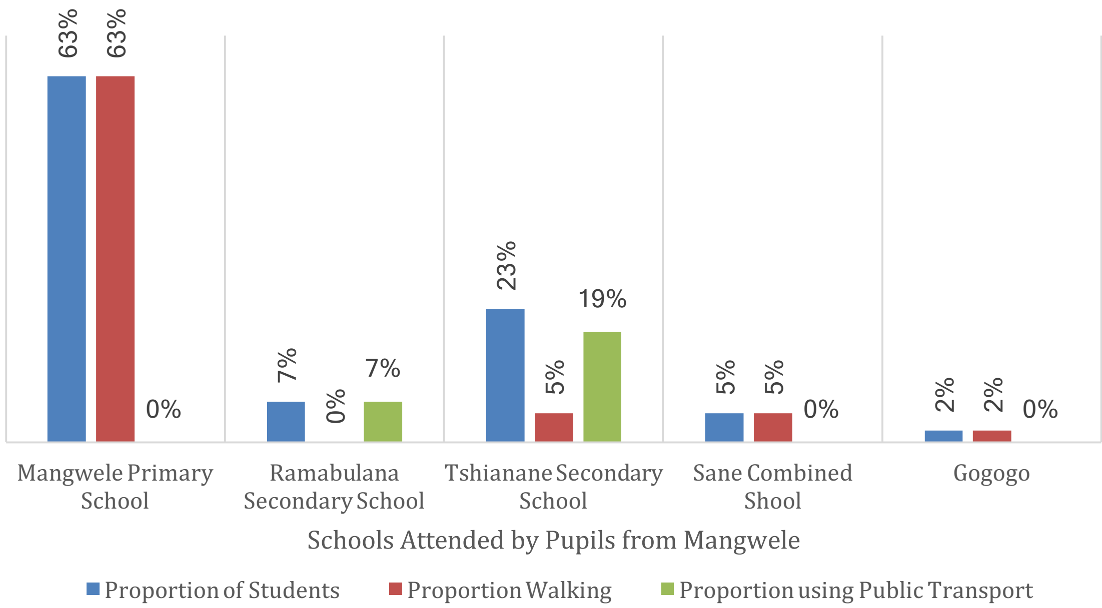


**Figure 4.1. Proportions of students from Mangwele in each school and transport mode from the sample.**

From Figure 4.1 it can be seen that Tshianane Secondary School is the secondary school most preferred by pupils. All students at Ramabulana Secondary School use public transport. 5% of all students in the sample walk to Tshianane, with 19% using public transport to the same school. All pupils in the sample attending Sane Combined School walk to the school from Mangwele. No further investigations were conducted for Gogogo, because the school is not situated close to the subject roads.

#### 4.2.1.1.2 Health care model testing – Mangwele

A summary of the sample data obtained at Mangwele for health care is shown in Table 4.13. Waiting times recorded in the survey varied amongst households from 20 minutes to 8 hours, and is shown in Figure 4.2. The average waiting time was reported as 149 minutes. Doctor visitation frequency was reported to be three times a week. This is higher than that recommended by Couper (2002).

**Table 4.13. Sample results summary from Mangwele data capturing for health care facilities.**

| | |
|---|---|
| **Average household size** | 4.6 |
| **Clinic** | Straight Hardt Clinic |
| **Travel distance (km)** | 12.8 |
| **Estimated walking time (minutes)** | 154 |
| **Public transport cost** | R10.58 |
| **Average waiting time (minutes)** | 149 |
| **Straight Hardt doctor visitation frequency** | 3 times a week |

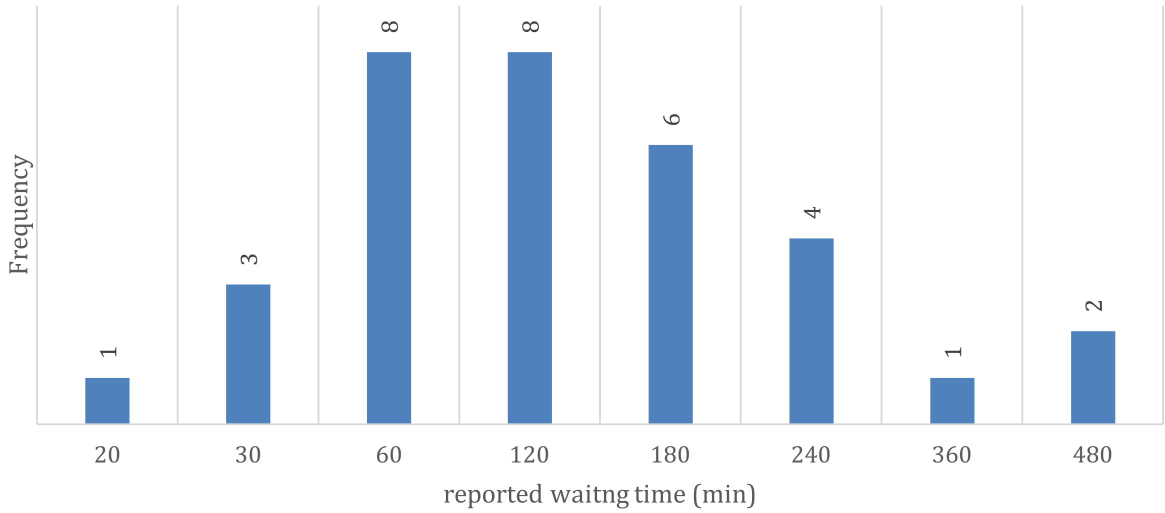


**Figure 4.2. Waiting time frequencies reported for Straight Hardt Clinic from Mangwele data capturing survey.**

The calculated accessibility indices for health care in Mangwele are shown in Table 4.14. As can be seen from the accessibility indices in the table, the clinic is located too far from Mangwele for walking (16.9km). The clinic has been recorded as having a good doctor visitation frequency and the quality accessibility index is lowered by the lengthy reported waiting times, which varied amongst the different households. The proportion of households travelling to Straight Hardt Clinic, summarised according to the transport mode of choice , in Table 4.15.

**Table 4.14. Estimated accessibility indices for transport mode and facility quality for Mangwele households.**

| | |
|---|---|
| **$AI_{TR}$ Public transport** | 99% |
| **$AI_{TR}$ Walking** | 1% |
| **$AI_{QT}$** | 69% |

**Table 4.15. Proportions of households travelling to Straight Hardt Clinic from Mangwele according to travel mode of choice.**

| Transport mode to clinic | Proportion of households |
|---|---|
| Walking | 6% |
| Using public transport | 94% |

#### *4.2.1.2 Sane results for method testing*

The results for Sane are also presented regarding education and health care.

##### 4.2.1.2.1 Education model testing – Sane

Table 4.16 summarises the educational data gathered at Sane during the data capturing survey. The results in Table 4.16 show that there are on average more household members in Sane than in Mangwele. Unlike Mangwele, there are more male students, with the majority still in primary school. There are more male students in secondary school than female students, unlike what was observed in Mangwele. The average income group as defined by Table 3.14 on page 69, is approximately 2 and therefore each household receives an average of between R801.00 and R1 633.33 (see table 3.14).

The furthest school attended from Sane is Tshianane Secondary School (at 10.91 km) and the closest is Sane Combined School, which is located in the same village. These results are reported in Table 4.17.

From Figure 4.3 it can be seen that only 1% of the student population in the households surveyed used public transport to Tshianane Secondary School from Sane. The survey revealed that the majority of pupils walk to school (76% to Sane Combined School, 20% to Ramabulana and 4% to Tshianane). Sane Combined School offers the best preference probability of walking and Tshianane offers the worst likelihood of preference for walking as it is the furthest.

**Table 4.16 Sample results summary from Sane data capturing survey of educational facilities.**

| | |
|---|---|
| **Average household size** | 5.4 |
| **Average number of female primary students in household** | 0.5 |
| **Average number of female secondary students in household** | 0.3 |
| **Average number of male primary students in household** | 0.9 |
| **Average number of male secondary students in household** | 0.4 |
| **Number of total students** | 130 |
| **Average students per house** | 2.1 |
| **Average income group** | 2[1] |
| Notes: [1]Between R801.00 and R1 633.33 | |

**Table 4.17 Subject school properties and their distances from Sane.**

| **Property** | **Sane Combined School** | **Ramabulana Secondary School** | **Tshianane Secondary School** |
|---|---|---|---|
| Travel distance (km) | 0.35 | 6.84 | 10.91 |
| Estimated walking time (minutes) | 4 | 82 | 131 |
| Average class size (students/class) | 24 | 36.6 | 28.9 |
| Average textbook availability | 50% | 100% | 85% |

Table 4.18 shows the estimated accessibility indices for the subject schools. The school with the highest accessibility index was determined to be Tshianane Secondary School. The distance of 10.9 km to this school from Sane justified the fare price of using public transport. Ramabulana and Tshianane Secondary Schools

had high accessibility indices for education quality. This could be as consequence of the relatively higher reported availability of textbooks at these two schools compared to that at Sane Combined School.

**Table 4.18 Estimated accessibility indices of subject schools for pupils from Sane.**

| **Index** | **Sane Combined School** | **Ramabulana Secondary School** | **Tshianane Secondary School** |
|---|---|---|---|
| P(public transport) = $AI_{TR}$ Public transport | 0.00% | 0.00% | 98% |
| P(walking) = $AI_{TR}$ Walking | 83% | 21% | 10% |
| *P(attending school) = $AI_{QT}$* | 69% | 97% | 96% |

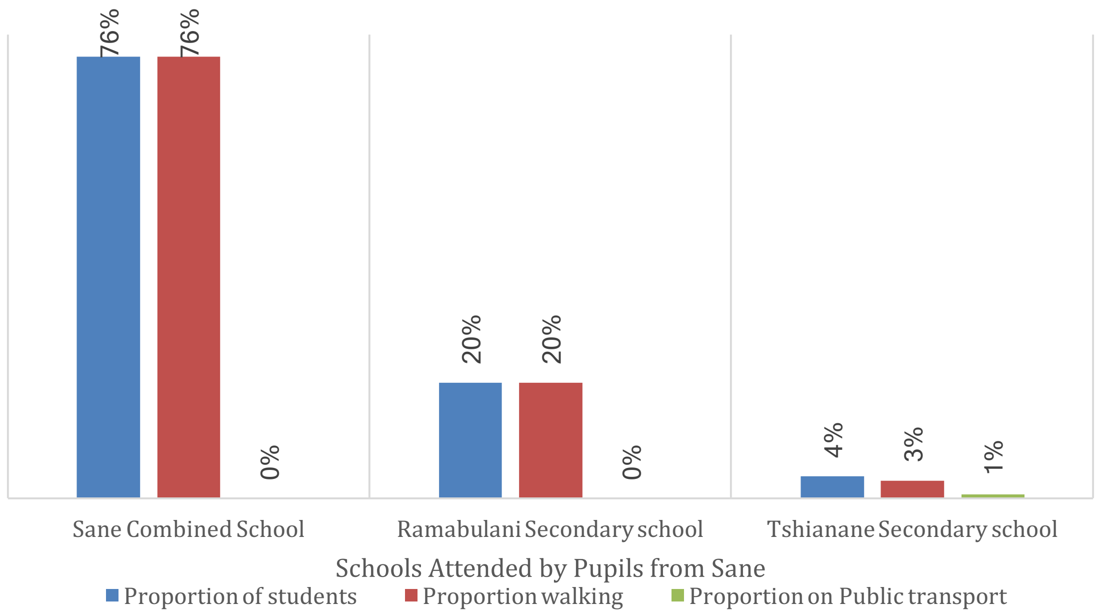


**Figure 4.3. Chart showing transport mode proportions of Sane students according to schools.**

#### 4.2.1.2.2 Health care model testing – Sane

A summary of the sample data obtained at Sane for health care is shown in Table 4.19. The travel distance to the nearest clinic is almost half that from Mangwele. The reported cost for public transport was R10.00, and this was more uniform throughout the respondents. The doctor visitation frequencies were the same, because the two communities consulted the same clinic.

**Table 4.19. Results summary of sample data from Sane health care data capturing survey.**

| | |
|---|---|
| **Average household size** | 5.4 |
| **Clinic** | Straight Hardt Clinic |
| **Travel distance (km)** | 6.8 |
| **Estimated walking time (minutes)** | 82 |
| **Public transport cost** | R10.00 |
| **Average waiting time (minutes)** | 112 |
| **Average doctor visitation at Straight Hardt Clinic** | 3 times a week |

Waiting times reported varied from 15 minutes to 6 hours amongst the households and this is shown in Figure 4.4. The average waiting time (112 minutes) reported was lower than that experienced by community members from Mangwele (149 minutes).

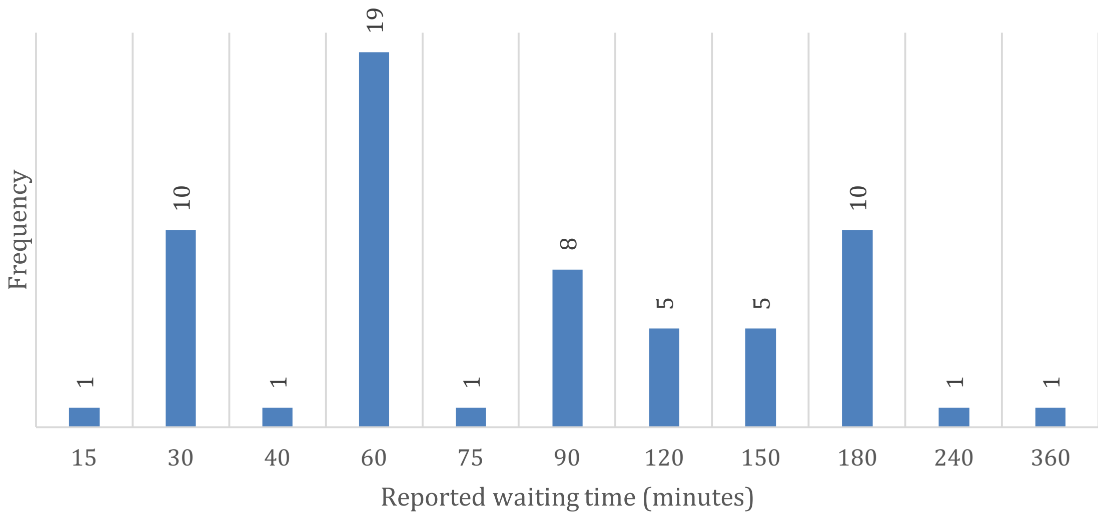


**Figure 4.4. Waiting time frequencies reported for Straight Hardt Clinic from Sane data capturing survey.**

**Table 4.20. Estimated accessibility indices for transport mode and facility quality for Sane households.**

| | |
|---|---|
| **P(public transport) = $AI_{TR}$ Public transport** | 78% |
| **P(walking) = $AI_{TR}$ Walking** | 22% |
| **P(using clinic) = $AI_{QT}$** | 79% |

As can be seen from the estimated accessibility indices in Table 4.20, the $AI_{TR}$ of walking to the clinic is higher than that observed in Mangwele. This is because the clinic is closer to the village of Sane (6.84 km) than Mangwele (12.86 km). It is, however, still too far for walking, and preference still lies with public transport. The clinic has a good reported doctor visitation frequency and the quality accessibility index benefits from the reported waiting times which varied amongst the different households as was observed in Mangwele.

The proportion of households according to the transport mode of choice is summarized in Table 4.21. The majority of commutes are taken by walking to the clinic.

**Table 4.21. Proportions of households travelling to Straight Hardt Clinic from Sane according to travel mode of choice.**

| Transport mode to clinic | Proportion of households |
|---|---|
| **Walking** | 58% |
| **Using public transport** | 42% |

### 4.2.2 Infrastructure Data Gathering

For the infrastructure data gathering results, the speed profile was taken to measure the quality of infrastructure for motorised travel modes. Speed was chosen as an indicator of the road condition as it can be correlated to the International Roughness Index (IRI). The speed profile was gathered, as explained in Chapter 3.5, by using a Garmin GPS and a measuring wheel. Figure 4.5 shows the travelled tracks when measuring the speed profile of the road. The waypoints marked beginning with M, show the locations where the road width was measured and pictures were taken.

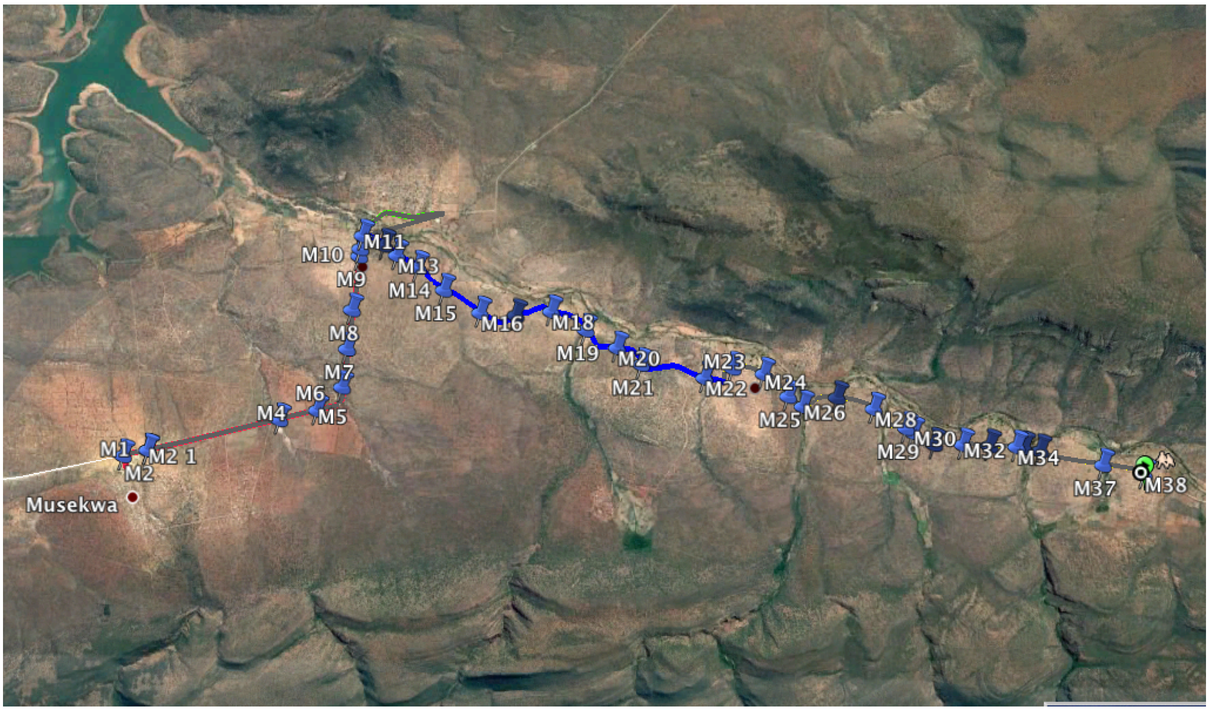


**Figure 4.5. Speed profile track and road width measurement points for subject road links.**

M38 represents the start point at Mangwele and M1 represents the end point at Tshianane.

#### *4.2.2.1 Public transport $Q_L$ – Quality of infrastructure for motorised transport*

The performance of the vehicle in relation to the infrastructure will be determined by the speed profile of the vehicle and the cross section width along the various road links. The ideal road width for vehicles is 6 m (see Chapter 3.5.3) and the ideal travel speed is a minimum of 45 km/h (see Chapter 3.5.2). This test was done after consideration of the road's classification and the types of vehicle observed on the road links.

##### 4.2.2.1.1 Mangwele to Sane Combined School (Road Link 1) – Public transport $Q_L$

The properties of the homogenous segments obtained through the cumulative differences are shown in Table 4.22 for Road Link 1 from Mangwele to Sane Combined School. Details of the individual segment properties are given in Appendix E.

**Table 4.22. Summary of speed and width profile segments recorded for Road Link 1 (Mangwele to Sane Combined School).**

| | |
|---|---|
| **Number of Segments** | 32 |
| **Average Ls (m)** | 188 |
| **Road link Ls (m)** | 6014 |
| **Average $V_{s,avg}$ (km/h)** | 29.4 |
| **Average Speed $Q_{L,s}$** | 68% |
| **Average $W_{s,avg}$ (m)** | 5.6 |
| **Average Width $Q_{L,s}$** | 91% |
| **Overall road link $Q_{L,s}$** | 65% |

The average speed $Q_{L,s}$ was observed as 68% and the average width $Q_{L,s}$ as 91%. This implies that 68% of the road links length conforms with the speed specification of the road and 91% with the width necessary to accommodate all vehicle types observed on the road link. The overall quality of the link from Mangwele to Sane

Combined School is approximately 65%. The overall road link $Q_{L,s}$ was calculated by taking the least favourable $Q_{L,s}$ of a homogenous segment as the $Q_{L,s}$ of that segment. The average width of the different homogenous sections give a much higher $Q_{L,s}$ (91%) than the average speed $Q_{L,s}$ (68%). This would imply that an upgrade of the entire road may not be warranted. This will be analysed in the upgrading and optimisation chapters.

#### 4.2.2.1.2 Sane Combined School to intersection 1 (Road Link 2) - Public transport $Q_L$

The properties of the homogenous segments obtained through the cumulative differences are shown in Table 4.23 for the Road Link Sane Combined School to Intersection 1. Details of the individual segment properties are given in Appendix E.

The overall quality of the Road Link from Sane Combined School to Intersection 1 was estimated to be approximately 66%. The average speed $Q_{L,s}$ observed from Mangwele to Sane (68%) and for this particular road link (66%) are similar. This implies that road conditions for motorised vehicles are similar. The width of this road link is currently slightly better than that from Mangwele to Sane Combined School (95%) compared with that of this Road Link (91%).

**Table 4.23. Summary of speed and width profile segments recorded for Road Link 2 (Sane Combined School to Intersection 1).**

| | |
|---|---|
| **Number of Segments** | 39 |
| **Average Ls (m)** | 136 |
| **Road link Ls (m)** | 5323 |
| **Average $V_{s,avg}$ (km/h)** | 29.9 |
| **Average Speed $Q_{L,s}$** | 66% |
| **Average $W_{s,avg}$ (m)** | 5.8 |
| **Average Width $Q_{L,s}$** | 95% |
| **Overall road link $Q_{L,s}$** | 66% |

#### 4.2.2.1.3 Intersection 1 to Ramabulana Secondary School (Road Link 3) - Public transport $Q_L$

The properties of the homogenous segments obtained through the cumulative differences are shown in Table 4.24 for Road Link 3 (Intersection 1 to Ramabulana Secondary School). Details of the individual segment properties are given in Appendix E.

**Table 4.24. Summary of speed and width profile segments recorded for Road Link 3 (Intersection 1 to Ramabulana Secondary School).**

| | |
|---|---|
| **Number of Segments** | 7 |
| **Average Ls (m)** | 160 |
| **Road link Ls (m)** | 1119 |
| **Average $V_{s,avg}$ (km/h)** | 26.5 |
| **Average Speed $Q_{L,s}$** | 59% |
| **Average $W_{s,avg}$ (m)** | 6 |
| **Average Width $Q_{L,s}$** | 100% |
| **Overall road link $Q_{L,s}$** | 59% |

The link above has the worst overall $Q_L$ of 59%. It is also the shortest link. The $Q_{L,s}$ results solely from the low travel speed because the average width $Q_{L,s}$ is 100% throughout the link. The width of the road conforms fully to the targeted 6m. The speed is low due to the many potholes observed in the road.

#### 4.2.2.1.4 Intersection 1 to Tshianane Secondary School (Road Link 4) - Public transport $Q_L$

The properties of the homogenous segments obtained through the cumulative differences are shown in Table 4.25 for Road Link 4 (Intersection 1 to Tshianane Secondary School). Details of the individual segment properties are given in Appendix E.

**Table 4.25. Summary of speed and width profile segments recorded for Road Link 4 (Intersection 1 to Tshianane Secondary School).**

| | |
|---|---|
| **Number of Segments** | 9 |
| **Average Ls (m)** | 556 |
| **Road link Ls (m)** | 5004 |
| **Average $V_{s,avg}$ (km/h)** | 50 |
| **Average Speed $Q_{L,s}$** | 94% |
| **Average $W_{s,avg}$ (m)** | 7.5 |
| **Average Width $Q_{L,s}$** | 100% |
| **Overall road link $Q_{L,s}$** | 94% |

This is the best performing link, with an overall $Q_L$ of approximately 94%. The road link has a fully conforming width and the minimum speed is attainable over 94% of the travel length.

#### *4.2.2.2 Pedestrians $Q_L$ – Quality of infrastructure for non-motorised transport*

The quality of infrastructure concerning pedestrians is estimated by assessing the shoulder width available for pedestrians to travel on when the road cross section is accommodating all of the present vehicle types. The vehicle types include one bus, one standard car and a two-way pedestrian walkway.

The available shoulder widths, $SW_{s,avg}$, available to pedestrians or any other non-motorised transport, are shown in Table 4.26 for each road link. $Q_{L,NMT}$ shows the percentage of the length of the road link conforming to the required shoulder width (1.2 m) as discussed in Chapter 3.5.3.

As can be seen from Table 4.26, Road Link 4 from Intersection 1 to Tshianane Secondary School has the most available shoulder width of the four road links. Road Link 3 consists of a paved surface of 6m but lacks a wide enough gravel shoulder. Road Link 1 is entirely an earth road and is also the narrowest of the links. Road Link 2 is a combination of paved sections and sections of earth and is also very narrow.

**Table 4.26. Quality of infrastructure results for non-motorised transport and $Q_{L,NMT}$ from available shoulder widths (SW).**

| Road Link | Segments | Length (m) | $SW_{s,avg}$ (m) | $Q_{L,NMT,S}$ |
|---|---|---|---|---|
| Road link 1 | 32 | 6014 | 0.19 | 16% |
| Road link 2 | 39 | 5323 | 0.22 | 19% |
| Road link 3 | 7 | 1119 | 0.2 | 17% |
| Road link 4 | 9 | 5004 | 0.93 | 78% |

#### *4.2.2.3 Summary*

Figure 4.6 summarises the estimated quality of the infrastructure results for all four links and both travel modes.

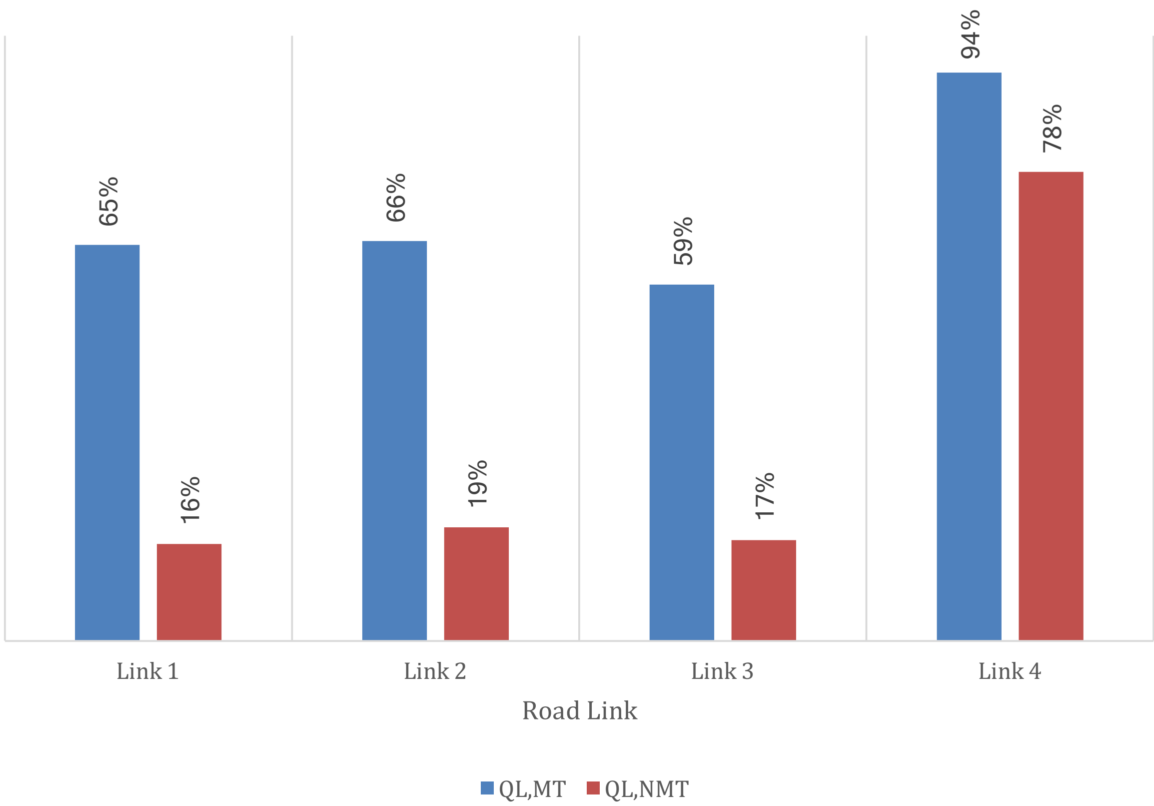


**Figure 4.6. Comparative graph showing quality of infrastructure of links for non-motorised transport ($Q_{L,NMT}$) and motorised transport ($Q_{L,MT}$).**

From Figure 4.6, the following is observed:

- Link 4 has the best quality, with motorised and non-motorised transport operating at 94% and 78% respectively of the required classification specifications.
- Link 3 has the worst quality for motorised transport with an overall $Q_{L,MT}$ of 59%.
- Link 1 has the worst quality for non-motorised transport with a $Q_{L,NMT}$ of only 16%.

## 4.3 Potential Projects Ranking using Weighted Accessibility Indices

Ranking of potential projects will be conducted in this chapter. The ranking was carried out by calculating the weighted accessibility index of each project. Potential projects need to be identified first before the ranking commences. Potential projects for this exercise are shown in Table 4.27.

**Table 4.27. Potential projects identified on subject road links and their lengths.**

| Project | Road Links | Project Length (km) | Community benefactors |
|---|---|---|---|
| Project 1 | 1 | 6.01 | Mangwele |
| Project 2 | 1, 2, 3 | 12.46 | Mangwele & Sane |
| Project 3 | 1, 2, 4 | 16.34 | Mangwele & Sane |
| Project 4 | 1, 2, 3, 4 | 17.46 | Mangwele & Sane |
| Project 5 | 2, 3 | 6.44 | Mangwele & Mainly Sane |
| Project 6 | 2, 4 | 10.33 | Mangwele & Mainly Sane |
| Project 7 | 2, 3, 4 | 11.45 | Mangwele & Mainly Sane |

Because the potential projects entail only road rehabilitation and upgrade, only the infrastructure quality factor will have an effect on the final accessibility index. The current infrastructure quality $Q_L$ for motorised and non-motorised travel modes is shown in Figure 4.7 according to the projects identified in Table 4.27. The infrastructure quality, after completion of work, is assumed to be 100% for each potential project. This is a reasonable assumption, as the construction work must meet the classification standards.

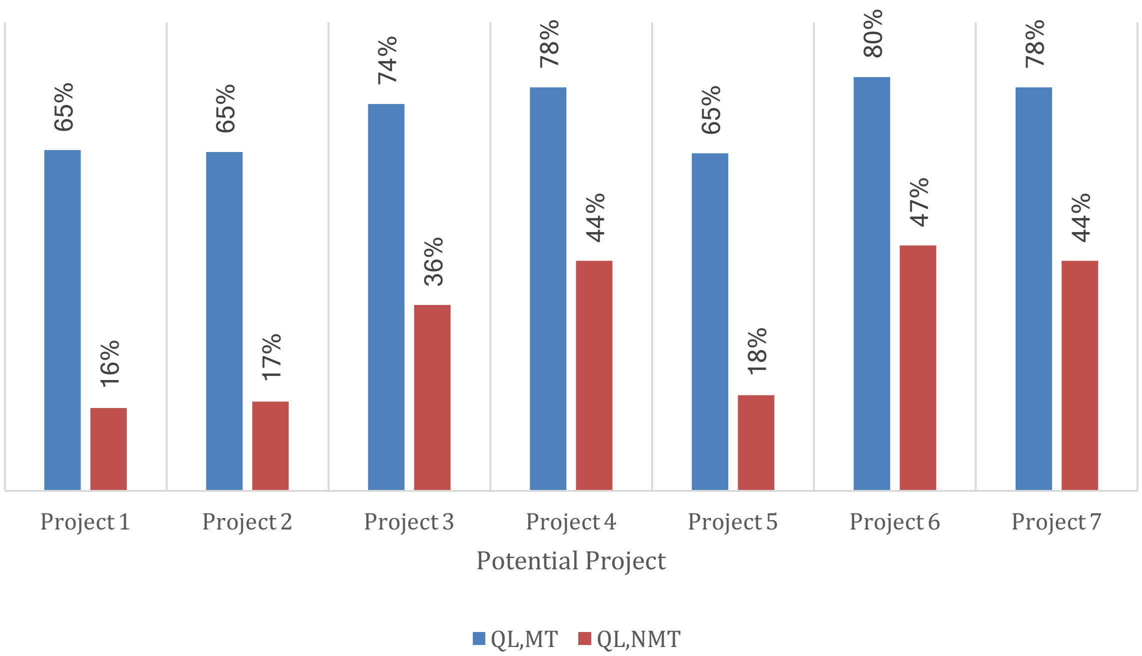


**Figure 4.7. Estimated current $Q_{L,MT}$ and $Q_{L,NMT}$ for potential projects.**

Project 6 has the highest current quality of infrastructure for motorised and non-motorised transport modes. This project links the village of Sane to Tshianane Secondary School (links 2 and 4). Project 1 has the lowest infrastructure quality for both motorised and non-motorised transport modes. This project includes link 1, which only connects the village of Mangwele to Sane Combined School.

The savings that will be made by completing each project were determined. The savings are simply the difference between the weighted accessibility index before the construction work and the index after the completion of the construction work. Equation 4.10 shows this. The weighted accessibility index is shown in Equation 3.17 on page 91 and depends largely in the AI index calculated as a product of the infrastructure quality index, the facility quality index and the transport quality index. Equation 3.17 also depends on the size of population using the road link to get to a specific facility. The population groups (POPG) for schools are shown in Table 4.28. The population groups (POPG) for the clinic are shown in Table 4.29. The investment made ($INSVT_{POPG}$) into the education and health departments are shown in Table 4.30. The ratios of accessibility savings to construction cost were determined for each project and were used to make a ranking of the projects, with the most efficient project being ranked first. Figure 4.9 summarises the savings, construction costs and the ratios of each project.

$$AI\ Savings = AI_w(before) - AI_w(after) \qquad \text{(Equation 4.10)}$$

where

$$AI_w(k) = \left(1 - AI_j(k)\right) \times POPG_j(k) \times INVST_{POPG} \qquad \text{(Equation 3.17)}$$

**Table 4.28. POPG values for the different schools according to village and mode of transport.**

| From/To | POPG | | |
|---|---|---|---|
| | Sane Combined School | Ramabulana Secondary School | Tshianane Secondary School |
| Mangwele (Walking) | 4.7 | 0 | 4.7 |
| Mangwele (Public Transport) | - | 7.1 | 18.8 |
| Sane (Walking) | - | 71.2 | 11.0 |
| Sane (Public Transport) | - | 0 | 2.7 |

**Table 4.29. POPG values for Straight Hardt Clinic according to village and mode of transport.**

| From/To | Straight Hardt Clinic (POPG) |
|---|---|
| Mangwele (Walking) | 13.4 |
| Mangwele (Public Transport) | 207.1 |
| Sane (Walking) | 316.8 |
| Sane (Public Transport) | 228.8 |

**Table 4.30. Investment values for educational and health department.**

| Facility | 2014 Budget | Users of Facility in South Africa | Investment per Capita ($INSVT_{POPG}$) |
|---|---|---|---|
| Basic education | R177 billion | 12 117 015 students | R14 607.56 |
| Public health care | R77 billion | 32 757 610 people | R2 350.60 |

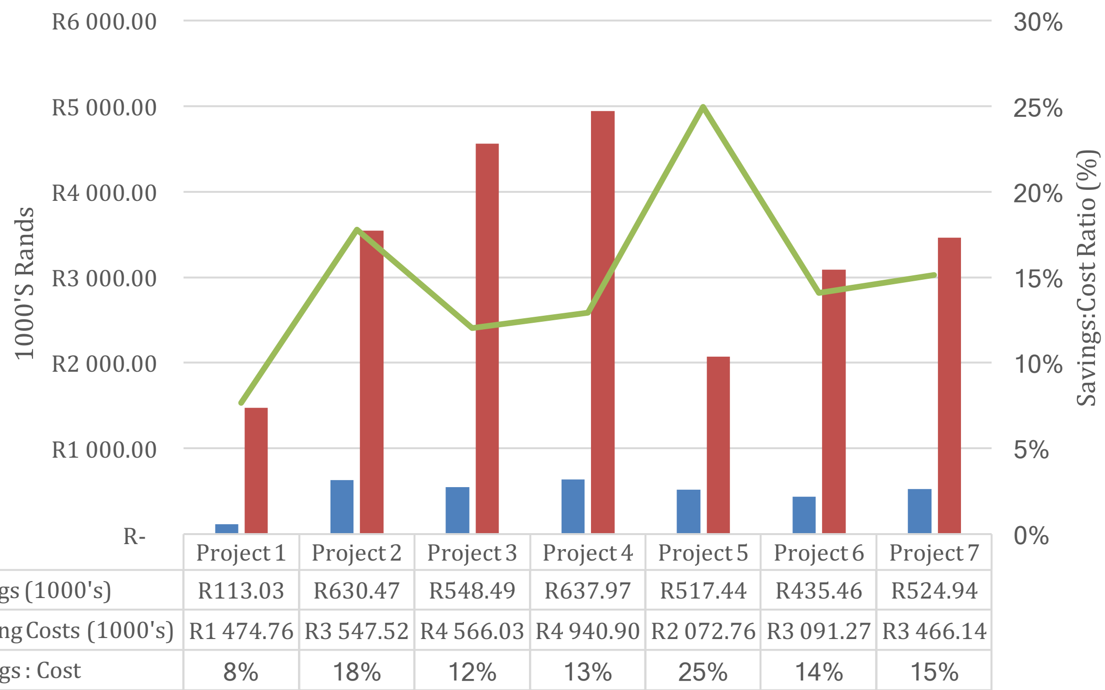


**Figure 4.8. Anticipated savings from weighted accessibility index, construction costs and AI savings:cost ratios of each potential project.**

The largest savings are made from Project 4 (R637 970.00). This project also has the highest required construction cost, which leads the project having the third lowest AI savings:cost ratio of 13%.

The highest ratio is estimated to be from Project 5. This project includes Road Links 2 and 3 and connects Sane to Ramabulana Secondary School and Straight Hardt clinic. This project has the highest ratio because residents of Mangwele also use the same route to get to the school and clinic.

The lowest ranked project is Project 1. This project consists of Road Link 1 and connects residents of Mangwele to Sane Combined School only. This is because only a few students (4) from Mangwele attend Sane Combined School. The route also makes up less than 50% of the travel route to the clinic.

The ranking is as follows:

1. Project 5
2. Project 2
3. Project 7
4. Project 6
5. Project 4
6. Project 3
7. Project 1

The most efficient potential project is Project 5. This project involves, largely, the dismantling of the badly damaged surfaced road sections and the construction of a gravel layer. The savings anticipated from the completion of the project are shown Table 4.31. As can be seen from the table, no savings from pupils to Sane Combined School are expected after completion of the Project. The majority of the savings is made from patients to the clinic from Sane. Students from Sane to Ramabulana Secondary School will be the most fortunate student benefactors.

The community of Sane will experience the most accessibility change. This is because Sane has a larger population than Mangwele as shown by the estimated POPG of each.

**Table 4.31. Anticipated savings of weighted accessibility index from Project 5 after completion of construction work.**

| To/From | Savings | |
|---|---|---|
| | Mangwele | Sane |
| Sane Combined | R- | R- |
| Ramabulana | R18 111.01 | R174 868.48 |
| Tshianane | R28 554.49 | R12 587.33 |
| Clinic | R60 594.81 | R222 721.66 |
| Total Savings | R517 437.78 | |
| Upgrading Costs | R2 072 757.50 | |
| AI Benefit:Cost | 25% | |

Figure 4.9 shows which transport mode contributes most to the savings. Non-motorised transport is anticipated to contribute 55% of the total savings from the change in the weighted accessibility index. This illustrates the importance of this travel mode in villages. Motorised transport is anticipated to contribute 45% towards the savings.

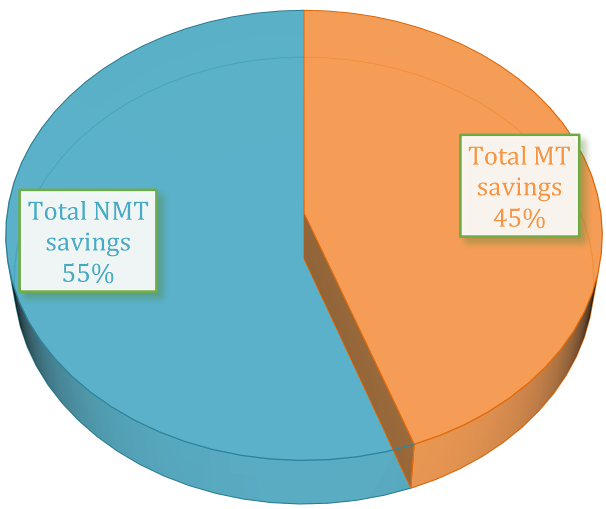


**Figure 4.9. Proportions of Project 5 weighted accessibility index savings according to transport mode.**

The anticipated weighted accessibility savings for Project 5 according to the village of departure, travel mode and destination are shown in Figure 4.10.

Figure 4.10 shows that the highest savings from Project 5 are obtained from pupils walking from the village of Sane to Ramabulana Secondary School. This is followed by persons travelling from Sane to Straight Hardt Clinic using both modes of transport. The community of Mangwele benefits the most only with journeys to Straight Hardt clinic using motorised transportation.

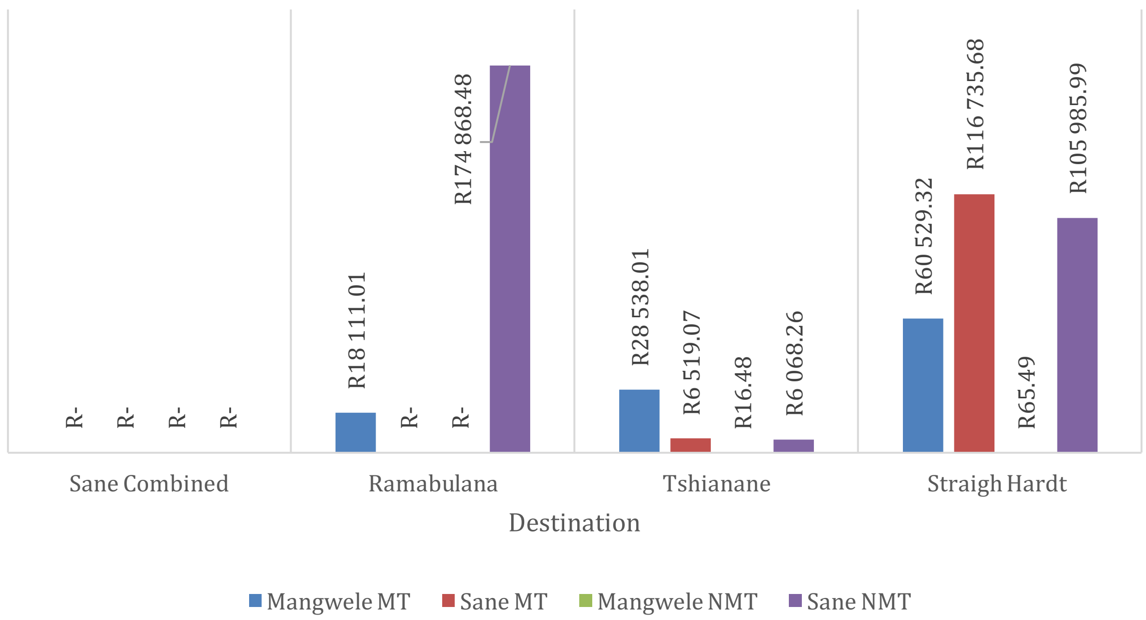


**Figure 4.10. Estimated Project 5 weighted accessibility index savings according to village, travel mode and destination.**

## 4.4 Optimisation of Selected Project

The optimisation of Project 5 was performed in case there is not enough capital to complete it in its entirety. The solver add-in in Microsoft Excel was used to select the segments from the links that will have the highest impact on the savings given the proportions of the required budget. The anticipated savings from reducing the budget are shown in Table 4.32. The table shows that, as a percentage there is less loss made in the savings than the loss on the available budget for the project (e.g. a 40% loss in budget translates to a 31% loss in potential savings)

**Table 4.32. Anticipated AI savings from proportioned Project 5 budgets.**

| Portion of full budget | Actual construction cost | AI savings | AI Savings:Cost Ratio | % Loss in Maximum Savings |
|---|---|---|---|---|
| 100% | R2 072 757.50 | R517 437.78 | 25% | 0% |
| 80% | R1 657 055.00 | R438 598.67 | 26% | 15% |
| 60% | R1 242 967.50 | R357 087.94 | 29% | 31% |
| 50% | R1 031 282.50 | R297 956.72 | 29% | 42% |
| 35% | R723 425.00 | R215 414.77 | 30% | 58% |

The selected segments for construction work from each budget portion are shown in Appendix H. The effects each budget proportion has on the quality of infrastructure per travel mode are shown in Figure 4.11.

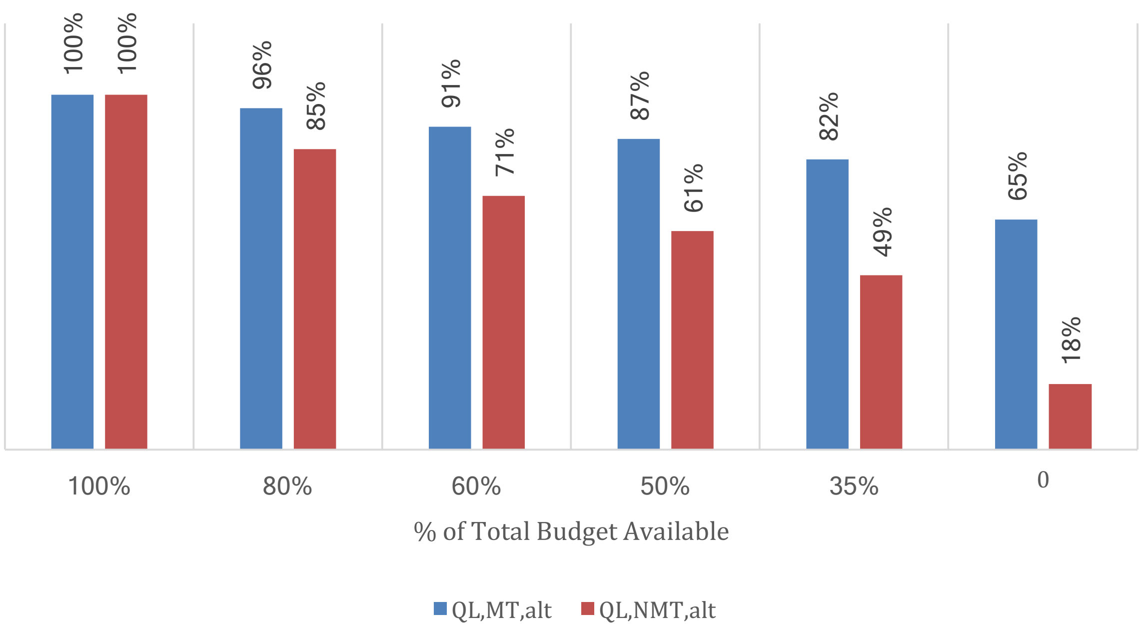


**Figure 4.11. Changes in Project 5 weighted AI savings with changing budget allocations.**

The effects of decreasing budget allocations are more severe in their effect on the pedestrian users of the road, as the road is largely too narrow. This is because the quality of the infrastructure in the case of non-motorised transport was relatively low to begin with (18%) when compared to that for motorised transport (65%). It is also because, when optimising the segments, the method does not allow for non-motorised upgrades to be done without upgrades/rehabilitation for motorised transport. In this sense, the entire cross section in the segment receives attention. The drop in $Q_L$ is higher for non-motorised transport with each drop in budget, relative to that of motorised transport. This is caused by the relatively higher $Q_L$ for motorised transport if no works are to be done.

# 5 Sensitivity Analysis

A sensitivity analysis exercise was performed to investigate the level of impact the variables have had on the potential AI savings from Project 5. This investigation can lead to further effective decisions being made about the quality of the facilities or the characteristics of the transport modes, which can increase the potential AI savings as estimated for Project 5. Further results are given in Appendix J.

**Table 5.1. Variables to be included in the sensitivity analysis exercise.**

| Education Quality | Education Transport | Health Care Quality | Health Care Transport |
|---|---|---|---|
| INCGRP | STU HH | DOC | WT |
| CLASS | SEC FEM | WAITt | PTCST |
| TEXTBKS | PRI FEM | | |
| | PRI MAL | | |
| | SEC MAL | | |
| | INC GRP | | |
| | WT | | |
| | PTCST | | |

Table 5.1 lists all the variables that will be investigated for their sensitivity to the potential AI savings of Project 5. The base savings are referred to as Scenario 0 (S0) are shown in Table 5.2.

**Table 5.2. Base values for weighted AI savings and savings after completion of proposed construction work for Project 5 Scenario 0.**

| **Scenario** | S0 |
|---|---|
| **Priced AI** | R2 248 093.51 |
| **Total Savings** | R517 437.78 |

## 5.1 Educational Variables

There are two models for three schools: one for the quality of the education facility and the other for the quality of the transport mode to the facility. Improving school quality will involve improving the availability of textbooks and/or the lowering of the number of learners in a classroom. Improving the transport mode quality will involve decreasing the cost of public transport and/or the walking time to the facility.

### 5.1.1 Effect of Textbook Availability (TEXTBKS)

The value of TEXTBKS was changed individually for each school. These values are shown in Table 5.3, and each change is described as a 'scenario'. The highlighted cells in the table represent those values which have been changed from the base Scenario S0, and whose percentage change is reflected in the table.

**Table 5.3. Sensitivity analysis Scenarios S0 to S6 for textbook availability (TEXTBKS) values for each school.**

| **Scenario** | S0 | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|
| **Ramabulana** | 1 | 1 | 1 | 1 | 0.6 | 1 | 1 |
| **Tshianane** | 0.85 | 0.85 | 1 | 0.85 | 0.85 | 0.51 | 0.85 |
| **Sane Combined** | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0.3 |
| **Percentage Change** | 0% | 0.0% | 17.6% | 100% | -40% | -40.0% | -40% |

**Table 5.4. Sensitivity analysis Scenarios S7 and S8 for textbook availability (TEXTBKS) values for each school.**

| **Scenario** | S7 | S8 |
|---|---|---|
| **Ramabulana** | 0.6 | 1 |
| **Tshianane** | 0.51 | 1 |
| **Sane Combined** | 0.3 | 1 |
| **Percentage Change** | -40% | 39% |

As can be seen from Table 5.3, the maximum value for TEXTBKS is 1 (or 100% TEXTBKS available). Figure 5.1 represents the results in Tables 5.3. and 5.4 graphically.

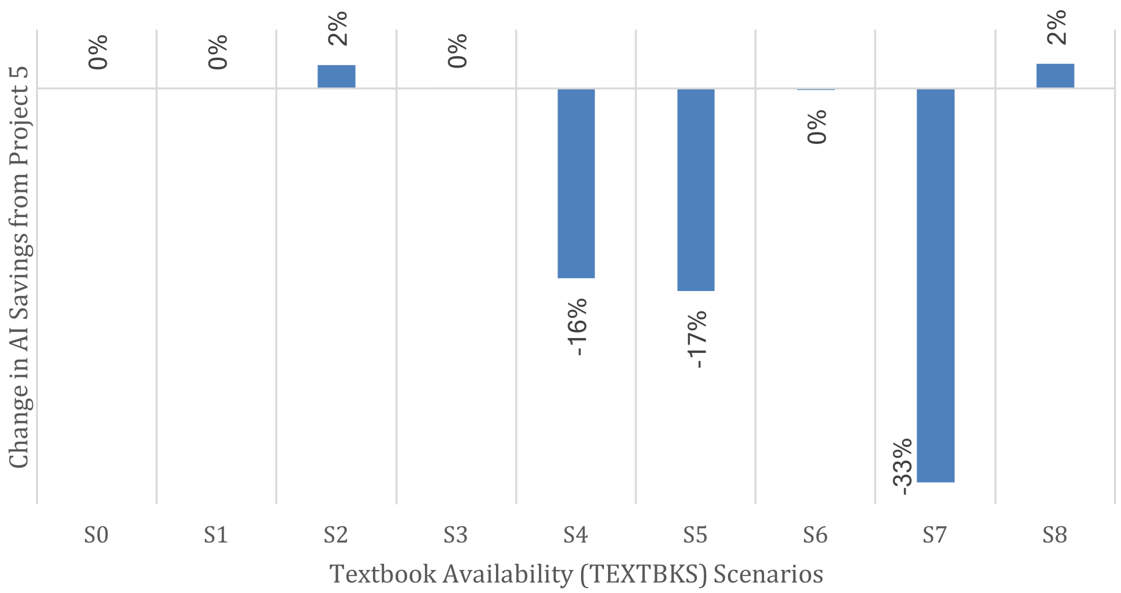


**Figure 5.1. Percentage change in AI savings of Project 5 with varying textbook availability (TEXTBKS) scenarios.**

The following conclusions can be made with reference to Figure 5.1:

- S1 has zero percentage change because the available textbooks were reported as 100%.
- The highest positive changes to the AI savings were only 2%, from S2 and S8. This was due to the increase in TEXBKS from Tshianane Secondary School.
- A positive or negative change to the availability of textbooks in Sane Combined School makes very little difference, because of the relativey low population group using the school (approximately 4% of total students).
- A 40% reduction in available textbooks in Ramabulana and Tshianane Secondary Schools caused a 16% and 17% reduction, respectively, in AI savings. This resulted in a combined 33% decrease for S7. S7 represents a 40% decrease in TEXTBKS for all schools.

### 5.1.2 Effect of Average Classroom Size (CLASS)

The values of average classroom size (CLASS) were changed individually for each school and were allocated into *scenarios*, just as was done for TEXTBKS (see Table 5.5). It was reported by John (2013) that in one school in the Eastern Cape, there were more than 1300 learners and only 24 teachers. This leads to an average of just over 54 learners per class. In a separate school, a grade two class was found to have 140 learners (John, 2013).

Bayet, *et al.* (2014) recommends a teacher to learner ratio of 1 to 25 for the lower grades of secondary schools. The average in the Western Cape is 29 learners per teacher and the most underperforming schools have a ratio of approximately 40 learners per teacher (Bayat, *et al.*, 2014).

**Table 5.5. Sensitivity analysis Scenarios S0 to S6 for average classroom size (CLASS) values for each school.**

| Scenarios | S0 | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|
| **Ramabulana High School** | 37 | 51 | 37 | 37 | 22 | 37 | 37 |
| **Tshianane Secondary School** | 29 | 29 | 40 | 29 | 29 | 17 | 29 |
| **Sane Combined School** | 24 | 24 | 24 | 34 | 24 | 24 | 14 |
| **Percentage Change** | 0% | 40.0% | 40% | 40% | -40.0% | -40% | -40% |

**Table 5.6. Sensitivity analysis Scenarios S7 and S8 for average classroom size (CLASS) values for each school.**

| Scenarios | S7 | S8 |
|---|---|---|
| **Ramabulana High School** | 54 | 25 |
| **Tshianane Secondary School** | 54 | 25 |
| **Sane Combined School** | 54 | 25 |
| **Percentage Change** | 87% | -14% |

Changing the size of an average classroom to 54, to match that reported by John (2013), represents an average increase of 87% in classroom size between the three schools. Changing the average size to 25, as was recommended by Bayet, *et al.* (2014), represents a decrease of 14% in classroom size between the three schools. The results from Tables 5.5 and 5.6 are illustrated in Figure 5.2 for each scenario.

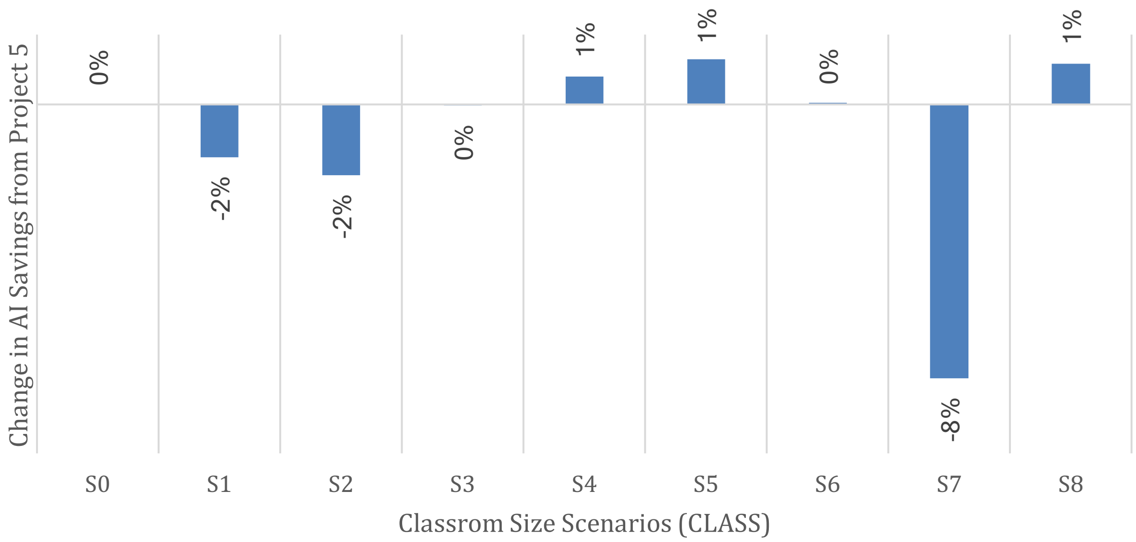


**Figure 5.2. Percentage change in AI savings of Project 5 with varying average classroom size (CLASS) scenarios.**

The following conclusions can be made with reference to Figure 5.2:

- Sane Combined School makes minimal difference in changes to the potential AI savings from Project 5 (S3 and S6).
- Ramabulana and Tshianane have similar effects on the savings but are not as significant to the changes applied to their values. A 40% change in their classroom size has only a 2% change on the savings.

Scenario 7 is a worst-case scenario, with all schools with a classroom size of 54 as was the case in a particular school in the Eastern Cape, as reported by John (2013). This, however, only causes an 8% drop in savings. Maintaining class size at the recommended size of 25 (a decrease of 14% on average), leads to only a 1% increase in savings. It can be concluded that TEXTBKS is more influential on the AI savings than CLASS.

### 5.1.3 Effect of Distance and Walking Time (WT)

Distance between the villages plays a more significant part for those walking than those using public transport. The fare charged for the bus remains the same for anyone from either village travelling to any of the facilities being studied in this research. The variable that takes into account distance, is the walking time (WT). This time is calculated assuming a walking speed of 5 km/h.

It is recommended that a school has a 5 km catchment radius (to 90% of population) (Green & Argue, 2012). S8 was designed to be the favourable scenario and limit all school distances from either village to 5 km. Schools that were already satisfying the recommendation were left as they were. This is shown in Table 5.8 for scenario S8. Scenario S7 represents the unfavourable scenario and involves increasing all distances by 40% of their original S0 values. Table 5.7 shows the current distances and public transport costs to the subject schools from Mangwele and Sane. The longest walking distance is observed between Mangwele and Tshianane Secondary School.

**Table 5.7. Current travel distances and public transport costs to subject schools from Sane and Mangwele.**

| Description | Village | Sane Combined School | Ramabulana Secondary School | Tshianane Secondary School |
|---|---|---|---|---|
| Distance from (km): | Sane | 0.35 | 6.84 | 10.91 |
| | Mangwele | 6.32 | 12.86 | 16.93 |
| Public transport cost from: | Sane | R6.36 | R6.36 | R6.36 |
| | Mangwele | R6.36 | R6.36 | R6.36 |

**Table 5.8. Descriptions for sensitivity analysis Scenarios S0, S7 and S8 for walking distance from villages to schools.**

| Scenario | Description |
|---|---|
| S7 ($S_{unfav}$) | 1.4*current |
| S8 ($S_{fav}$) | 5 km (if current > 5 km) |
| S0 | Current |

Table 5.9 shows the different scenarios investigated by changing the distances from Sane to the respective schools as shown. Table 5.10 shows Scenarios S7 and S8 for travelling from Sane to the schools.

**Table 5.9. Sensitivity analysis Scenarios S0 to S6 for walking distances values for each school from Sane.**

| Scenario | S0 | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|
| **Ramabulana** | 6.8 | 9.6 | 6.8 | 6.8 | 4.1 | 6.8 | 6.8 |
| **Tshianane** | 10.9 | 10.9 | 15.3 | 10.9 | 10.9 | 6.6 | 10.9 |
| **Sane Combined** | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.2 |
| **Percentage Change** | 0% | 40% | 40% | 40% | -40% | -40% | -40% |

**Table 5.10. Sensitivity analysis Scenarios S7 and S8 for walking distances values for each school from Sane.**

| Scenario | S7 ($S_{unfav}$) | S8 ($S_{fav}$) |
|---|---|---|
| **Ramabulana** | 9.6 | 5.0 |
| **Tshianane** | 15.3 | 5.0 |
| **Sane Combined** | 0.5 | 0.4 |
| **Percentage Change** | 40% | -29% |

Table 5.11 shows the distances of Scenarios S0 to S6 from Mangwele to the respective schools. Table 5.12 shows distances for Scenarios S7 and S8.

**Table 5.11. Sensitivity analysis Scenarios S0 to S6 for walking distances values for each school from Mangwele.**

| Scenario | S0 | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|
| **Ramabulana** | 12.9 | 18.0 | 12.9 | 12.9 | 7.7 | 12.9 | 12.9 |
| **Tshianane** | 16.9 | 16.9 | 23.7 | 16.9 | 16.9 | 10.2 | 16.9 |
| **Sane Combined** | 6.3 | 6.3 | 6.3 | 8.8 | 6.3 | 6.3 | 3.8 |
| **Percentage Change** | 0% | 40% | 40% | 40% | -40% | -40% | -40% |

**Table 5.12. Sensitivity analysis Scenarios S7 and S8 for walking distances values for each school from Mangwele.**

| Scenario | S7 ($S_{unfav}$) | S8 ($S_{fav}$) |
|---|---|---|
| **Ramabulana** | 18.0 | 5 |
| **Tshianane** | 23.7 | 5 |
| **Sane Combined** | 8.8 | 5 |
| **Percentage Change** | 40% | -29% |

Figure 5.3 is a graphical representation of Tables 5.9 to 5.12. From Figure 5.3, the following can be deduced:

- Pupils from Sane have a greater influence on the AI savings of Project 5 than those of Mangwele. This is because of the relatively small number of students enrolled from Mangwele (35) compared to those from Sane (85). More so is that there is an estimated 71 students enrolled in Ramabulana Secondary School from Sane, hence the high values of S1 and S4.
- The largest negative influence would come from increasing the distance to Ramabulana Secondary School. Pupils from Sane generally walk to this school and those from Mangwele use the bus service (see Table 5.13). Because there is no modal split model, pupils will still be assumed to walk to Ramabulana Secondary School from Sane even though the distance could actually make them switch to using the bus service.

- The largest positive influence on the AI savings from Project 5, is the decrease in distance to Ramabulana Secondary School. The reason for this is similar to that described in Point 1.
- Achieving the '5 km maximum' recommendation improves the savings by approximately 41%. Most of this saving is from the reduction in distance to Ramabulana Secondary School alone.

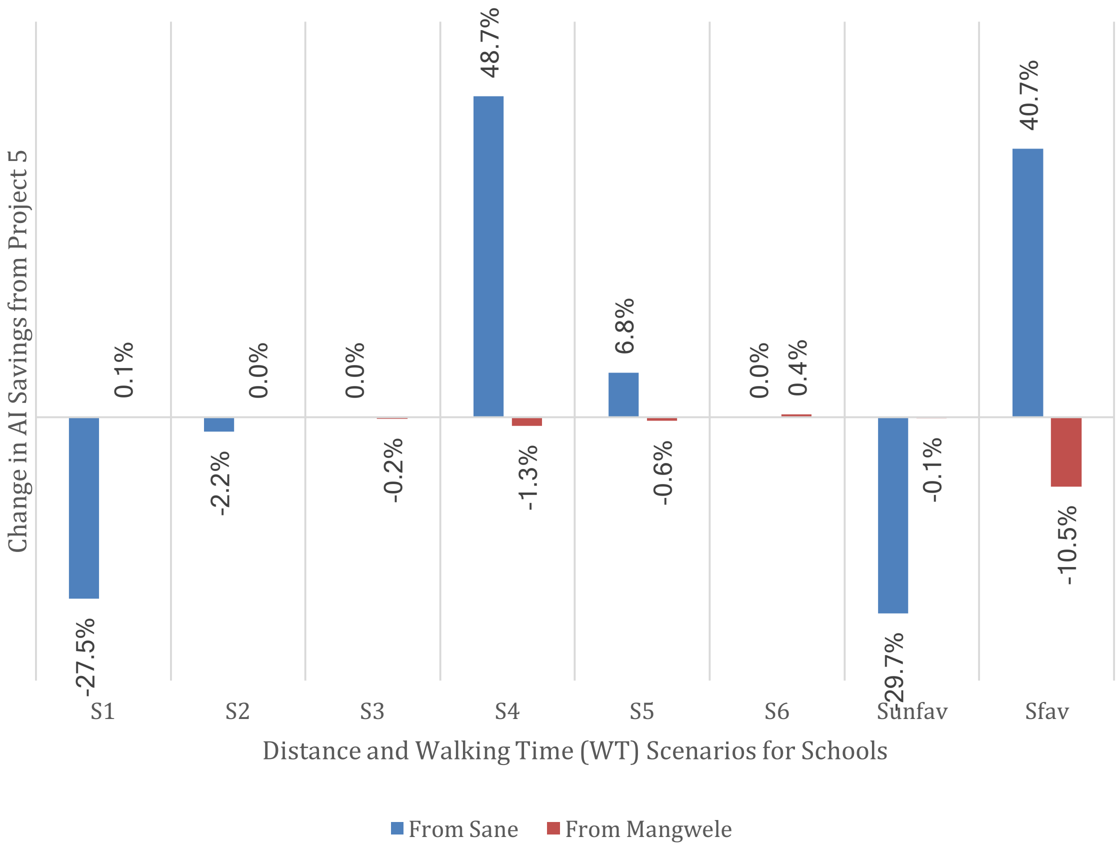


**Figure 5.3. Percentage change in AI savings of Project 5 with varying walking distance scenarios to schools from Sane and Mangwele.**

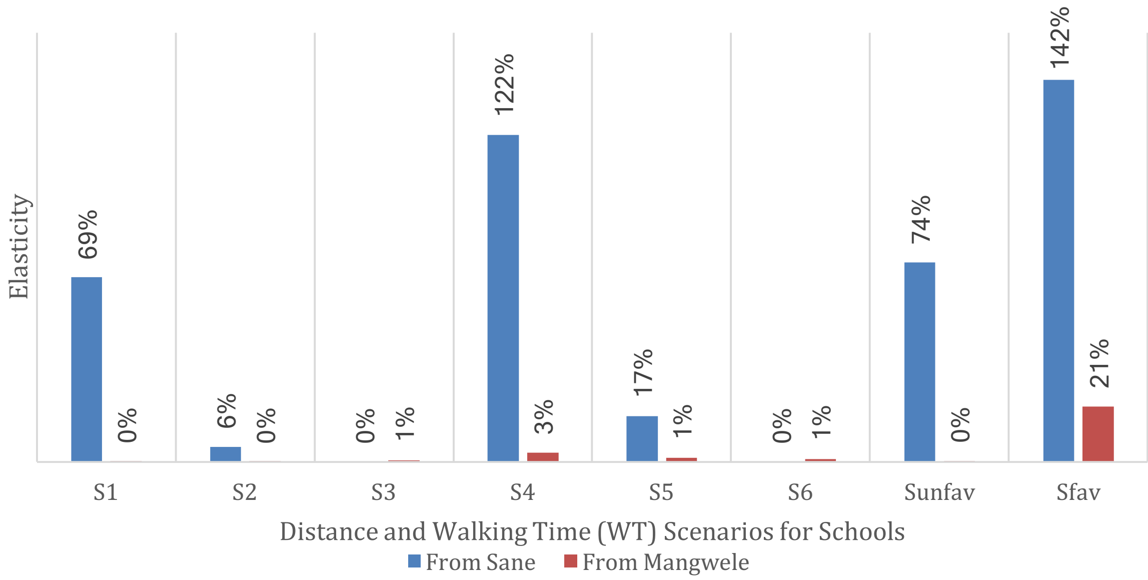


**Figure 5.4. Elasticity results on weighted AI savings for walking distance scenarios from each village to the subject schools.**

Figure 5.4 shows the elasticity of each scenario from both villages. Elasticity is described as the change in AI savings divided by the change in the variable. It is evident from the chart that the walking distance to Ramabulana Secondary School from Sane has the highest elasticity.

**Table 5.13. Estimated number of pupils enrolled at each subject school from Mangwele and Sane according to travel mode.**

| From/To | POPG | | |
|---|---|---|---|
| | **Sane Combined School** | **Ramabulana Secondary School** | **Tshianane Secondary School** |
| Mangwele (Walking) | 4.7 | 0 | 4.71 |
| Mangwele (Public Transport) | - | 7.1 | 18.8 |
| Sane (Walking) | - | 71.2 | 11.0 |
| Sane (Public Transport) | - | 0 | 2.7 |

Table 5.13 shows the estimated number of students enrolled at each school. Most enrolled students are from Sane, with Ramabulana Secondary School getting the largest proportion of the students.

### 5.1.4 Effect of Public Transport Cost (PTCST)

The cost of transport is largely associated with the bus service from the villages to the schools and vice-versa. The service is currently paid for on a monthly basis (R280.00 per person). In this chapter, the effect of the cost on the potential savings of Project 5 will be investigated. The costs were varied as shown in Tables 5.14 and 5.15. From Table 5.13, it can be seen that the most users of public transport to school, are users from Mangwele to Tshianane

**Table 5.14. Sensitivity analysis Scenarios S0 to S6 for public transport cost (PCST) values for each school from Sane and Mangwele.**

| Scenario | S0 | S1 | S2 | S3 | S4 | S5 | S6 |
|---|---|---|---|---|---|---|---|
| **Ramabulana** | R6.36 | R8.90 | R6.36 | R6.36 | R3.82 | R6.36 | R6.36 |
| **Tshianane** | R6.36 | R6.36 | R8.90 | R6.36 | R6.36 | R3.82 | R6.36 |
| **Sane Combined** | R6.36 | R6.36 | R6.36 | R8.90 | R6.36 | R6.36 | R3.82 |
| **Percentage Change** | 0% | 40.0% | 40% | 40% | -40.0% | -40% | -40% |

**Table 5.15. Sensitivity analysis Scenarios $S_{unfav}$ to $S_{fav}$ for public transport cost (PCST) values for each school from Sane and Mangwele school.**

| Scenario | $S_{unfav}$ | $S_{fav}$ |
|---|---|---|
| **Ramabulana** | R8.90 | R3.82 |
| **Tshianane** | R8.90 | R3.82 |
| **Sane Combined** | R8.90 | R3.82 |
| **Percentage Change** | 40% | -40% |

Figure 5.5 is a graphical representation of the scenarios in Tables 5.14 and 5.15.

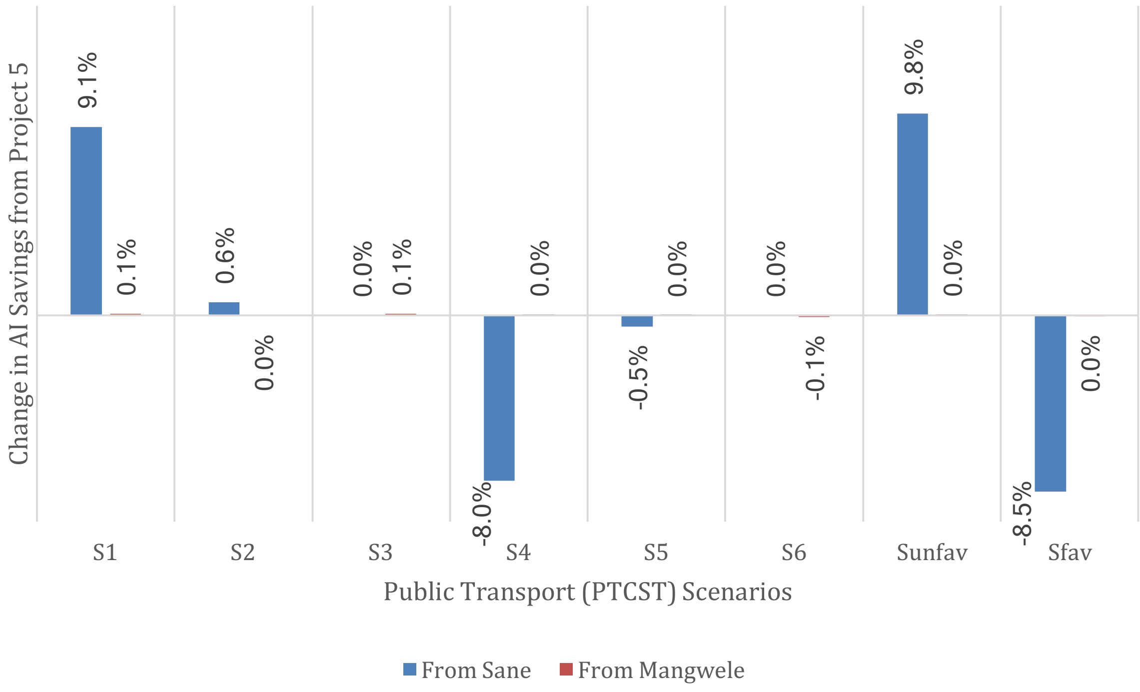


**Figure 5.5. Percentage change in AI savings of Project 5 with varying public transport cost (PTCST) scenarios to schools from Sane and Mangwele each.**

From Figure 5.5, the following can be deduced:

- Pupils going to Ramabulana Secondary School from Sane have the highest influence on the AI savings. The other schools make a negligible difference to the change in savings.
- Pupils walking to Ramabulana Secondary School have the biggest effect on PTCST, because the increase in bus fare increases the preference for walking. They are the sole contributors to gain as seen in Figure 5.5.
- The decrease in the bus fare to Ramabulana decreases the preference to walking. Because there is no modal split model, the pupils walking are now trapped into only walking and are at a disadvantage.
- There same structures are seen in $S_{unfav}$ and $S_{fav}$.

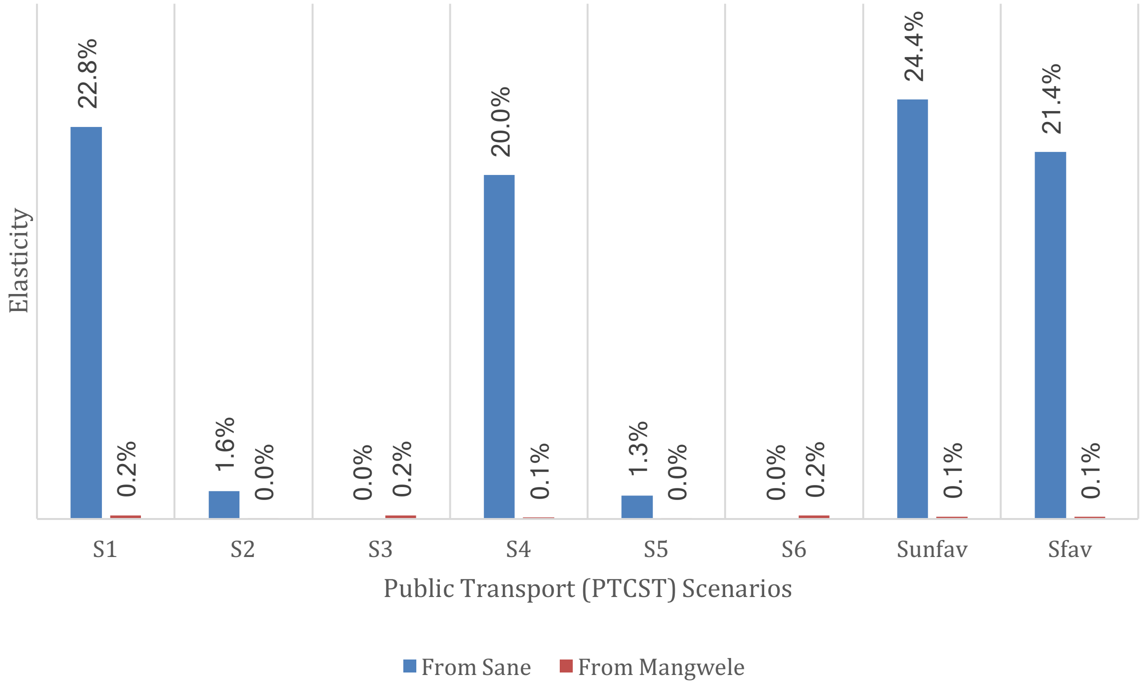


**Figure 5.6. Elasticity results on weighted AI savings for public transport cost (PTCST) scenarios from each village to the subject schools.**

Figure 5.6 shows the elasticity of the variables as calculated for the various scenarios. Scenarios S1 and S4 have the highest elasticity for reasons similar to those of these scenarios having the biggest effect on the AI savings.

### 5.1.5 Effects of Household Income (INC GROUP)

The average household expenditure in the period from September 2008 to August 2009 was R 74 292 in South Africa (Statistics South Africa, 2011). Considering inflation, this figure is approximately R106 250 in October 2016 (Crause, 2014). This translates to R 8 854 per month. This amount will form the favourable scenario for household income. The lower limit of the poverty line was determined to be R620 per capita in March 2011 (Statistics South Africa, 2014a). The lower limit poverty will be taken as representing the unfavourable scenario for household income. This translates to approximately R830 per capita in October 2016 (Crause, 2014). The upper limit poverty line is R2 380 in a household of four people adjusted for October 2016 (Statistics South Africa, 2014a). The upper limit falls under category 3. This implies that on average, households in both villages fall below the upper limit poverty line. This is shown in Figure 5.7.

The scenarios for the household income are shown in Table 5.16. The average household size for the villages, according to Table 3.4, is four persons.

**Table 5.16. Descriptions for sensitivity analysis Scenarios S0, S1, S2, $S_{unfav}$ and $S_{fav}$ for average household income (INC GROUP) from villages and income categories.**

| Scenario | Description | Income Category (Table 3.14) |
|---|---|---|
| $S_0$ | Current values | Current category (2) |
| S1 | R800 | 1 |
| S2 | R2 367 | 3 |
| $S_{unfav}$ | R 830 * 4 = R 3320 | 4 |
| $S_{fav}$ | R 8 854 | 5 |

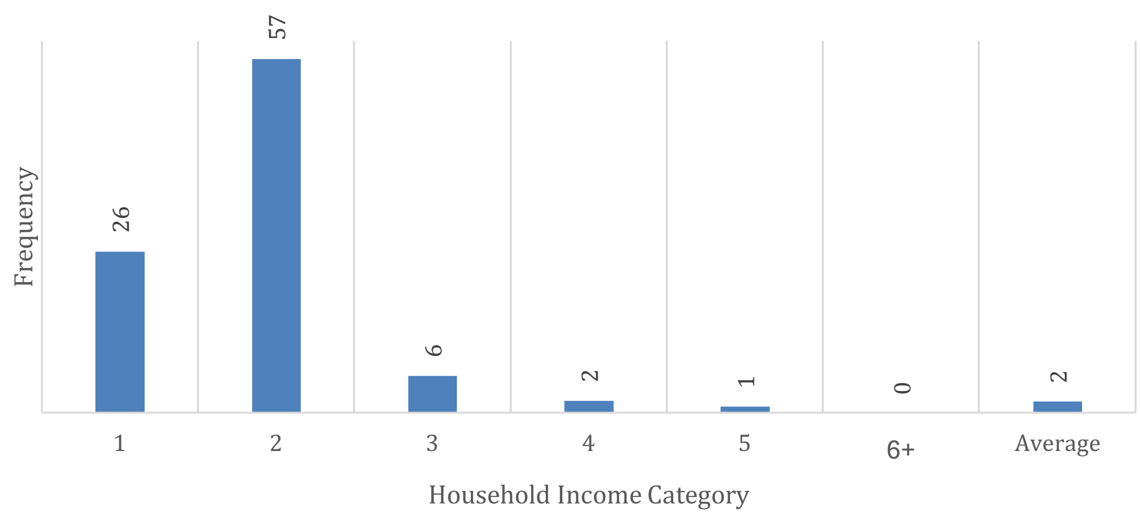


**Figure 5.7. Income category frequencies for Sane and Mangwele combined.**

The resulting savings, which can be expected from varying the income categories, are shown in Figure 5.8.

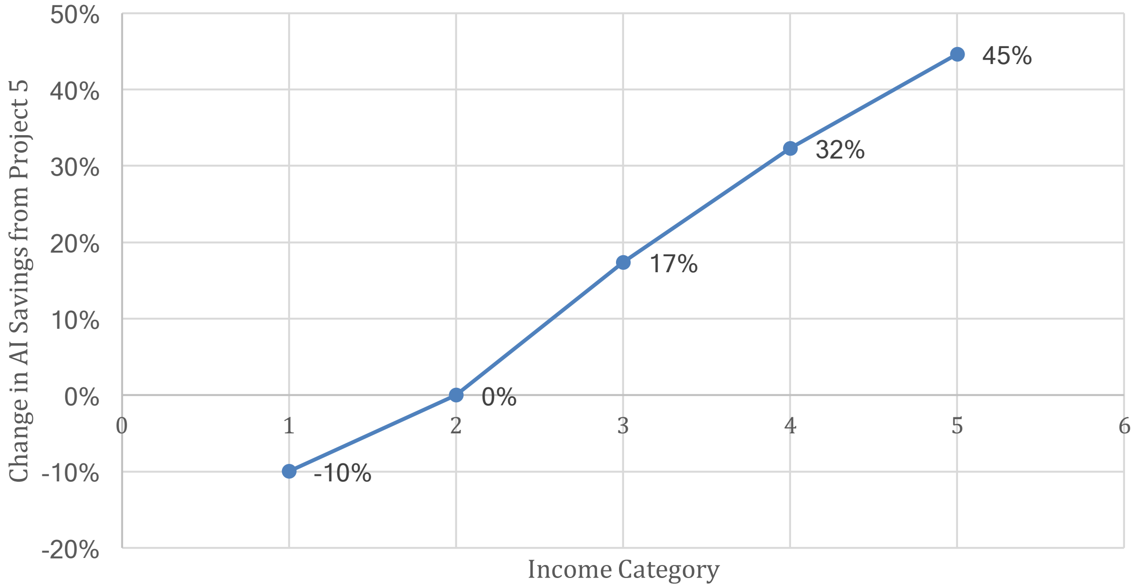


**Figure 5.8. Percentage change in AI savings of Project 5 with varying average household income categories (INC GROUP) scenarios from Sane and Mangwele.**

The savings increase when the household income increases. An increase in income group decreases satisfaction with the quality of schools. Savings from walking increase with increasing income group, whilst savings from public transport users decrease. The resulting increase in AI savings is from pupils walking to schools.

### 5.1.6 Effect of Student Characteristics (STU HH, PRI FEM, SEC FEM, PRI MAL and SEC MAL)

The number of students in a household, the type of school they are in and their respective genders all affect the quality and transport models for education. These factors will be investigated in this section, to study the changes they will have on the savings as forecast from results of Project 5.

The number of students will be changed as shown in Tables 5.17 and 5.18.

**Table 5.17. Sensitivity analysis Scenarios S0 to S8 for average student characteristics for households in Sane.**

| Scenario | STU HH | PRI FEM | SEC FEM | PRI MAL | SEC MAL | Description |
|---|---|---|---|---|---|---|
| S0 | 1.4 | 0.4 | 0.4 | 0.5 | 0.2 | None |
| S1 | 1.5 | 0.5 | 0.4 | 0.5 | 0.2 | (PRI FEM) * 1.40 |
| S2 | 1.5 | 0.4 | 0.5 | 0.5 | 0.2 | (SEC FEM) * 1.4 |
| S3 | 1.6 | 0.4 | 0.4 | 0.7 | 0.2 | (PRI MAL) * 1.4 |
| S4 | 1.5 | 0.4 | 0.4 | 0.5 | 0.2 | SEC MAL) * 1.4 |
| S5 | 1.2 | 0.2 | 0.4 | 0.5 | 0.2 | (PRI FEM) * 0.6 |
| S6 | 1.2 | 0.4 | 0.2 | 0.5 | 0.2 | (SEC FEM) * 0.6 |
| S7 | 1.2 | 0.4 | 0.4 | 0.3 | 0.2 | (PRI MAL) * 0.6 |
| S8 | 1.3 | 0.4 | 0.4 | 0.5 | 0.1 | (SEC MAL) * 0.6 |

**Table 5.18. Sensitivity analysis Scenarios S0 to S8 for average student characteristics for households in Mangwele.**

| Scenario | STU HH | PRI FEM | SEC FEM | PRI MAL | SEC MAL | Description |
|---|---|---|---|---|---|---|
| S0 | 2.1 | 0.5 | 0.3 | 0.9 | 0.4 | None |
| S1 | 2.5 | 0.8 | 0.3 | 0.9 | 0.4 | (PRI FEM) * 1.40 |
| S2 | 2.3 | 0.5 | 0.5 | 0.9 | 0.4 | (SEC FEM) * 1.4 |
| S3 | 2.5 | 0.5 | 0.3 | 1.3 | 0.4 | (PRI MAL) * 1.4 |
| S4 | 2.3 | 0.5 | 0.3 | 0.9 | 0.6 | (SEC MAL) * 1.4 |
| S5 | 1.9 | 0.3 | 0.3 | 0.9 | 0.4 | (PRI FEM) * 0.6 |
| S6 | 2.0 | 0.5 | 0.2 | 0.9 | 0.4 | (SEC FEM) * 0.6 |
| S7 | 1.8 | 0.5 | 0.3 | 0.5 | 0.4 | (PRI MAL) * 0.6 |
| S8 | 2.0 | 0.5 | 0.3 | 0.9 | 0.3 | (SEC MAL) * 0.6 |

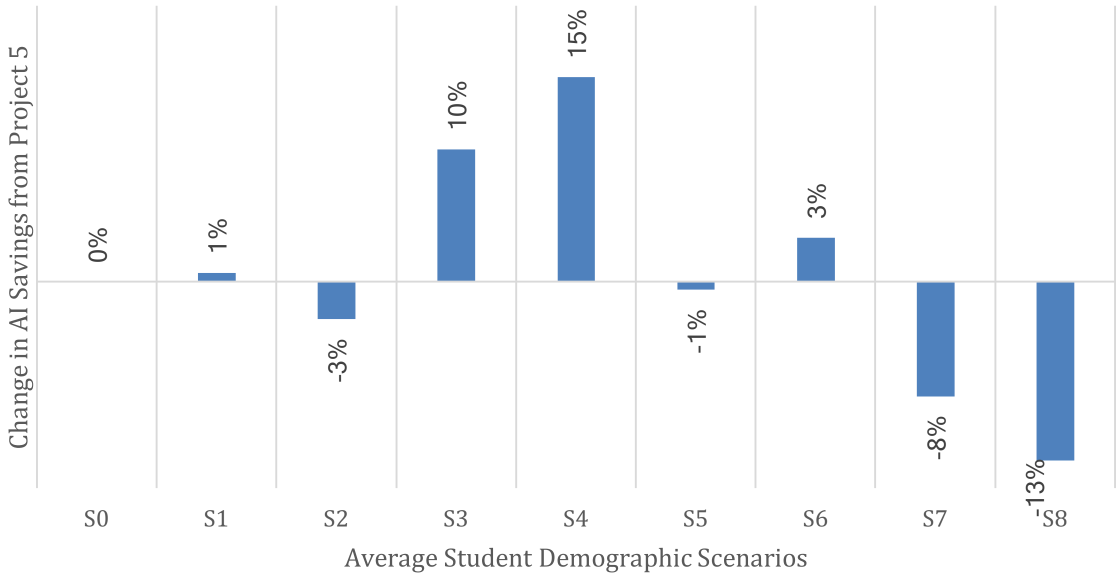


**Figure 5.9. Percentage change in AI savings of Project 5 with varying average household student characteristic scenarios from Sane and Mangwele.**

From Figure 5.9, increasing and decreasing the number of males in secondary school (S4 and S8) had the biggest effect on increase and decrease in savings, of 15% and -13% respectively. Primary male numbers resulted in the second highest increase and decrease in AI savings. This is because of their lesser preference for public transport compared to their female counterparts.

### 5.1.7 Comparison of Education Variables

Figure 5.10 shows the effects of decreasing and increasing each variable in the educational models on the AI savings of Project 5. The variables are compared at 40% increase and 40% decrease.

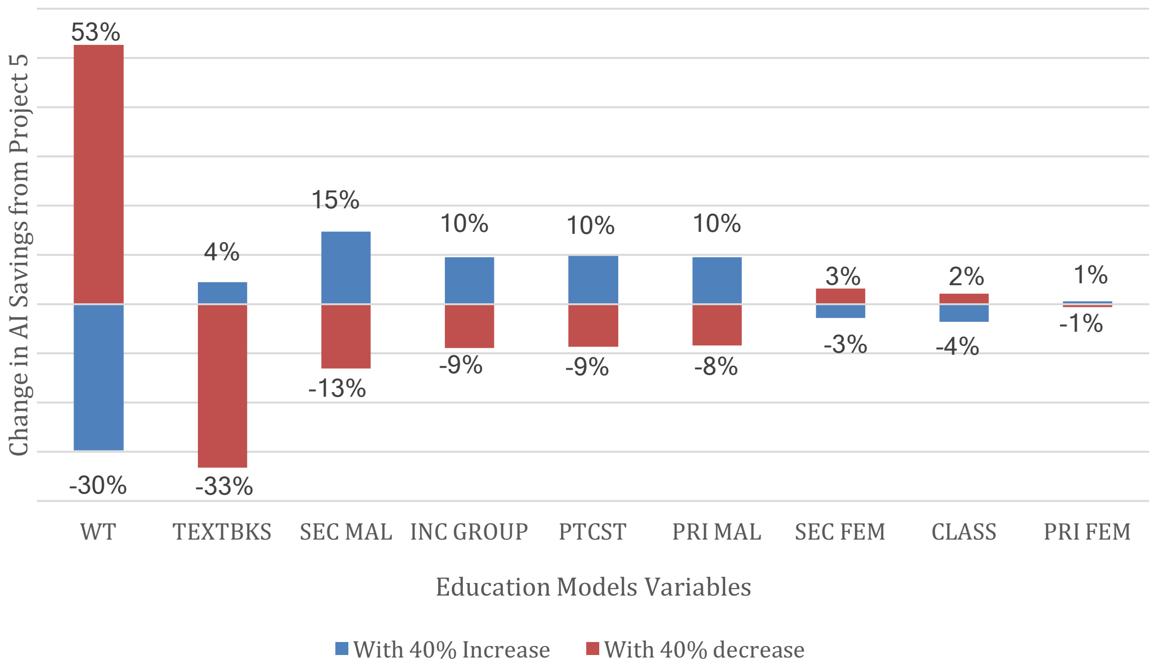


**Figure 5.10. Comparison of sensitivity of variables to the Project 5 AI savings when value is increased and decreased by 40%.**

Walking time (WT) has the biggest influence on the savings. This is followed by textbook availability (TEXTBKS), and number of secondary males (SEC MAL). It should be noted that the effect of walking time (WT) is affected by the lack of a modal split model.

## 5.2 Health Care Variables

The health care quality model is dependent on the waiting time (WAITt) at the clinic and the doctor availability (DOC) variables. The health care transport model is dependent on the walking time (WT) and the public transport cost (PCOST). The effects these variables have on the overall potential savings of Project 5 will be investigated in this section.

### 5.2.1 Effects of Waiting Time (WAITt)

The waiting time in this model has only two levels, these are:

- Two hours or more
- Less than two hours

The scenarios which will be investigated in this section are shown in Table 5.19.

**Table 5.19. Sensitivity analysis Scenarios S0 to S4 for average waiting time at Straight Hardt Clinic for households in Mangwele and Sane.**

| Scenario | S0 | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|
| WAITt | Current | 2 hours or more | Less than 2 hours | Waiting times * 1.4 | Waiting times * 0.6 |

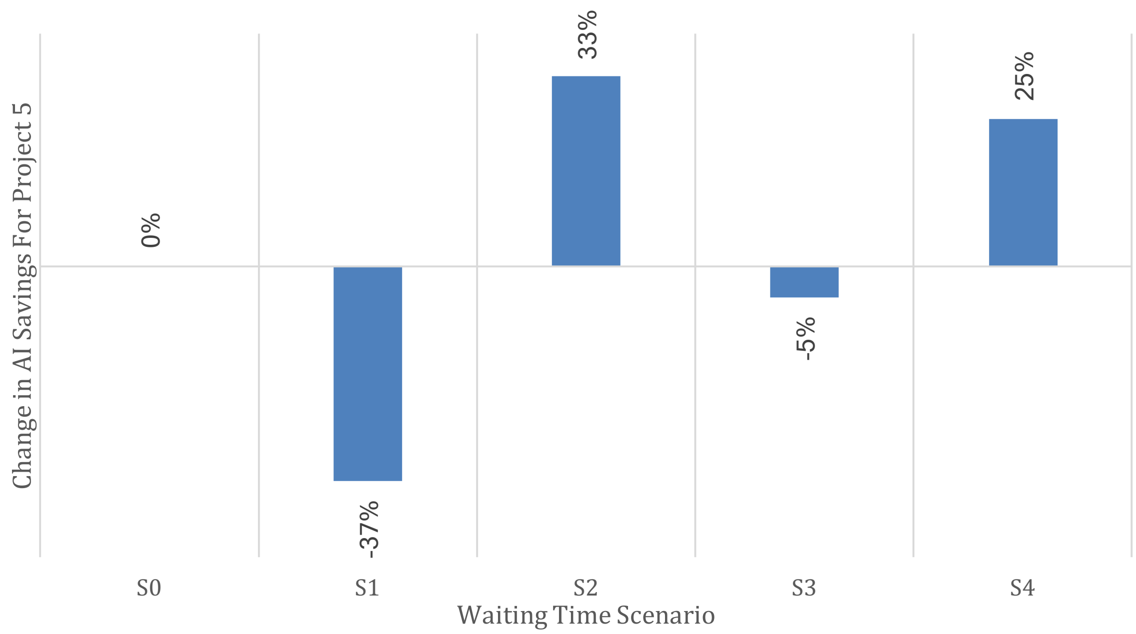


**Figure 5.11. Percentage change in AI savings of Project 5 with varying waiting time (WAITt) at Straight Hardt Clinic scenarios.**

From Figure 5.11, increasing the waiting times to two hours or more has the biggest negative impact on the savings (-37%). If all community members experienced a waiting time of less than two hours at the clinic, savings could increase by 33%.

### 5.2.2 Effect of Doctor Visitation (DOC)

The doctor visitation frequency is described as the number of days between doctor visitations at the clinic. The model input for this variable is the number of days between the visits. The scenarios for the sensitivity analysis of the DOC variable are shown in Table 5.20.

**Table 5.20. AI savings sensitivity analysis Scenarios S0 to S5 for doctor visitation (DOC) at Straight Hardt Clinic.**

| Scenario | Frequency of Doctor Visitation |
|---|---|
| S1 | Every day (1 day) |
| S2 | Once a week (7 days) |
| S3 | Once a month (30.42 days) |
| S4 | Current * 1.4 |
| S5 | Current * 0.6 |

The changes in Project 5 AI Savings caused by the scenarios in Table 5.20 are shown in Figure 5.12.

From Figure 5.12, it can be seen that decreasing the frequency of visitations to one each day, improves the savings by only 2%. The current visitation frequency of every second day is viewed as very positive for the social well-being of the communities. Decreasing the frequency of visitations to once per month has very high negative impacts on the potential savings from implementing Project 5.

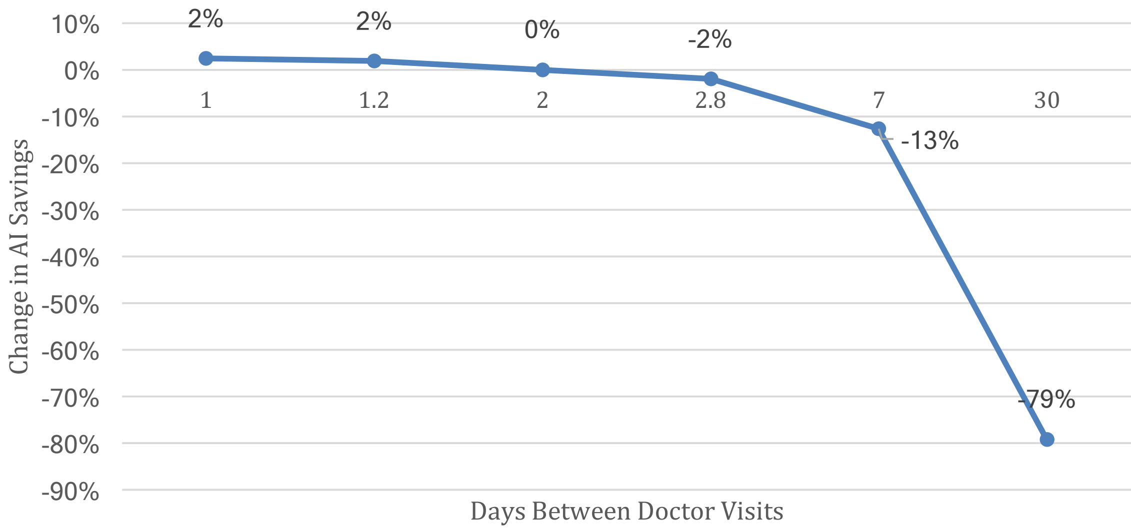


**Figure 5.12. Percentage change in AI savings of Project 5 with varying doctor visitation (DOC) scenario values at Straight Hardt Clinic.**

### 5.2.3 Effect of Transport Cost (PTCST)

The transport AI for the clinic is affected by the costs of public transport and the time taken to walk to the clinic. The resulting effect the cost of transport has on Project 5 savings will be investigated in this section. The scenarios that will be used to investigate the variable PTCST are shown in Table 5.21.

**Table 5.21. AI savings sensitivity analysis Scenarios S0 to S5 for public transport cost (PTCST) to Straight Hardt Clinic.**

| Scenario | Value | Average | Percentage change from current |
|---|---|---|---|
| S0 | Current values | R10.20 | 0% |
| S1 | R0 | R0.00 | -100% |
| S2 | R5 | R5.00 | -51% |
| S3 | R15 | R15.00 | 47% |
| S4 | Current value * 1.4 | R14.28 | 40% |
| S5 | Current value * 0.6 | R6.12 | -40% |

Scenario S1 represents a case where free transport is provided to the clinic. The most expensive fare is from Scenario S3 at R15.00 and this represents a 47% increase from the currently charged bus fare in the area.

Figure 5.13 shows the potential change caused by changing the PTCST variables according the various Scenarios listed in Table 5.21.

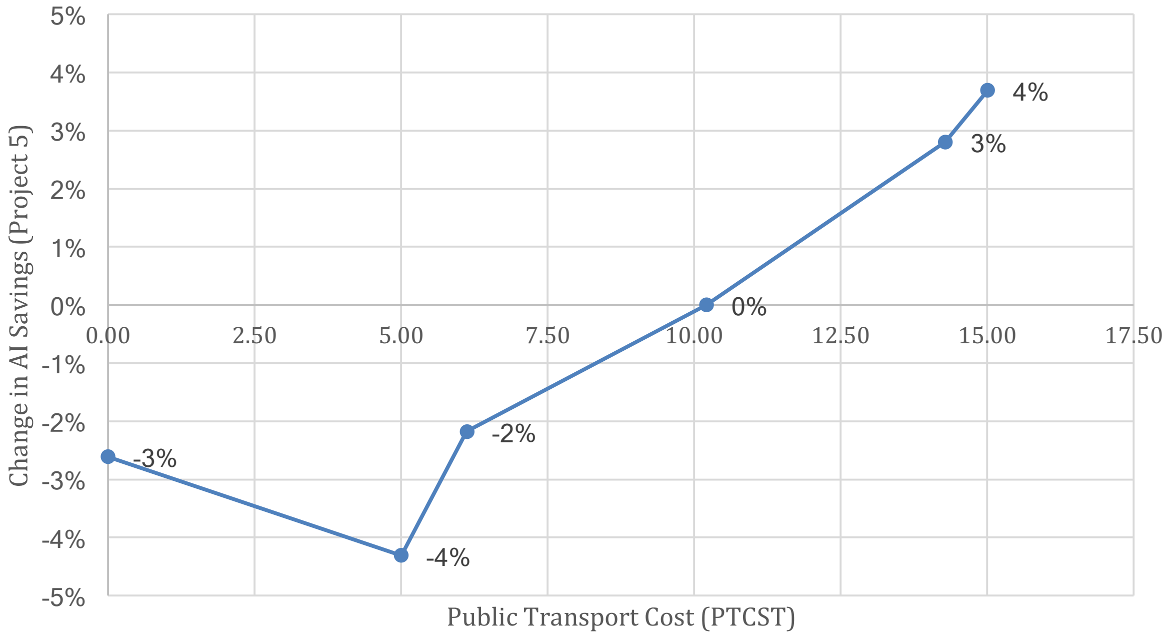


**Figure 5.13. Percentage change in AI savings of Project 5 with varying public transport cost (PTCST) values at Straight Hardt Clinic.**

From Figure 5.13, it is evident that increasing the current cost to go to the clinic increases the potential AI savings of Project 5. This is because of the savings made from walking to the clinic from Sane. The preference for walking increases with increasing PTCST, which in turn increases the savings from walking to the clinic from Sane (see Figure 5.15). The savings from using the bus from Sane to the clinic decreases with increasing PTCST (see Figure 5.14). This decrease, however, is less than the increase witnessed from the walking group.

Project 5 entails work on Road Links 2 and 3. This means that for patients from Sane, their entire journey is improved. Road Link 1 will remain unchanged and therefore the benefits of Project 5 for Mangwele residents will be experienced only once they reach Road Link 2. The community members from Mangwele are trapped into using the bus service because the distance from Mangwele to the clinic is too great to walk (12.8 km). Their preference does not change by any significant margin when the cost increases, because of the overwhelming walking time. This is shown in Figure 5.16.

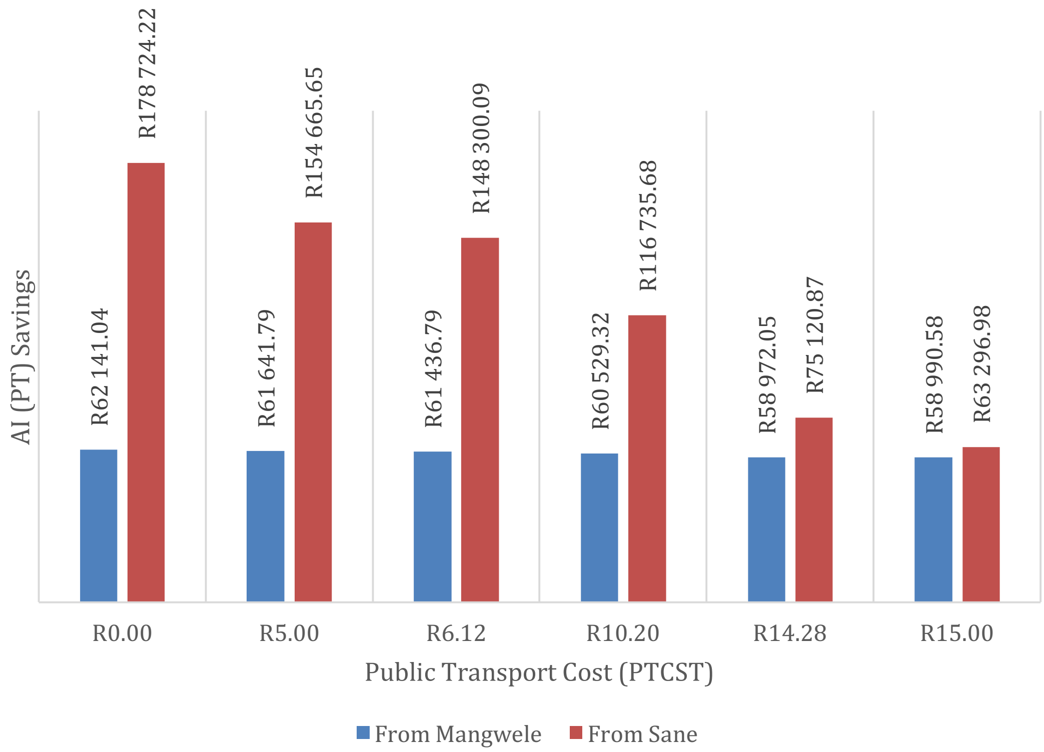


**Figure 5.14. Effect of varying public transport costs (PTCST) in AI (public transport) cost savings.**

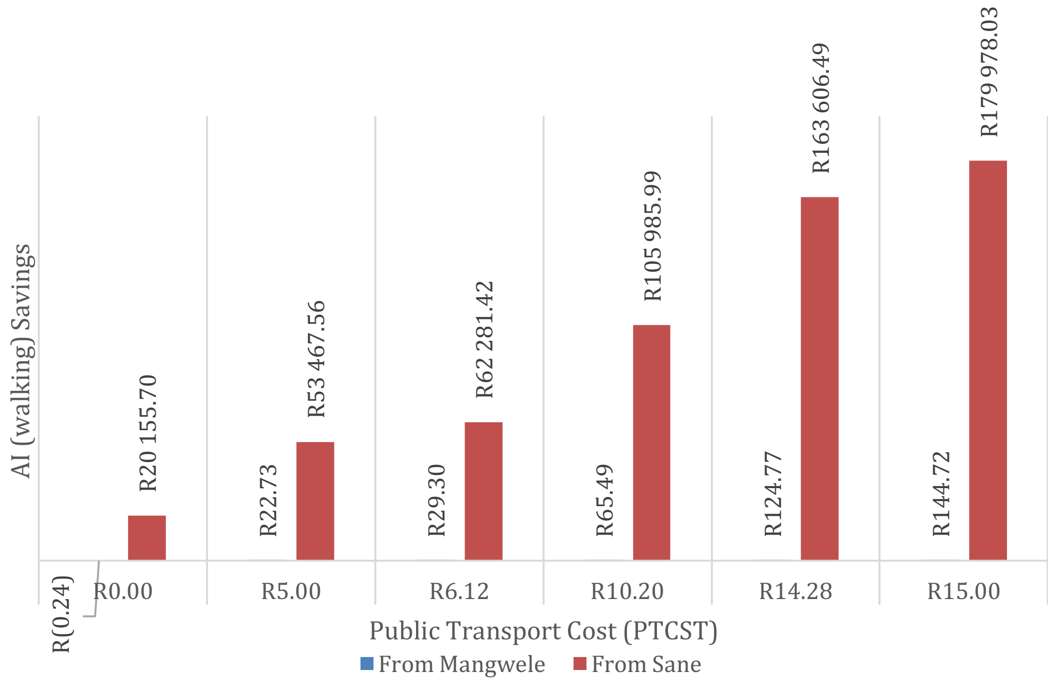


**Figure 5.15. Savings from those walking to the clinic according to varying public transport costs (PTCST).**

It should be noted that the model did not take into account the fact that commuters who use public transport can decide to walk or not to go when the fare was perceived as being unreasonably expensive. This affected the values, as it had been assumed that the same number of commutes on the bus and by walking would always occur, regardless of the PTCST value.

### 5.2.4 Effect of Clinic Distance and Walking Time (WT)

The distance to a clinic influences the walking time (WT) to the clinic. This variable is only effective on the transportation model to the clinic. The distances to the clinic from the villages are shown in Table 5.22.

**Table 5.22. Distances and walking times to Straight Hardt Clinic from Sane and Mangwele.**

| From | Distance (km) | Walking time (WT) (minutes) |
|---|---|---|
| Sane | 6.8 | 82 |
| Mangwele | 12.82 | 153.84 |

Those who walk from Mangwele to the clinic experience the longest walking time.

The scenarios, which will be considered when investigating the sensitivity WT has on the AI Savings from Project 5, are shown in Tables 5.23, 5.24 and 5.25. The tables also show the hypothetical location of the clinic in the different scenarios.

**Table 5.23. AI savings sensitivity analysis Scenarios S0 to S3 for walking distances to Straight Hardt Clinic from Sane and Mangwele.**

| Scenario | S0 | S1 | S2 | S3 |
|---|---|---|---|---|
| **Sane (S) (km)** | 6.8 | 11 | 6 | 5 |
| **Mangwele (M) (km)** | 12.8 | 5 | 0 | 1 |
| **Location** | Current position | Before Mangwele | In Mangwele | Between M and S |

**Table 5.24. AI savings sensitivity analysis Scenarios S4 to S6 for walking distances to Straight Hardt Clinic from Sane and Mangwele.**

| Scenario | S4 | S5 | S6 |
|---|---|---|---|
| **Sane (S) (km)** | 1 | 0 | 5 |
| **Mangwele (M) (km)** | 5 | 6 | 11 |
| **Location** | Between M and S | In Sane | After Sane |

**Table 5.25. AI savings sensitivity analysis Scenarios S7 and S8 for walking distances to Straight Hardt Clinic from Sane and Mangwele.**

| **Scenario** | S7 | S8 |
|---|---|---|
| **Sane (S) (km)** | 9.5 | 4.1 |
| **Mangwele (M) (km)** | 17.9 | 7.7 |
| **Location** | After Sane | After Sane |

The longest distance to the Straight Hardt Clinic is in Scenario S7 from Mangwele at approximately 18 km. S2 represents a scenario where the clinic is located in Mangwele and S5 where it is located in Sane.

The potential AI Savings from the Scenarios are shown in Figure 5.18 for AI Savings from Mangwele, Sane and the total from both villages. The percentage change in AI Savings according to having the clinic at varying distances from Mangwele, according to the scenarios, is shown in Figure 5.17.

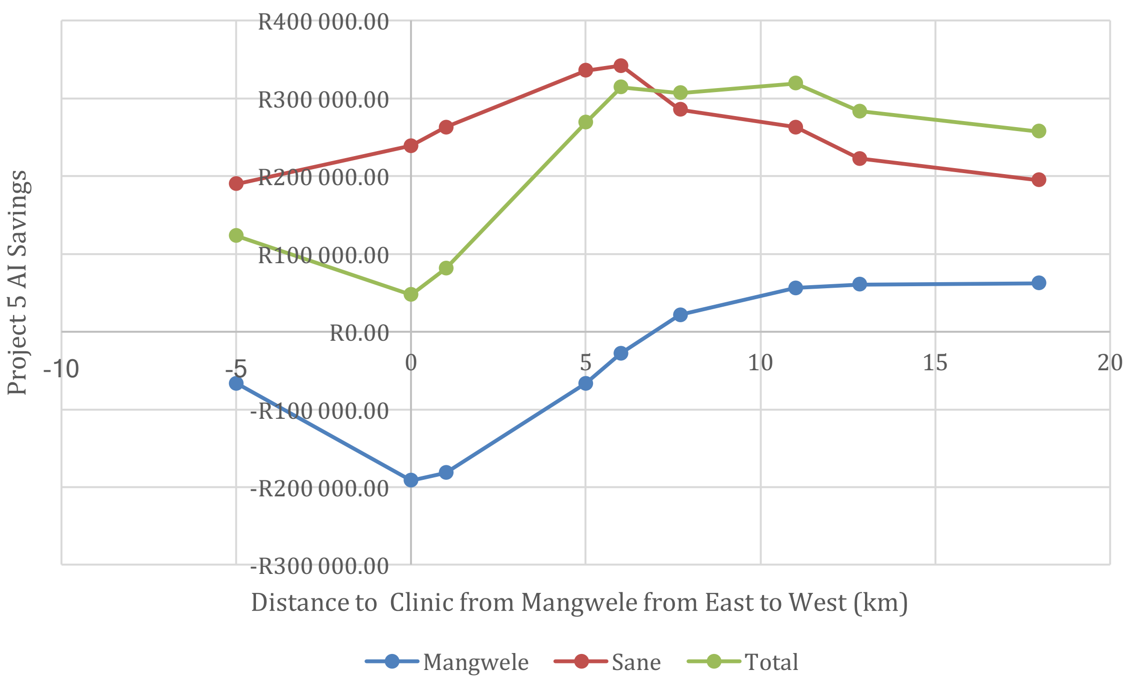


**Figure 5.16. Potential AI savings according varying clinic distances from Mangwele.**

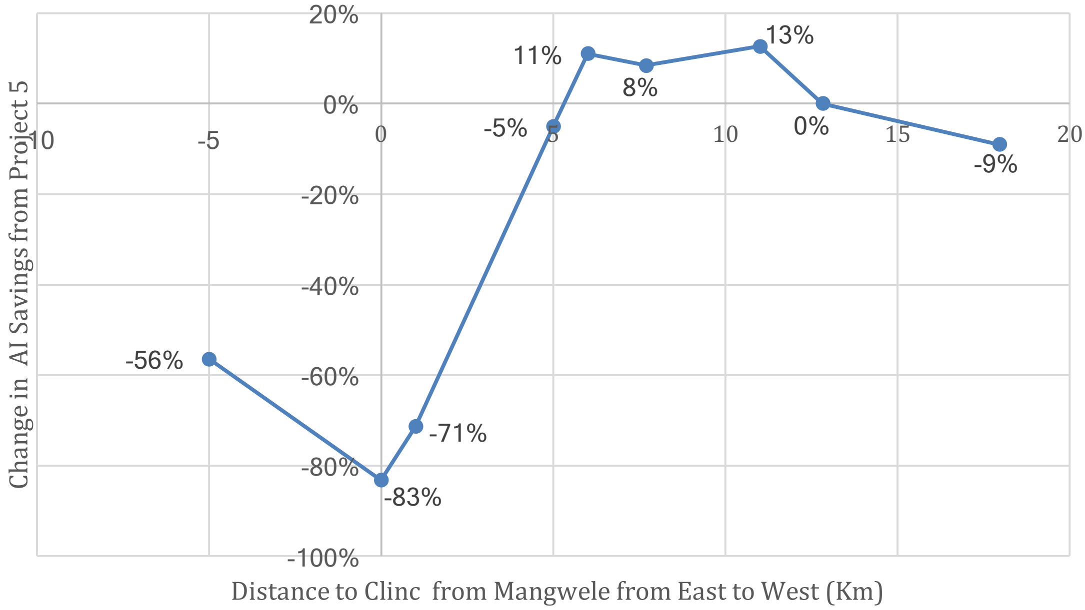


**Figure 5.17. Percentage change in base Project 5 AI savings according to varying clinic distance from Mangwele.**

The AI savings from Sane came from both the persons walking and those on public transport. The numbers in these modes of transport remained fixed in this exercise, owing to the lack of a modal split model. The trend from Sane is that the persons walking stop contributing positively to the savings when the distance to the clinic is approximately 5 km. This is also about the same distance that the public transport users start contributing positively to the AI savings. The peak for those who walk is when the clinic is located in Sane. The peak for public transport users was found at approximately 11 km from Sane. This, amount saved, however, is much lower than in the case of those walking (R201 350.64 vs R535 639.00). The combined savings from both modes peak when the clinic is located within Sane.

Clinic users from Mangwele were recorded to mostly use public transport. The lack of a model transport split model means that only a few persons will walk given the varying distance of the clinic. Therefore, the majority of the AI savings in this instance are mainly from the public transport users with savings from those who walk only peaking with R12 181.79 when the clinic is located in Mangwele. The AI savings from users of public transport peaks when the clinic is located at approximately 18 km from the village. The combined savings from both modes also peaks at 18 km. This is because very few people who walk were recorded from Mangwele.

### 5.2.5 Comparison of Health Care Variables

Figure 5.18 shows that the variable with the biggest influence on savings is the waiting time (WAITt). This is followed by walking time (WT), public transport cost (PCST) and doctor visitation frequency (DOC).

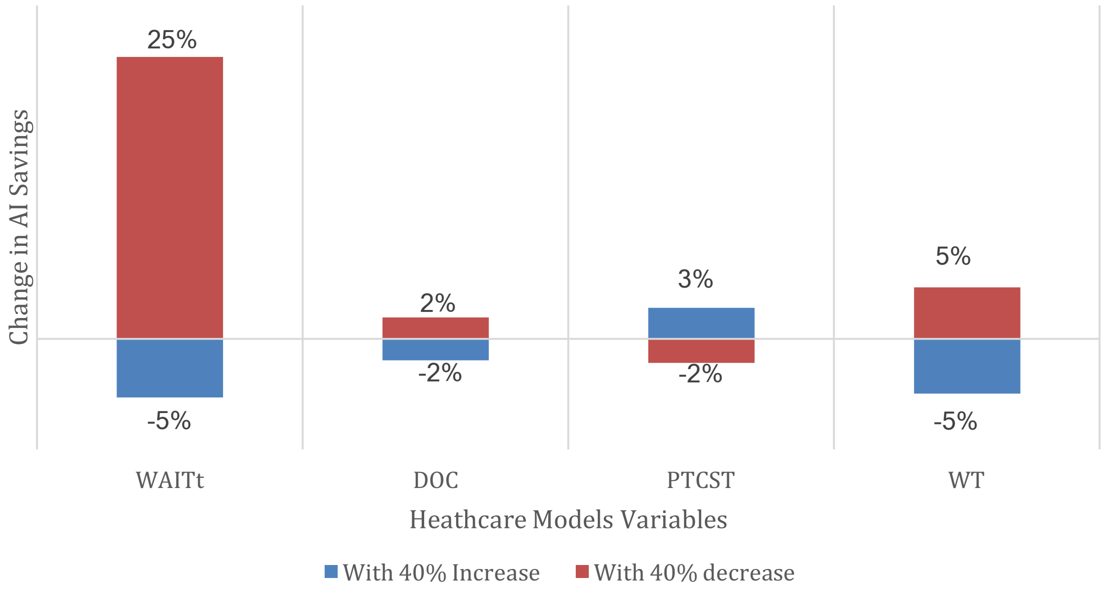


**Figure 5.18. Comparison of effect of health care variables.**

## 5.3 Discussion

When considering Figures 5.10 and 5.18, we can see that walking time (WT) to schools has the biggest impact on the AI Savings from Project 5. Walking time to the clinic does not have the same impact as that witnessed for schools. This is because there are more patients using public transport (436) than patients walking to the clinic (330). There are 92 people walking to schools, compared to only 29 people using public transport to school. It should be noted, again, that when it comes to analysing the effects of walking time (WT) and public transport cost (PTCST), the model has its shortcomings due to the absence of a modal split option. Thus, people are always fixed to their current transport mode and this gives exaggerated estimates for extreme cases such as free transport or very short walking times.

Waiting time at the clinic (WAITt) is the most influential variable in the AI savings. Community members may be frustrated with the waiting times, as some respondents from Sane and Mangwele reported experiencing waiting times in excess of six hours, which could also be an isolated incident or an exaggeration.

Availability of textbooks (TEXTBKS) was found to be the second most influential variable. AI Savings are currently more susceptible to a decrease in TEXTBKS, this leads to relatively high losses in savings. This is because TEXTBKS figures are currently rated as high in Tshianane and Ramabulana Secondary Schools.

Overall, the schools have the most significant influence on AI savings. Part of the reason for this, is the per capita investment in basic education, which is relatively higher than that in health care. The basic education per capita investment is six times more than the health care investment.

# 6 Conclusions and Recommendations

## 6.1 Discussion

The objective of the methodology presented in this project is to facilitate decision-making processes in cases where the potential for social upliftment resulting from road development needs to be considered. This was discussed, in Section 1.1, as being of particularly great importance for rural roads in isolated communities. A methodology for estimating an accessibility index, which takes into account infrastructure condition, quality of educational and health care facilities, as well as also transportation characteristics, was used to successfully rank road project alternatives. This was done by prioritising projects according to a system which uses the communities' own preferences for facilities and their chosen mode of transport by which to reach them. The use of the stated preference experiments made it possible to avoid subjectively rating the condition of the schools, clinic and the transportation modes. The accessibility index of each project is a measure of the accessibility of a community to a facility with qualities that they prefer and the means to use them.

The methodology demonstrated, allows for the allocation of an accessibility index ranking, which can be appraised in monetary terms and consequently allows for comparison with the project costs and other figures from alternative projects. This was performed by considering the number of users of education and health care facilities, as well as the budget allocation to each facility from its respective department. This allowed for a more objective means of placing weights on the individual index for each facility, as well as allowing the index to be converted into monetary terms.

It should be noted that it was not the social benefits that were appraised, but the amount of the investment made by the Basic Education and Health care Departments that was not efficiently beneficial to the particular individuals. This was done because of challenges facing their accessibility to these facilities.

It was also demonstrated in the field surveys that the methodology does not require specialised test equipment or extensive training of individuals. This was meant to reduce the cost of the pre-investigations to mitigate the challenges faced in South Africa where there is a backlog in assessing the current conditions of unpaved roads as discussed in Chapter 1.2.

## 6.2 Key findings

The most efficient project (Project 5), of the hypothetical projects presented in Chapter 4.3, was one with high traffic and a low infrastructure conformity to non-motorised transport. The conformity to pedestrians was estimated to be present in less than 20% of the lengths of both links in the project. The following key findings were made during the exercise:

- Non-motorised transport is just as important, if not more so, than motorised transport in rural areas. Results from Project 5 showed that 55% of AI savings were from non-motorised commutes.
- The optimisation exercise performed in Chapter 4.4 shows that with a constrained budget, it is more efficient to increase infrastructure conformity for non-motorised transport than for motorised transport.
- Considering the influence of the split in the number of users between education (students enrolled) and public health care (people reporting, as outlined in Chapter 3.7), education has a far greater per capita investment than health care. Per capita investment in education was found to be six times more than that for health care.
- The most preferred conditions at a clinic involves the attributes of a waiting time of less than two hours and a doctor visitation frequency of at least twice a week.
- A 100% availability of textbooks draws a strong preference to attendance at a school, even with large classes present.
- Preference to attending a school does not depend on a learner’s gender, nor whether they are in primary or secondary grades. The only significant variables for preference in school attendance were found to be the availability of textbooks and the number of learners in the classrooms (albeit, to a lesser extent).

- Preference for a particular mode of transport to school is affected by the distance to be walked and cost of public transport. The preference is, furthermore, affected by the gender of the learner, whether the learner is in primary or secondary grades, and also the income of the household. Female students have a higher preference for using public transport than their male counterparts do.
- Significant variables for a preference for transport mode to clinics were found to be the cost of public transport and the walking time alone. This was different from the preferences of transport to school, in that no personal variables influenced the preference significantly.

## 6.3 Limitations

The following are the current limitations of the method:

- The lack of a modal split model makes it difficult to predict the effect that changes in transport characteristics will have on the outcome.
- Sectors in the road with severe damage could be left unchecked using the current method. This could leave unsafe localised areas unchecked.
- The vehicle used for the speed profiling needs to be similar to that used for IRI Response Type Roughness Measuring Systems measurement vehicles. This is especially in relation to the type of suspension and tyres used.

## 6.4 Recommendations for future research

The following recommendations are proposed for future research:

- More stated preference experiments need to be performed to include other transport modes such as private vehicles, other forms of public transport if available and other forms of non-motorised transport modes such as bicycles and animal drawn carts.
- The achievable comfortable speed needs to be calibrated with IRI to obtain acceptable minimum thresholds that are aligned with current minimum IRI standards.

- A modal split model needs to be incorporated into the model to study the effects of varying walking times and public transport costs.
- The frequency of availability of public transport needs to be taken into account, as it is not always available in rural areas and this further hampers accessibility.
- A pre-study of the subject communities should include obtaining more accurate population numbers to enhance the estimation of sample sizes.
- Severe road damage needs to be reported, as this can be unsafe for commuters.
- General road conditions, such as type of surfacing, need to be recorded to ensure sound cost estimates.
- Other facilities, such as police stations, which are at the forefront of achieving the goals stated in the NDP, should also be considered.

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# Appendix A1 – Education Quality Stated Preference Experiment

UNIVERSITEIT STELLENBOSCH UNIVERSITY

**Household Travel Survey - Education Quality Preference**

| | | | |
|---|---|---|---|
| Interviewer: | Fhatuwani L. Nemvumoni | Questionaire number | |
| Date: | | Household no.: | |
| Signature: | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **1. Number of students:** | | *Please specify number of students in household* | | | | |
| **2. Gender:** | | | | | | *M/F* |
| **3. Grade:** | | | | | | *Years* |
| **4. School type** | | | | | | *P/S* |
| **5. Household income:** | | *(1 = R1 - R800) (2 = R801 - R1600) (3 = R1601 - R3200) (4 = R3201 - R6400) (5 = R6401 - R12 800) (6 = R12 801 - R25 600) (7 = R25 600 +)* | | | | |

| Option 1 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *30* | *All subjects* | |
| Mark selection | | | |

| Option 2 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *60* | *Some subjects* | |
| Mark selection | | | |

| Option 3 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *30* | *Some subjects* | |
| Mark selection | | | |

| Option 4 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *45* | *Most Subjects* | |
| Mark selection | | | |

| Option 5 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *45* | *Some subjects* | |
| Mark selection | | | |

| Option 6 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *60* | *Most subjects* | |
| Mark selection | | | |

| Option 7 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *45* | *All subjects* | |
| Mark selection | | | |

| Option 8 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *60* | *All subjects* | |
| Mark selection | | | |

| Option 9 | Number of learners in class | Subjects with textbooks | Not go |
|---|---|---|---|
| | *30* | *Most Subjects* | |
| Mark selection | | | |

# Appendix A2 – Health Care Quality Stated Preference Experiment

**Household Travel Survey - Healthcare Quality Choice**

UNIVERSITEIT STELLENBOSCH UNIVERSITY

| | | | |
|---|---|---|---|
| Interviewer: | Fhatuwani L. Nemvumoni | Questionaire number | |
| Date: | | | |
| Signature: | | | |
| Location: | | | |

| | | |
|---|---|---|
| **Household size:** | | |
| **Household income:** | | *(1 = R1 - R800) (2 = R801 - R1600) (3 = R1601 - R3200) (4 = R3201 - R6400) (5 = R6401 - R12 800) (6 = R12 801 - R25 600) (7 = R25 600 +)* |

| | | | |
|---|---|---|---|
| **Option 1** | **Doctor visitation** | **Waiting time** | **Not go** |
| | *Once a month* | *Less than 2 hours* | |
| Mark selection | | | |

| | | | |
|---|---|---|---|
| **Option 2** | **Doctor visitation** | **Waiting time** | **Not go** |
| | *Twice a week* | *More than 2 hours* | |
| Mark selection | | | |

| | | | |
|---|---|---|---|
| **Option 3** | **Doctor visitation** | **Waiting time** | **Not go** |
| | *Once a week* | *More than 2 hours* | |
| Mark selection | | | |

| | | | |
|---|---|---|---|
| **Option 4** | **Doctor visitation** | **Waiting time** | **Not go** |
| | *Twice a week* | *Less than 2 hours* | |
| Mark selection | | | |

| | | | |
|---|---|---|---|
| **Option 5** | **Doctor visitation** | **Waiting time** | **Not go** |
| | *Once a month* | *More than 2 hours* | |
| Mark selection | | | |

| | | | |
|---|---|---|---|
| **Option 6** | **Doctor visitation** | **Waiting time** | **Not go** |
| | *Once a week* | *Less than 2 hours* | |
| Mark selection | | | |

# Appendix A3 – Education Transport Stated Preference Experiment

| | | | | | | |
|---|---|---|---|---|---|---|
| UNIVERSITEIT STELLENBOSCH UNIVERSITY | **Household Travel Survey - Education Transport Mode Choice** | | | | | |
| | Interviewer: | Fhatuwani L. Nemvumoni | | Questionaire number | | |
| | Date: | | | Location: | | |
| **1. Number of students in houshold:** | | *Please specify number of students in household* | | | | |
| **2. Gender:** | (1) | (2) | (3) | (4) | (5) | *M/F* |
| **3. Age:** | (1) | (2) | (3) | (4) | (5) | *Years* |
| **4. School type** | (1) | (2) | (3) | (4) | (5) | *P/S* |
| **5. Household income:** | | *(1 = R1 - R800)* *(4 = R3201 - R6400)* *(7 = R25 600 +)* | *(2 = R801 - R1600)* *(5 = R6401 - R12 800)* | *(3 = R1601 - R3200)* *(6 = R12 801 - R25 600)* | | |
| **3. Please describe any motorised vehicles owned by the household (in working condition)** | | | | | | |

| Option | Walking Time | Public Transport Cost | Not go |
|---|---|---|---|
| **Option 1** | *30 Minutes* | *R5.00* | |
| Mark selection | | | |
| **Option 2** | *2 Hours* | *R10.00* | |
| Mark selection | | | |
| **Option 3** | *30 Minutes* | *R10.00* | |
| Mark selection | | | |
| **Option 4** | *1 Hour* | *R15.00* | |
| Mark selection | | | |
| **Option 5** | *1 Hour* | *R10.00* | |
| Mark selection | | | |
| **Option 6** | *2 Hours* | *R15.00* | |
| Mark selection | | | |
| **Option 7** | *1 Hour* | *R5.00* | |
| Mark selection | | | |
| **Option 8** | *2 Hours* | *R5.00* | |
| Mark selection | | | |
| **Option 9** | *30 Minutes* | *R15.00* | |
| Mark selection | | | |

# Appendix A4 –Health Care Transport Stated Preference Experiment

| | | | | |
|---|---|---|---|---|
| **Household Travel Survey - Healthcare Transport Mode Choice** | | | | |
| Interviewer: | Fhatuwani L. Nemvumoni | | Questionaire number | |
| Date: | | | Location: | |
| **1. Household size:** | | | | |
| **2. Household income:** | | (1 = R1 - R800) (4 = R3201 - R6400) (7 = R25 600 +) | (2 = R801 - R1600) (5 = R6401 - R12 800) | (3 = R1601 - R3200) (6 = R12 801 - R25 600) |
| **3. Please describe any motorised vehicles owned by the household (in working condition)** | | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 1** | *30 Minutes* | *R5.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 2** | *2 Hours* | *R10.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 3** | *30 Minutes* | *R10.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 4** | *1 Hour* | *R15.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 5** | *1 Hour* | *R10.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 6** | *2 Hours* | *R15.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 7** | *1 Hour* | *R5.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 8** | *2 Hours* | *R5.00* | |
| Mark selection | | | |

| | **Walking Time** | **Public Transport Cost** | **Not go** |
|---|---|---|---|
| **Option 9** | *30 Minutes* | *R15.00* | |
| Mark selection | | | |

# Appendix B – Village Data Collection Survey

| Household Travel Survey | | | | | | | UNIVERSITEIT STELLENBOSCH UNIVERSITY |
|---|---|---|---|---|---|---|---|
| Interviewer: | Fhatuwani L. Nemvumoni | | Questionaire number | | | | |
| Signature: | | | Date: | | | | |
| 1. Household size | | | People who sleep at and travel from home | | | | |
| 2. Please specify grade and school name for each student | | | | 6. Mark Travel choice | | | 7. Gender M/F |
| 3. Student | 4. Grade | 5. School Name | | Walk | Public Transport | | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 8. Household income: | | *(1 = R1 - R800) (5 = R6401 - R12 800)* | *(2 = R801 - R1600) (6 = R12 801 - R25 600)* | *(3 = R1601 - R3200) (7 = R25 600 +)* | *(4 = R3201 - R6400)* | | |
| 9. Which clinic do you normally visit? | | | | | | | |
| 10. Do you walk (W) or use public transport (PT)? | | Travel time | | Travel cost | | | |
| 11. How long do you wait at the clinic? | | | | minutes | hours | | |

# Appendix C – Data and Regression

See attached CD

# Appendix D – Village Data Results

See attached CD

# Appendix E – Motorised Transport Infrastructure Condition

Mangwele to Sane Combined School

| Segment | $L_s$ (m) | $V_{s,avg}$ (km/h) | $W_{s,avg}$ (m) | Speed $Q_{L,s}$ | Width $Q_{L,s}$ | $Q_{L,s}$ |
|---|---|---|---|---|---|---|
| 1 | 95 | 17.42 | 7.40 | 39% | 100% | 39% |
| 2 | 452 | 34.36 | 6.02 | 76% | 100% | 76% |
| 3 | 217 | 17.80 | 5.30 | 40% | 88% | 40% |
| 4 | 486 | 44.81 | 4.87 | 100% | 81% | 81% |
| 5 | 305 | 17.40 | 4.59 | 39% | 77% | 39% |
| 6 | 84 | 38.00 | 4.00 | 84% | 67% | 67% |
| 7 | 419 | 15.15 | 5.24 | 34% | 87% | 34% |
| 8 | 194 | 31.44 | 6.82 | 70% | 100% | 70% |
| 9 | 141 | 18.65 | 7.00 | 41% | 100% | 41% |
| 10 | 161 | 29.48 | 7.00 | 66% | 100% | 66% |
| 11 | 528 | 18.55 | 4.63 | 41% | 77% | 41% |
| 12 | 265 | 41.01 | 4.75 | 91% | 79% | 79% |
| 13 | 6 | 23.00 | 4.75 | 51% | 79% | 51% |
| 14 | 97 | 39.09 | 6.10 | 87% | 100% | 87% |
| 15 | 152 | 15.80 | 6.10 | 35% | 100% | 35% |
| 16 | 347 | 38.82 | 5.93 | 86% | 99% | 86% |
| 17 | 11 | 20.00 | 5.50 | 44% | 92% | 44% |
| 18 | 172 | 37.07 | 5.50 | 82% | 92% | 82% |
| 19 | 416 | 41.89 | 5.49 | 93% | 91% | 91% |
| 20 | 6 | 21.00 | 5.50 | 47% | 92% | 47% |
| 21 | 194 | 42.00 | 5.49 | 93% | 91% | 91% |
| 22 | 330 | 21.30 | 5.45 | 47% | 91% | 47% |
| 23 | 46 | 15.00 | 5.45 | 33% | 91% | 33% |
| 24 | 76 | 25.95 | 5.45 | 74% | 91% | 74% |
| 25 | 428 | 31.92 | 5.94 | 91% | 99% | 91% |
| 26 | 110 | 25.00 | 6.00 | 71% | 100% | 71% |
| 27 | 8 | 28.00 | 6.00 | 80% | 100% | 80% |
| 28 | 18 | 22.33 | 6.00 | 64% | 100% | 64% |
| 29 | 67 | 27.00 | 6.50 | 77% | 100% | 77% |
| 30 | 38 | 22.95 | 6.50 | 66% | 100% | 66% |
| 31 | 80 | 29.00 | 6.50 | 83% | 100% | 83% |
| 32 | 65 | 15.71 | 6.50 | 45% | 100% | 45% |
| $L_R$ (m) | 6014 | | | | $Q_L$ | 65 % |

Sane Combined School to intersection 1

| Segment | $L_s$ (m) | $V_{s,avg}$ (km/h) | $W_{s,avg}$ (m) | Speed $Q_{L,s}$ | Width $Q_{L,s}$ | $Q_{L,s}$ |
|---|---|---|---|---|---|---|
| 1 | 777.0 | 39.1 | 6.5 | 87% | 100% | 87% |
| 2 | 58.0 | 23.0 | 6.5 | 51% | 100% | 51% |
| 3 | 104.0 | 34.0 | 6.5 | 76% | 100% | 76% |
| 4 | 28.0 | 20.0 | 6.5 | 45% | 100% | 45% |
| 5 | 8.0 | 29.0 | 6.5 | 64% | 100% | 64% |
| 6 | 144.0 | 20.4 | 6.5 | 45% | 100% | 45% |
| 7 | 116.0 | 38.4 | 6.5 | 85% | 100% | 85% |
| 8 | 99.0 | 21.3 | 6.3 | 47% | 100% | 47% |
| 9 | 136.0 | 45.0 | 6.0 | 100% | 100% | 100% |
| 10 | 21.0 | 19.2 | 6.0 | 43% | 100% | 43% |
| 11 | 15.0 | 27.0 | 6.0 | 60% | 100% | 60% |
| 12 | 33.0 | 20.1 | 6.0 | 45% | 100% | 45% |
| 13 | 100.0 | 30.9 | 6.0 | 69% | 100% | 69% |
| 14 | 80.0 | 33.9 | 6.0 | 75% | 100% | 75% |
| 15 | 23.0 | 21.0 | 6.0 | 47% | 100% | 47% |
| 16 | 71.0 | 36.0 | 6.0 | 80% | 100% | 80% |
| 17 | 54.0 | 24.0 | 6.0 | 53% | 100% | 53% |
| 18 | 271.0 | 24.0 | 5.9 | 53% | 98% | 53% |
| 19 | 61.0 | 36.0 | 5.2 | 80% | 87% | 80% |
| 20 | 5.0 | 19.0 | 5.2 | 42% | 87% | 42% |
| 21 | 106.0 | 27.4 | 5.2 | 61% | 87% | 61% |
| 22 | 311.0 | 20.1 | 5.2 | 45% | 87% | 45% |
| 23 | 46.0 | 32.8 | 5.2 | 73% | 87% | 73% |
| 24 | 10.0 | 17.6 | 5.2 | 39% | 87% | 39% |
| 25 | 57.0 | 29.0 | 5.2 | 64% | 87% | 64% |
| 26 | 158.0 | 19.2 | 5.2 | 43% | 86% | 43% |
| 27 | 47.0 | 28.0 | 5.1 | 62% | 85% | 62% |
| 28 | 51.0 | 20.4 | 5.1 | 45% | 85% | 45% |
| 29 | 8.0 | 27.0 | 5.1 | 60% | 85% | 60% |
| 30 | 237.0 | 18.6 | 5.1 | 41% | 85% | 41% |
| 31 | 176.0 | 47.8 | 5.7 | 100% | 94% | 94% |
| 32 | 37.0 | 27.0 | 6.0 | 60% | 100% | 60% |
| 33 | 303.0 | 29.7 | 6.0 | 66% | 100% | 66% |
| 34 | 41.0 | 25.0 | 6.0 | 56% | 100% | 56% |
| 35 | 165.0 | 30.6 | 6.0 | 68% | 100% | 68% |
| 36 | 167.0 | 18.1 | 5.7 | 40% | 95% | 40% |
| 37 | 900.0 | 31.9 | 5.4 | 71% | 89% | 71% |
| 38 | 63.0 | 25.0 | 5.6 | 56% | 93% | 56% |
| 39 | 236.0 | 28.9 | 6.0 | 64% | 100% | 64% |
| $L_R$ (m) | 5323.0 | | | | Link $Q_L$ | 62% |

Intersection 1 to Ramabulana Secondary School and Straight Hardt Clinic

| Intersection 1 to Ramabulana Secondary School and Straight Hardt Clinic | | | | | | |
|---|---|---|---|---|---|---|
| Segment | $L_s$ (m) | $V_{s,avg}$ (km/h) | $W_{s,avg}$ (m) | Speed $Q_{L,s}$ | Width $Q_{L,s}$ | $Q_{L,s}$ |
| 1 | 106.0 | 21.7 | 6.0 | 48% | 100% | 48% |
| 2 | 225.0 | 40.3 | 6.0 | 90% | 100% | 90% |
| 3 | 213.0 | 19.2 | 6.0 | 43% | 100% | 43% |
| 4 | 59.0 | 30.0 | 6.0 | 67% | 100% | 67% |
| 5 | 20.0 | 23.0 | 6.0 | 51% | 100% | 51% |
| 6 | 171.0 | 31.0 | 6.0 | 69% | 100% | 69% |
| 7 | 325.0 | 20.6 | 6.0 | 46% | 100% | 46% |
| $L_R$ (m) | 1119.0 | | | | Link $Q_L$ | 59% |

Intersection 1 to Tshianane Secondary School

| Intersection 1 to Tshianane Secondary School | | | | | | |
|---|---|---|---|---|---|---|
| Segment | $L_s$ (m) | $V_{s,avg}$ (km/h) | $W_{s,avg}$ (m) | Speed $Q_{L,s}$ | Width $Q_{L,s}$ | $Q_{L,s}$ |
| 1 | 325.0 | 24.3 | 6.0 | 54% | 100% | 54% |
| 2 | 178.0 | 49.0 | 6.0 | 100% | 100% | 100% |
| 3 | 202.0 | 49.0 | 8.0 | 100% | 100% | 100% |
| 4 | 483.0 | 38.7 | 8.0 | 86% | 100% | 86% |
| 5 | 912.0 | 57.0 | 9.7 | 100% | 100% | 100% |
| 6 | 241.0 | 38.0 | 6.7 | 85% | 100% | 85% |
| 7 | 1936.0 | 58.0 | 6.6 | 100% | 100% | 100% |
| 8 | 443.0 | 47.6 | 8.1 | 100% | 100% | 100% |
| 9 | 284.0 | 37.0 | 8.1 | 82% | 100% | 82% |
| $L_R$ (m) = | 5004.0 | | | | Link $Q_L$ | 94% |

# Appendix F – Non-motorised Transport Infrastructure Condition

Mangwele to Sane Combined School

| Segment | $L_s$ (m) | $SW_{s,avg}$ (m) | $Q_{L,NMT,S}$ | Extra width required (m) |
|---|---|---|---|---|
| 1 | 95 | 1.20 | 100% | 0.00 |
| 2 | 452 | 0.22 | 18% | 0.98 |
| 3 | 217 | 0.00 | 0% | 1.70 |
| 4 | 486 | 0.00 | 0% | 2.13 |
| 5 | 305 | 0.00 | 0% | 2.41 |
| 6 | 84 | 0.00 | 0% | 3.00 |
| 7 | 419 | 0.00 | 0% | 1.76 |
| 8 | 194 | 1.02 | 85% | 0.18 |
| 9 | 141 | 1.20 | 100% | 0.00 |
| 10 | 161 | 1.20 | 100% | 0.00 |
| 11 | 528 | 0.00 | 0% | 2.37 |
| 12 | 265 | 0.00 | 0% | 2.25 |
| 13 | 6 | 0.00 | 0% | 2.25 |
| 14 | 97 | 0.30 | 25% | 0.90 |
| 15 | 152 | 0.30 | 25% | 0.90 |
| 16 | 347 | 0.13 | 11% | 1.07 |
| 17 | 11 | 0.00 | 0% | 1.50 |
| 18 | 172 | 0.00 | 0% | 1.50 |
| 19 | 416 | 0.00 | 0% | 1.51 |
| 20 | 6 | 0.00 | 0% | 1.50 |
| 21 | 194 | 0.00 | 0% | 1.51 |
| 22 | 330 | 0.00 | 0% | 1.55 |
| 23 | 46 | 0.00 | 0% | 1.55 |
| 24 | 76 | 0.00 | 0% | 1.55 |
| 25 | 428 | 0.14 | 11% | 1.06 |
| 26 | 110 | 0.20 | 17% | 1.00 |
| 27 | 8 | 0.20 | 17% | 1.00 |
| 28 | 18 | 0.20 | 17% | 1.00 |
| 29 | 67 | 0.70 | 58% | 0.50 |
| 30 | 38 | 0.70 | 58% | 0.50 |
| 31 | 80 | 0.70 | 58% | 0.50 |
| 32 | 65 | 0.70 | 58% | 0.50 |
| $L_R$ (m) = | 6014 | Link $Q_{L,NMT}$ = | 15.98% | |

Sane Combined School to Intersection 1

| Segment | $L_s$ (m) | $SW_{s,avg}$ | $Q_{L,NMT,S}$ | Extra width required (m) |
|---|---|---|---|---|
| 1 | 777.0 | 0.70 | 58% | 0.50 |
| 2 | 58.0 | 0.70 | 58% | 0.50 |
| 3 | 104.0 | 0.70 | 58% | 0.50 |
| 4 | 28.0 | 0.70 | 58% | 0.50 |
| 5 | 8.0 | 0.70 | 58% | 0.50 |
| 6 | 144.0 | 0.70 | 58% | 0.50 |
| 7 | 116.0 | 0.70 | 58% | 0.50 |
| 8 | 99.0 | 0.53 | 44% | 0.67 |
| 9 | 136.0 | 0.20 | 17% | 1.00 |
| 10 | 21.0 | 0.20 | 17% | 1.00 |
| 11 | 15.0 | 0.20 | 17% | 1.00 |
| 12 | 33.0 | 0.20 | 17% | 1.00 |
| 13 | 100.0 | 0.20 | 17% | 1.00 |
| 14 | 80.0 | 0.20 | 17% | 1.00 |
| 15 | 23.0 | 0.20 | 17% | 1.00 |
| 16 | 71.0 | 0.20 | 17% | 1.00 |
| 17 | 54.0 | 0.20 | 17% | 1.00 |
| 18 | 271.0 | 0.06 | 5% | 1.14 |
| 19 | 61.0 | 0.00 | 0% | 1.80 |
| 20 | 5.0 | 0.00 | 0% | 1.80 |
| 21 | 106.0 | 0.00 | 0% | 1.80 |
| 22 | 311.0 | 0.00 | 0% | 1.80 |
| 23 | 46.0 | 0.00 | 0% | 1.80 |
| 24 | 10.0 | 0.00 | 0% | 1.80 |
| 25 | 57.0 | 0.00 | 0% | 1.80 |
| 26 | 158.0 | 0.00 | 0% | 1.83 |
| 27 | 47.0 | 0.00 | 0% | 1.90 |
| 28 | 51.0 | 0.00 | 0% | 1.90 |
| 29 | 8.0 | 0.00 | 0% | 1.90 |
| 30 | 237.0 | 0.00 | 0% | 1.90 |
| 31 | 176.0 | 0.00 | 0% | 1.34 |
| 32 | 37.0 | 0.20 | 17% | 1.00 |
| 33 | 303.0 | 0.20 | 17% | 1.00 |
| 34 | 41.0 | 0.20 | 17% | 1.00 |
| 35 | 165.0 | 0.20 | 17% | 1.00 |
| 36 | 167.0 | 0.00 | 0% | 1.29 |
| 37 | 900.0 | 0.00 | 0% | 1.64 |
| 38 | 63.0 | 0.00 | 0% | 1.40 |
| 39 | 236.0 | 0.20 | 17% | 1.00 |
| $L_R$ (m) = | 5323.0 | Link $Q_{L,NMT}$ = | 18.74% | |

Intersection 1 to Ramabulana Secondary School and Straight Hardt Clinic (Road Link 3)

| Segment | $L_s$ (m) | $SW_{s,avg}$ | $Q_{L,NMT,S}$ | Extra width required (m) |
|---|---|---|---|---|
| 1 | 106.0 | 0.20 | 17% | 1.00 |
| 2 | 225.0 | 0.20 | 17% | 1.00 |
| 3 | 213.0 | 0.20 | 17% | 1.00 |
| 4 | 59.0 | 0.20 | 17% | 1.00 |
| 5 | 20.0 | 0.20 | 17% | 1.00 |
| 6 | 171.0 | 0.20 | 17% | 1.00 |
| 7 | 325.0 | 0.20 | 17% | 1.00 |
| $L_R$ (m) = | 1119.0 | Link $Q_{L,NMT}$ = | 16.67% | |

Intersection 1 to Tshianane Secondary School

| Segment | $L_s$ (m) | $SW_{s,avg}$ | $Q_{L,NMT,S}$ | Extra width required (m) |
|---|---|---|---|---|
| 1 | 325.0 | 0.20 | 17% | 1.00 |
| 2 | 178.0 | 0.20 | 17% | 1.00 |
| 3 | 202.0 | 1.20 | 100% | 0.00 |
| 4 | 483.0 | 1.20 | 100% | 0.00 |
| 5 | 912.0 | 1.20 | 100% | 0.00 |
| 6 | 241.0 | 0.90 | 75% | 0.30 |
| 7 | 1936.0 | 0.80 | 67% | 0.40 |
| 8 | 443.0 | 1.20 | 100% | 0.00 |
| 9 | 284.0 | 1.20 | 100% | 0.00 |
| $L_R$ (m) = | 5004.0 | Link $Q_{L,NMT}$ = | 77.52% | |

## Appendix G – Project Ranking Results

| Project 1 - Link 1 | | |
|---|---|---|
| To/From | Savings | |
| | Mangwele | Sane |
| Sane Combined | R8 033.81 | R- |
| Ramabulana | R16 602.50 | R- |
| Tshianane | R32 842.46 | R- |
| Clinic | R55 550.62 | R- |
| Total Savings | R | 113 029.40 |
| Upgrading Costs | R | 1 474 760.00 |
| AI Benefit:Cost | 8% | |

| Project 2 - Links 1, 2 and 3 | | |
|---|---|---|
| To/From | Savings | |
| | Mangwele | Sane |
| Sane Combined | R8 033.81 | R- |
| Ramabulana | R34 713.51 | R174 868.48 |
| Tshianane | R61 396.95 | R12 587.33 |
| Clinic | R116 145.44 | R222 721.66 |
| Total Savings | R | 630 467.18 |
| Upgrading Costs | R | 3 547 517.50 |
| AI Benefit:Cost | 18% | |

| Project 3 - Links 1, 2 and 4 | | |
|---|---|---|
| To/From | Savings | |
| | Mangwele | Sane |
| Sane Combined | R8 033.81 | R- |
| Ramabulana | R31 037.47 | R143 854.78 |
| Tshianane | R66 222.60 | R15 266.68 |
| Clinic | R103 848.04 | R180 230.46 |
| Total Savings | R | 548 493.84 |
| Upgrading Costs | R | 4 566 031.00 |
| AI Benefit:Cost | 12% | |

| Project 4 - Links 1, 2, 3 and 4 | | |
|---|---|---|
| To/From | Savings | |
| | Mangwele | Sane |
| Sane Combined | R8 033.81 | R- |
| Ramabulana | R34 713.51 | R174 868.48 |
| Tshianane | R66 222.60 | R15 266.68 |
| Clinic | R116 145.44 | R222 721.66 |
| Total Savings | R | 637 972.17 |
| Upgrading Costs | R | 4 940 896.00 |
| AI Benefit:Cost | 13% | |

| Project 5 - Links 2 and 3 | | |
|---|---|---|
| To/From | Savings | |
| | Mangwele | Sane |
| Sane Combined | R- | R- |
| Ramabulana | R18 111.01 | R174 868.48 |
| Tshianane | R28 554.49 | R12 587.33 |
| Clinic | R60 594.81 | R222 721.66 |
| Total Savings | R 517 437.78 | |
| Upgrading Costs | R 2 072 757.50 | |
| AI Benefit:Cost | 25% | |

| Project 6 - Links 2 and 4 | | |
|---|---|---|
| To/From | Savings | |
| | Mangwele | Sane |
| Sane Combined | R- | R- |
| Ramabulana | R14 434.97 | R143 854.78 |
| Tshianane | R33 380.14 | R15 266.68 |
| Clinic | R48 297.42 | R180 230.46 |
| Total Savings | R 435 464.45 | |
| Upgrading Costs | R 3 091 271.00 | |
| AI Benefit:Cost | 14% | |

| Project 7 - Links 2, 3 and 4 | | |
|---|---|---|
| To/From | Savings | |
| | Mangwele | Sane |
| Sane Combined | R- | R- |
| Ramabulana | R18 111.01 | R174 868.48 |
| Tshianane | R33 380.14 | R15 266.68 |
| Clinic | R60 594.81 | R222 721.66 |
| Total Savings | R 524 942.77 | |
| Upgrading Costs | R 3 466 136.00 | |
| AI Benefit:Cost | 15% | |

# Appendix H – Optimisation

| Link | Segment | Portion of budget | | | |
|---|---|---|---|---|---|
| | | 80% | 60% | 50% | 35% |
| Sane to intersection | 1 | 1.0 | 0.0 | 0.0 | 0.0 |
| | 2 | 1.0 | 1.0 | 0.0 | 0.0 |
| | 3 | 1.0 | 0.0 | 0.0 | 0.0 |
| | 4 | 1.0 | 1.0 | 0.0 | 1.0 |
| | 5 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 6 | 1.0 | 0.0 | 0.0 | 0.0 |
| | 7 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 8 | 0.0 | 1.0 | 1.0 | 0.0 |
| | 9 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 10 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 11 | 0.0 | 0.0 | 0.0 | 1.0 |
| | 12 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 13 | 1.0 | 1.0 | 1.0 | 0.0 |
| | 14 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 15 | 1.0 | 1.0 | 0.0 | 1.0 |
| | 16 | 1.0 | 0.0 | 0.0 | 1.0 |
| | 17 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 18 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 19 | 0.0 | 0.0 | 1.0 | 0.0 |
| | 20 | 1.0 | 1.0 | 1.0 | 0.0 |
| | 21 | 1.0 | 1.0 | 1.0 | 0.0 |
| | 22 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 23 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 24 | 1.0 | 0.0 | 0.0 | 1.0 |
| | 25 | 1.0 | 0.0 | 1.0 | 1.0 |
| | 26 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 27 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 28 | 1.0 | 1.0 | 0.0 | 1.0 |
| | 29 | 0.0 | 1.0 | 0.0 | 0.0 |
| | 30 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 31 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 32 | 1.0 | 1.0 | 1.0 | 0.0 |
| | 33 | 1.0 | 1.0 | 0.0 | 0.0 |
| | 34 | 1.0 | 1.0 | 0.0 | 1.0 |
| | 35 | 0.0 | 0.0 | 1.0 | 0.0 |
| | 36 | 1.0 | 1.0 | 1.0 | 0.0 |
| | 37 | 1.0 | 1.0 | 0.0 | 0.0 |
| | 38 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 39 | 1.0 | 0.0 | 1.0 | 0.0 |
| Intersection to Ramabulana | 1 | 1.0 | 1.0 | 1.0 | 0.0 |
| | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 3 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 4 | 0.0 | 0.0 | 1.0 | 0.0 |
| | 5 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 6 | 0.0 | 0.0 | 0.0 | 1.0 |
| | 7 | 1.0 | 1.0 | 1.0 | 1.0 |

## Appendix J – Sensitivity analysis

Effect of textbook availability (TEXTBKS)

| Textbooks (all schools) | | S0 | S1 | S2 | S3 |
|---|---|---|---|---|---|
| Properties | Priced AI | R2 248 093.51 | R2 248 093.51 | R2 237 792.34 | R2 247 511.80 |
| | Total Savings | R517 437.78 | R517 437.78 | R527 738.95 | R518 019.49 |
| | Change in savings | 0% | 0% | 1.99% | 0.11% |
| | Elasticity | - | - | 11.3% | 0.1% |
| $AI_Q$ (Mangwele) | Ramabulana | 97% | 97% | 97% | 97% |
| | Tshianane | 94% | 94% | 98% | 94% |
| | Sane Combined | 71% | 71% | 71% | 99% |
| Savings | Ramabulana | R18 111.01 | R18 111.01 | R18 111.01 | R18 111.01 |
| | Tshianane | R28 554.49 | R28 554.49 | R37 403.60 | R28 554.49 |
| | Sane Combined | R- | R- | R- | R581.71 |
| $AI_Q$ (Sane) | Ramabulana | 97% | 97% | 97% | 97% |
| | Tshianane | 96% | 96% | 98% | 96% |
| Savings | Ramabulana | R174 868.48 | R174 868.48 | R174 868.48 | R174 868.48 |
| | Tshianane | R12 587.33 | R12 587.33 | R14 039.39 | R12 587.33 |
| Total Clinic Savings | Total Clinic Savings | R283 316.47 | R283 316.47 | R283 316.47 | R283 316.47 |

| Textbooks (all schools) | | S4 | S5 | S6 | S7 | S8 |
|---|---|---|---|---|---|---|
| Properties | Priced AI | R2 330 812.37 | R2 336 258.54 | R2 248 775.28 | R2 419 659.18 | R2 237 210.63 |
| | Total Savings | R434 718.92 | R429 272.75 | R516 756.01 | R345 872.11 | R528 320.66 |
| | Change in savings | -15.99% | -17.04% | -0.13% | -33.16% | 2.10% |
| | Elasticity | 40.0% | 42.6% | 0.3% | 82.9% | 5.4% |
| $AI_Q$ (Mangwele) | Ramabulana | 68% | 97% | 97% | 68% | 97% |
| | Tshianane | 94% | 62% | 94% | 62% | 98% |
| | Sane Combined | 71% | 71% | 40% | 40% | 99% |
| Savings | Ramabulana | R(6 345.54) | R18 111.01 | R18 111.01 | R(6 345.54) | R18 111.01 |
| | Tshianane | R28 554.49 | R(45 534.68) | R28 554.49 | R(45 534.68) | R37 403.60 |
| | Sane Combined | R- | R- | R(681.77) | R(681.77) | R581.71 |
| $AI_Q$ (Sane) | Ramabulana | 71% | 97% | 97% | 71% | 97% |
| | Tshianane | 96% | 68% | 96% | 68% | 98% |
| Savings | Ramabulana | R116 606.16 | R174 868.48 | R174 868.48 | R116 606.16 | R174 868.48 |
| | Tshianane | R12 587.33 | R(1 488.54) | R12 587.33 | R(1 488.54) | R14 039.39 |
| Total Clinic Savings | Total Clinic Savings | R283 316.47 | R283 316.47 | R283 316.47 | R283 316.47 | R283 316.47 |

Effect of average classroom size (CLASS)

| Scenarios | | S0 | S1 | S2 | S3 |
|---|---|---|---|---|---|
| Properties | Priced AI | R2 248 093.51 | R2 255 945.35 | R2 258 606.28 | R2 248 303.79 |
| | Total Savings | R517 437.78 | R509 585.94 | R506 925.01 | R517 227.50 |
| | Change in savings | 0% | -1.52% | -2.03% | -0.04% |
| | Elasticity | - | -3.8% | -5.1% | -0.1% |
| $AI_Q$ (Mangwele) | Ramabulana | 97% | 94% | 97% | 97% |
| | Tshianane | 94% | 94% | 90% | 94% |
| | Sane Combined | 71% | 71% | 71% | 62% |
| Savings | Ramabulana | R18 111.01 | R15 766.60 | R18 111.01 | R18 111.01 |
| | Tshianane | R28 554.49 | R28 554.49 | R19 570.79 | R28 554.49 |
| | Sane Combined | R- | R- | R- | R(210.28) |
| $AI_Q$ (Sane) | Ramabulana | 97% | 95% | 97% | 97% |
| | Tshianane | 96% | 96% | 93% | 96% |
| Savings | Ramabulana | R174 868.48 | R169 361.05 | R174 868.48 | R174 868.48 |
| | Tshianane | R12 587.33 | R12 587.33 | R11 058.26 | R12 587.33 |
| Total Clinic Savings | Total Clinic Savings | R283 316.47 | R283 316.47 | R283 316.47 | R283 316.47 |

| Scenarios | | S4 | S5 | S6 | S7 | S8 |
|---|---|---|---|---|---|---|
| Properties | Priced AI | R2 243 971.55 | R2 241 472.19 | R2 247 918.93 | R2 288 724.24 | R2 242 062.62 |
| | Total Savings | R521 559.74 | R524 059.10 | R517 612.36 | R476 807.05 | R523 468.67 |
| | Change in savings | 0.80% | 1.28% | 0.03% | -7.85% | 1.17% |
| | Elasticity | -2.0% | -3.2% | -0.1% | -9.1% | -8.5% |
| $AI_Q$ (Mangwele) | Ramabulana | 98% | 97% | 97% | 94% | 98% |
| | Tshianane | 94% | 96% | 94% | 83% | 95% |
| | Sane Combined | 71% | 71% | 80% | 38% | 70% |
| Savings | Ramabulana | R19 343.07 | R18 111.01 | R18 111.01 | R15 146.55 | R19 150.56 |
| | Tshianane | R28 554.49 | R34 237.07 | R28 554.49 | R3 039.68 | R30 760.59 |
| | Sane Combined | R- | R- | R174.58 | R(704.86) | R(20.39) |
| $AI_Q$ (Sane) | Ramabulana | 99% | 97% | 97% | 94% | 98% |
| | Tshianane | 96% | 97% | 96% | 87% | 96% |
| Savings | Ramabulana | R177 758.38 | R174 868.48 | R174 868.48 | R167 902.46 | R177 307.01 |
| | Tshianane | R12 587.33 | R13 526.08 | R12 587.33 | R8 106.74 | R12 954.43 |
| Total Clinic Savings | Total Clinic Savings | R283 316.47 | R283 316.47 | R283 316.47 | R283 316.47 | R283 316.47 |

Effect of School Distances

| From Sane | | S0 | S1 | S2 | S3 | S4 | S5 | S6 | $S_{unfav}$ | $S_{fav}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Properties | Priced AI | R2 248 093.51 | R2 390 375.08 | R2 259 550.75 | R2 248 093.51 | R1 996 144.66 | R2 213 082.97 | R2 248 093.51 | R2 401 832.33 | R2 037 359.88 |
| | Total Savings | R517 437.78 | R375 156.21 | R505 980.54 | R517 437.78 | R769 386.63 | R552 448.33 | R517 437.78 | R363 698.96 | R728 171.41 |
| | Change in savings | 0.00% | -27.50% | -2.21% | 0.00% | 48.69% | 6.77% | 0.00% | -29.71% | 40.73% |
| | Elasticity | - | -68.7% | -5.5% | 0.0% | -121.7% | -16.9% | 0.0% | -74.3% | -142.3% |
| Walking | Ramabulana | 21% | 7% | 21% | 21% | 46% | 21% | 21% | 7% | 37% |
| | Tshianane | 9% | 9% | 1% | 9% | 9% | 35% | 9% | 1% | 47% |
| | Savings | R180 936.73 | R38 655.16 | R169 479.49 | R180 936.73 | R432 885.58 | R215 947.28 | R180 936.73 | R27 197.92 | R391 670.36 |
| Public Transport | Ramabulana | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Tshianane | 98% | 98% | 98% | 98% | 98% | 98% | 98% | 98% | 98% |
| | Savings | R6 519.07 | R6 519.07 | R6 519.07 | R6 519.07 | R6 519.07 | R6 519.07 | R6 519.07 | R6 519.07 | R6 519.07 |
| Other Properties | Total Clinic Savings | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 |
| | Total Savings from Sane | R410 177.47 | R267 895.90 | R398 720.23 | R410 177.47 | R662 126.32 | R445 188.02 | R410 177.47 | R256 438.65 | R620 911.10 |
| | Total Savings from Mangwele | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 |

| From Mangwele | | S0 | S1 | S2 | S3 | S4 | S5 | S6 | $S_{unfav}$ | $S_{fav}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Properties | Priced AI | R2 248 093.51 | R2 247 669.39 | R2 248 024.26 | R2 249 160.07 | R2 254 847.01 | R2 250 959.41 | R2 245 966.08 | R2 248 666.70 | R2 302 385.13 |
| | Total Savings | R517 437.78 | R517 861.90 | R517 507.03 | R516 371.22 | R510 684.28 | R514 571.88 | R519 565.21 | R516 864.59 | R463 146.16 |
| | Change in savings | 0.00% | 0.08% | 0.01% | -0.21% | -1.31% | -0.55% | 0.41% | -0.11% | -10.49% |
| | Elasticity | - | 0.2% | 0.0% | -0.5% | 3.3% | 1.4% | -1.0% | -0.3% | 20.6% |
| Walking | Ramabulana | 0.00% | 0.00% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Tshianane | 0.06% | 0.06% | 0% | 0% | 0% | 2% | 0% | 0% | 25% |
| | Sane Combined | 2.22% | 2.22% | 2% | 1% | 2% | 2% | 5% | 1% | 4% |
| | Savings | R16.48 | R16.48 | R(21.35) | R(1 050.09) | R16.48 | R1 595.99 | R2 143.91 | R(1 087.91) | R18 015.47 |
| Public Transport | Ramabulana | 80.445% | 80.856% | 80% | 80% | 74% | 80% | 80% | 81% | 57% |
| | Tshianane | 80.209% | 80.209% | 80% | 80% | 80% | 79% | 80% | 80% | 63% |
| | Sane combined | 0.000% | 0.000% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Savings | R46 649.02 | R47 073.14 | R46 756.09 | R46 649.02 | R39 895.51 | R42 203.61 | R46 649.02 | R47 180.22 | R(25 641.60) |
| Other properties | Total Clinic Savings | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 |
| | Total Savings from Sane | R107 260.31 | R107 684.43 | R107 329.56 | R106 193.74 | R100 506.80 | R104 394.41 | R109 387.74 | R106 687.11 | R52 968.69 |
| | Total Savings from Mangwele | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 |

Effects of transport cost sensitivity analysis

| From Mangwele | | S0 | S1 | S2 | S3 | S4 | S5 | S6 | $S_{unfav}$ | $S_{fav}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Properties | Priced AI | R2 248 093.51 | R2 247 669.39 | R2 248 122.02 | R2 247 668.76 | R2 247 964.86 | R2 248 073.17 | R2 248 448.92 | R2 247 877.03 | R2 248 299.93 |
| | Total Savings | R517 437.78 | R517 861.90 | R517 409.27 | R517 862.53 | R517 566.43 | R517 458.12 | R517 082.37 | R517 654.26 | R517 231.36 |
| | Change in savings | 0.00% | 0.08% | -0.01% | 0.08% | 0.02% | 0.00% | -0.07% | 0.04% | -0.04% |
| | Elasticity | - | 0.2% | 0.0% | 0.2% | -0.1% | 0.0% | 0.2% | 0.1% | 0.1% |
| Walking | Ramabulana | 0.00% | 0.00% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Tshianane | 0.06% | 0.06% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Sane Combined | 2.22% | 2.22% | 2% | 3% | 2% | 2% | 2% | 3% | 2% |
| | Savings | R16.48 | R16.48 | R32.06 | R441.23 | R16.48 | R5.37 | R(338.94) | R456.80 | R(350.05) |
| Public Transport | Ramabulana | 80.445% | 80.270% | 80% | 80% | 81% | 80% | 80% | 80% | 81% |
| | Tshianane | 80.209% | 80.209% | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| | Sane combined | 0.000% | 0.000% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Savings | R46 649.02 | R46 469.26 | R46 604.93 | R46 649.02 | R46 777.67 | R46 680.47 | R46 649.02 | R46 425.18 | R46 809.12 |
| Other properties | Total Clinic Savings | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 |
| | Total Savings from Sane | R107 260.31 | R107 080.55 | R107 231.80 | R107 685.06 | R107 388.96 | R107 280.65 | R106 904.90 | R107 476.79 | R107 053.89 |
| | Total Savings from Mangwele | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 | R410 177.47 |
| From Sane | | S0 | S1 | S2 | S3 | S4 | S5 | S6 | $S_{unfav}$ | $S_{fav}$ |
| Properties | Priced AI | R2 248 093.51 | R2 200 857.73 | R2 244 790.00 | R2 248 093.51 | R2 289 506.36 | R2 250 883.29 | R2 248 093.51 | R2 197 554.22 | R2 292 296.14 |
| | Total Savings | R517 437.78 | R564 673.56 | R520 741.29 | R517 437.78 | R476 024.93 | R514 648.00 | R517 437.78 | R567 977.08 | R473 235.15 |
| | Change in savings | 0.00% | 9.13% | 0.64% | 0.00% | -8.00% | -0.54% | 0.00% | 9.77% | -8.54% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Elasticity | - | 22.8% | 1.6% | 0.0% | 20.0% | 1.3% | 0.0% | 24.4% | 21.4% |
| Walking | Ramabulana | 0.00% | 25.84% | 21% | 21% | 17% | 21% | 21% | 26% | 17% |
| | Tshianane | 0.06% | 9.48% | 12% | 9% | 9% | 7% | 9% | 12% | 7% |
| | Savings | R16.48 | R228 172.52 | R184 578.50 | R180 936.73 | R139 523.88 | R177 901.93 | R180 936.73 | R231 814.28 | R136 489.08 |
| Public Transport | Ramabulana | 80.445% | 0.000% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| | Tshianane | 80.209% | 97.659% | 97% | 98% | 98% | 98% | 98% | 97% | 98% |
| | Savings | R46 649.02 | R6 519.07 | R6 180.83 | R6 519.07 | R6 519.07 | R6 764.10 | R6 519.07 | R6 180.83 | R6 764.10 |
| Other properties | Total Clinic Savings | R60 594.81 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 |
| | Total Savings from Sane | R107 260.31 | R457 413.25 | R413 480.98 | R410 177.47 | R368 764.62 | R407 387.69 | R410 177.47 | R460 716.77 | R365 974.84 |
| | Total Savings from Mangwele | R410 177.47 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 | R107 260.31 |

Effect of income category on Project 5

| Scenario | | | $S_1$ | $S_0$ | $S_2$ | $S_{unfav}$ | $S_{fav}$ |
|---|---|---|---|---|---|---|---|
| Income Category | | | 1 | 2 | 3 | 4 | 5 |
| Average monthly category income | | | R799.50 | R1 232.83 | R2 366.62 | R4 774.96 | R9 633.30 |
| Change in income category (ref S0) | | | -10% | 0% | 17% | 32% | 45% |
| $A_{IQ}$ Quality | $AI_Q$ (Mangwele) | Ramabulana | 98% | 97% | 95% | 93% | 88% |
| | | Tshianane | 97% | 94% | 91% | 87% | 80% |
| | | Sane Combined | 76% | 71% | 55% | 43% | 32% |
| | $AI_Q$ (Sane) | Ramabulana | 98% | 97% | 95% | 93% | 88% |
| | | Tshianane | 97% | 96% | 91% | 87% | 80% |
| $A_{TR}$ Walking | From Mangwele | Ramabulana | 0% | 0.000% | 0% | 0.000% | 0% |
| | | Tshianane | 0% | 0.056% | 0% | 0.145% | 0% |
| | | Sane Combined | 2% | 2% | 3% | 3% | 3% |
| | From Sane | Ramabulana | 16% | 21% | 31% | 41% | 52% |
| | | Tshianane | 6% | 9% | 15% | 21% | 29% |
| $A_{TR}$ Public Transport | From Mangwele | Ramabulana | 82% | 80% | 79% | 76% | 72% |
| | | Tshianane | 82% | 80% | 78% | 74% | 68% |
| | | Sane Combined | 0% | 0% | 0% | 0% | 0% |
| | From Sane | Ramabulana | 0% | 0% | 0% | 0% | 0% |
| | | Tshianane | 99% | 98% | 96% | 93% | 89% |
| Savings from Walking | From Mangwele | Ramabulana | R- | R- | R- | R- | R- |
| | | Tshianane | R(1.23) | R16.48 | R38.02 | R77.17 | R137.12 |
| | | Sane Combined | R(55.18) | R- | R626.96 | R663.07 | R468.86 |
| | From Sane | Ramabulana | R119 513.56 | R174 868.48 | R267 616.32 | R354 841.50 | R436 607.67 |
| | | Tshianane | R2 000.89 | R6 068.26 | R12 889.99 | R19 654.55 | R25 902.13 |

| Scenario | | | $S_1$ | $S_0$ | $S_2$ | $S_{unfav}$ | $S_{fav}$ |
|---|---|---|---|---|---|---|---|
| Income Category | | | 1 | 2 | 3 | 4 | 5 |
| Average monthly category income | | | R799.50 | R1 232.83 | R2 366.62 | R4 774.96 | R9 633.30 |
| Change in income category (ref S0) | | | -10% | 0% | 17% | 32% | 45% |
| Savings from Public Transport | From Mangwele | Ramabulana | R19 256.83 | R18 111.01 | R16 281.91 | R13 413.76 | R9 041.43 |
| | | Tshianane | R34 672.41 | R28 538.01 | R22 261.27 | R11 027.75 | R(4 977.65) |
| | | Sane Combined | R- | R- | R- | R- | R- |
| | From Sane | Ramabulana | R- | R- | R- | R- | R- |
| | | Tshianane | R7 277.00 | R6 519.07 | R4 340.10 | R1 650.91 | R(2 162.97) |
| Savings According to School | | Ramabulana | R138 770.38 | R192 979.49 | R283 898.23 | R368 255.26 | R445 649.10 |
| | | Tshianane | R43 949.07 | R41 141.82 | R39 529.38 | R32 410.39 | R18 898.63 |
| | | Sane Combined | R(55.18) | R- | R626.96 | R663.07 | R468.86 |
| Savings from walking from Mangwele | | | R(56.40) | R16.48 | R664.98 | R740.24 | R605.97 |
| Savings from walking from Sane | | | R121 514.44 | R180 936.73 | R280 506.31 | R374 496.05 | R462 509.80 |
| Savings from using PT from Mangwele | | | R53 929.24 | R46 649.02 | R38 543.18 | R24 441.51 | R4 063.78 |
| Savings from using PT from Sane | | | R7 277.00 | R6 519.07 | R4 340.10 | R1 650.91 | R(2 162.97) |
| General Savings | Clinic savings from Mangwele | | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 |
| | Clinic Savings from Sane | | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 |
| | Total Savings from Sane | | R351 513.11 | R410 177.47 | R507 568.08 | R598 868.63 | R683 068.50 |
| | Total Savings from Mangwele | | R114 467.65 | R107 260.31 | R99 802.97 | R85 776.57 | R65 264.57 |
| | Total Savings | | R465 980.75 | R517 437.78 | R607 371.05 | R684 645.19 | R748 333.06 |
| | Change in savings | | -10% | 0% | 17% | 32% | 45% |
| | Priced AI | | R2 299 550.54 | R2 248 093.51 | R2 158 160.24 | R2 080 886.10 | R2 017 198.23 |

Effect of number of students

| Scenario | | | S0 | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|---|---|
| $AI_Q$ | $AI_Q$ (Mangwele) | Ramabulana | 97.06% | 97.06% | 97.06% | 97.06% | 97.06% |
| | | Tshianane | 94% | 94% | 94% | 94% | 94% |
| | | Sane Combined | 71% | 71% | 71% | 71% | 71% |
| | $AI_Q$ (Sane) | Ramabulana | 97.32% | 97.32% | 97.32% | 97.32% | 97.32% |
| | | Tshianane | 96% | 96% | 96% | 96% | 96% |
| $A_{TR}$ Walking | From Mangwele | Ramabulana | 0% | 0% | 0% | 0% | 0% |
| | | Tshianane | 0% | 0% | 0% | 0% | 0% |
| | | Sane Combined | 2% | 2% | 2% | 2% | 3% |
| | From Sane | Ramabulana | 21% | 21% | 20% | 26% | 27% |
| | | Tshianane | 9% | 9% | 9% | 12% | 20% |
| $A_{TR}$ Public Transport | From Mangwele | Ramabulana | 80% | 80% | 80% | 80% | 80% |
| | | Tshianane | 80% | 80% | 80% | 80% | 80% |
| | | Sane Combined | 0% | 0% | 0% | 0% | 0% |
| | From Sane | Ramabulana | 0% | 0% | 0% | 0% | 0% |
| | | Tshianane | 98% | 98% | 98% | 97% | 96% |
| Savings from Walking | From Mangwele | Ramabulana | R- | R- | R- | R- | R- |
| | | Tshianane | R16.48 | R18.97 | R12.27 | R29.91 | R25.20 |
| | | Sane Combined | R- | R- | R(64.38) | R113.71 | R796.28 |
| | From Sane | Ramabulana | R174 868.48 | R178 141.62 | R160 750.44 | R222 056.40 | R236 246.39 |
| | | Tshianane | R6 068.26 | R6 086.18 | R5 848.45 | R8 839.62 | R21 047.81 |

| Scenario | | | S0 | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|---|---|
| Savings from Public Transport | From Mangwele | Ramabulana | R18 111.01 | R18 095.50 | R18 157.04 | R17 951.65 | R18 002.79 |
| | | Tshianane | R28 538.01 | R28 534.22 | R28 542.66 | R28 520.53 | R28 462.36 |
| | | Sane Combined | R- | R- | R- | R- | R- |
| | From Sane | Ramabulana | R- | R- | R- | R- | R- |
| | | Tshianane | R6 519.07 | R6 519.07 | R6 678.25 | R6 227.06 | R6 067.35 |
| Savings According to School | | Ramabulana | R192 979.49 | R196 237.13 | R178 907.48 | R240 008.05 | R254 249.18 |
| | | Tshianane | R41 141.82 | R41 158.44 | R41 081.63 | R43 617.11 | R55 602.72 |
| | | Sane Combined | R- | R- | R(64.38) | R113.71 | R796.28 |
| Savings from walking from Mangwele | | | R16.48 | R18.97 | R(52.11) | R143.62 | R821.48 |
| Savings from walking from Sane | | | R180 936.73 | R184 227.80 | R166 598.89 | R230 896.01 | R257 294.20 |
| Savings from using PT from Mangwele | | | R46 649.02 | R46 629.73 | R46 699.70 | R46 472.18 | R46 465.15 |
| Savings from using PT from Sane | | | R6 519.07 | R6 519.07 | R6 678.25 | R6 227.06 | R6 067.35 |
| Clinic savings from Mangwele | | | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 |
| Clinic Savings from Sane | | | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 |
| Total Savings from Sane | | | R410 177.47 | R413 468.54 | R395 998.80 | R459 844.73 | R486 083.21 |
| Total Savings from Mangwele | | | R107 260.31 | R107 243.51 | R107 242.40 | R107 210.61 | R107 881.44 |
| Total Savings | | | R517 437.78 | R520 712.05 | R503 241.20 | R567 055.34 | R593 964.65 |
| Priced AI | | | R2 248 093.51 | R2 244 819.24 | R2 262 290.09 | R2 198 475.95 | R2 171 566.64 |

| Scenario | S5 | S6 | S7 | S8 |
|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| $AI_Q$ | $AI_Q$ (Mangwele) | Ramabulana | 97.06% | 97.06% | 97.06% | 97.06% |
| | | Tshianane | 94% | 94% | 94% | 94% |
| | | Sane Combined | 71% | 71% | 71% | 71% |
| | $AI_Q$ (Sane) | Ramabulana | 97.32% | 97.32% | 97.32% | 97.32% |
| | | Tshianane | 96% | 96% | 96% | 96% |
| $A_{TR}$ Walking | From Mangwele | Ramabulana | 0% | 0% | 0% | 0% |
| | | Tshianane | 0% | 0% | 0% | 0% |
| | | Sane Combined | 2% | 2% | 2% | 1% |
| | From Sane | Ramabulana | 21% | 23% | 17% | 15% |
| | | Tshianane | 9% | 10% | 8% | 3% |
| $A_{TR}$ Public Transport | From Mangwele | Ramabulana | 80% | 80% | 81% | 81% |
| | | Tshianane | 80% | 80% | 80% | 80% |
| | | Sane Combined | 0% | 0% | 0% | 0% |
| | From Sane | Ramabulana | 0% | 0% | 0% | 0% |
| | | Tshianane | 98% | 97% | 98% | 98% |
| Savings from Walking | From Mangwele | Ramabulana | R- | R- | R- | R- |
| | | Tshianane | R14.24 | R21.65 | R6.50 | R10.81 |
| | | Sane Combined | R- | R76.12 | R(89.37) | R(567.56) |
| | From Sane | Ramabulana | R171 715.76 | R191 221.59 | R133 867.54 | R116 122.26 |
| | | Tshianane | R6 051.24 | R6 336.87 | R3 667.00 | R(2 308.13) |

| Scenario | | | S5 | S6 | S7 | S8 |
|---|---|---|---|---|---|---|
| Savings from Public Transport | From Mangwele | Ramabulana | R18 125.73 | R18 054.50 | R18 205.10 | R18 181.75 |
| | | Tshianane | R28 541.50 | R28 532.15 | R28 551.00 | R28 576.17 |
| | | Sane Combined | R- | R- | R- | R- |
| | From Sane | Ramabulana | R- | R- | R- | R- |
| | | Tshianane | R6 519.07 | R6 325.19 | R6 738.89 | R6 818.61 |
| Savings According to School | | Ramabulana | R189 841.49 | R209 276.09 | R152 072.64 | R134 304.01 |
| | | Tshianane | R41 126.05 | R41 215.87 | R38 963.39 | R33 097.45 |
| | | Sane Combined | R- | R76.12 | R(89.37) | R(567.56) |
| Savings from walking from Mangwele | | | R14.24 | R97.77 | R(82.87) | R(556.76) |
| Savings from walking from Sane | | | R177 766.99 | R197 558.46 | R137 534.54 | R113 814.13 |
| Savings from using PT from Mangwele | | | R46 667.23 | R46 586.65 | R46 756.10 | R46 757.92 |
| Savings from using PT from Sane | | | R6 519.07 | R6 325.19 | R6 738.89 | R6 818.61 |
| Clinic savings from Mangwele | | | R60 594.81 | R60 594.81 | R60 594.81 | R60 594.81 |
| Clinic Savings from Sane | | | R222 721.66 | R222 721.66 | R222 721.66 | R222 721.66 |
| Total Savings from Sane | | | R407 007.73 | R426 605.31 | R366 995.09 | R343 354.40 |
| Total Savings from Mangwele | | | R107 276.28 | R107 279.23 | R107 268.04 | R106 795.97 |
| Total Savings | | | R514 284.01 | R533 884.55 | R474 263.13 | R450 150.37 |
| Priced AI | | | R2 251 247.28 | R2 231 646.74 | R2 291 268.16 | R2 315 380.92 |

Effect of clinic waiting times

| Scenario | | | S0 | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|---|---|
| Scenario description | | | S0 | Sunfav (> 2 hours) | Sfav (< 2 hours) | WAITt*1.4 | WAITt*0.6 |
| $AI_Q$ | | From Mangwele | 69% | 56% | 92% | 69% | 84% |
| | | From Sane | 79% | 56% | 92% | 74% | 91% |
| $A_{TR}$ Public Transport | | From Mangwele | 99% | 99% | 99% | 99% | 99% |
| | | From Sane | 78% | 78% | 78% | 78% | 78% |
| $A_{TR}$ Walking | | From Mangwele | 1% | 1% | 1% | 1% | 1% |
| | | From Sane | 22% | 22% | 22% | 22% | 22% |
| Savings | Public Transport | From Mangwele | R60 529.32 | R7 090.79 | R154 046.76 | R60 529.32 | R122 874.28 |
| | | From Sane | R116 735.68 | R17 982.61 | R171 049.86 | R96 985.06 | R166 112.21 |
| | Walking | From Mangwele | R65.49 | R47.73 | R96.57 | R65.49 | R86.21 |
| | | From Sane | R105 985.99 | R67 369.41 | R127 225.10 | R98 262.67 | R125 294.27 |
| | Clinic Savings Mangwele | | R60 594.81 | R7 138.52 | R154 143.33 | R60 594.81 | R122 960.49 |
| | Clinic Savings Sane | | R222 721.66 | R85 352.02 | R298 274.96 | R195 247.73 | R291 406.48 |
| | Total Clinic | | R283 316.47 | R92 490.54 | R452 418.29 | R255 842.55 | R414 366.97 |
| | Total Education | | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 |
| | Total Savings | | R517 437.78 | R326 611.85 | R686 539.59 | R489 963.85 | R648 488.27 |

Effect of doctor visitation frequency

| Doctor visitation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Scenario | | | S0 | S1 | S2 | S3 | S4 | S5 |
| $AI_Q$ | | From Mangwele | 69% | 70% | 61% | 26% | 68% | 70% |
| | | From Sane | 79% | 80% | 73% | 38% | 78% | 80% |
| $A_{TR}$ Public Transport | | From Mangwele | 99% | 99% | 99% | 99% | 99% | 99% |
| | | From Sane | 78% | 78% | 78% | 78% | 78% | 78% |
| $A_{TR}$ Walking | | From Mangwele | 1% | 1% | 1% | 1% | 1% | 1% |
| | | From Sane | 22% | 22% | 22% | 22% | 22% | 22% |
| Savings | Public Transport | From Mangwele | R60 529.32 | R66 511.55 | R29 282.88 | R(110 674.94) | R55 665.53 | R65 324.33 |
| | | From Sane | R116 735.68 | R121 270.37 | R92 067.35 | R(54 484.27) | R113 008.32 | R120 374.65 |
| | Walking | From Mangwele | R65.49 | R67.48 | R55.11 | R8.59 | R63.87 | R67.08 |
| | | From Sane | R105 985.99 | R107 759.24 | R96 339.64 | R39 031.84 | R104 528.43 | R107 408.98 |
| | Clinic Savings Mangwele | | R60 594.81 | R66 579.02 | R29 337.98 | R(110 666.35) | R55 729.40 | R65 391.42 |
| | Clinic Savings Sane | | R222 721.66 | R229 029.61 | R188 406.98 | R(15 452.44) | R217 536.75 | R227 783.62 |
| | Total Clinic | | R283 316.47 | R295 608.63 | R217 744.96 | R(126 118.79) | R273 266.15 | R293 175.04 |
| | Total Education | | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 |
| | Total Savings | | R517 437.78 | R529 729.94 | R451 866.27 | R108 002.52 | R507 387.46 | R527 296.35 |

Effect of transport cost to school

| Scenario | | | S0 | S1 | S2 | S3 | S4 | S5 |
|---|---|---|---|---|---|---|---|---|
| $AI_Q$ | | From Mangwele | 69% | 69% | 69% | 69% | 69% | 69% |
| | | From Sane | 79% | 79% | 79% | 79% | 79% | 79% |
| $A_{TR}$ Public Transport | | From Mangwele | 99% | 100% | 100% | 99% | 99% | 100% |
| | | From Sane | 78% | 93% | 87% | 65% | 68% | 85% |
| $A_{TR}$ Walking | | From Mangwele | 1% | 0% | 0% | 1% | 1% | 0% |
| | | From Sane | 22% | 7% | 13% | 35% | 32% | 15% |
| Savings | Public Transport | From Mangwele | R60 529.32 | R62 141.04 | R61 641.79 | R58 990.58 | R58 972.05 | R61 436.79 |
| | | From Sane | R116 735.68 | R178 724.22 | R154 665.65 | R63 296.98 | R75 120.87 | R148 300.09 |
| | Walking | From Mangwele | R65.49 | R(0.24) | R22.73 | R144.72 | R124.77 | R29.30 |
| | | From Sane | R105 985.99 | R20 155.70 | R53 467.56 | R179 978.03 | R163 606.49 | R62 281.42 |
| | Clinic Savings Mangwele | | R60 594.81 | R62 140.80 | R61 664.52 | R59 135.30 | R59 096.82 | R61 466.10 |
| | Clinic Savings Sane | | R222 721.66 | R198 879.92 | R208 133.21 | R243 275.01 | R238 727.36 | R210 581.51 |
| | Total Clinc | | R283 316.47 | R261 020.72 | R269 797.73 | R302 410.31 | R297 824.17 | R272 047.60 |
| | Total Education | | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 |
| | Total Savings | | R517 437.78 | R495 142.02 | R503 919.04 | R536 531.61 | R531 945.48 | R506 168.91 |

Effect of distance to clinic

| Scenario | | | S0 | S1 | S2 | S3 | S4 |
|---|---|---|---|---|---|---|---|
| $AI_Q$ | | From Mangwele | 69% | 69% | 69% | 69% | 69% |
| | | From Sane | 79% | 79% | 79% | 79% | 79% |
| $A_{TR}$ Public Transport | | From Mangwele | 99% | 52% | 5% | 8% | 52% |
| | | From Sane | 78% | 98% | 68% | 54% | 9% |
| $A_{TR}$ Walking | | From Mangwele | 1% | 46% | 95% | 91% | 46% |
| | | From Sane | 22% | 2% | 32% | 46% | 91% |
| Savings | Public Transport | From Mangwele | R60 529.32 | R(72 568.73) | R(203 516.82) | R(193 168.09) | R(72 568.73) |
| | | From Sane | R116 735.68 | R201 350.64 | R74 261.56 | R12 625.27 | R(176 834.72) |
| | Walking | From Mangwele | R65.49 | R5 952.17 | R12 181.79 | R11 676.20 | R5 952.17 |
| | | From Sane | R105 985.99 | R(11 173.20) | R164 796.30 | R250 138.86 | R512 468.07 |
| | Clinic Savings Mangwele | | R60 594.81 | R(66 616.56) | R(191 335.03) | R(181 491.89) | R(66 616.56) |
| | Clinic Savings Sane | | R222 721.66 | R190 177.44 | R239 057.86 | R262 764.13 | R335 633.35 |
| | Total Clinic | | R283 316.47 | R123 560.89 | R47 722.83 | R81 272.24 | R269 016.80 |
| | Total Education | | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 |
| | Total Savings | | R517 437.78 | R357 682.19 | R281 844.14 | R315 393.55 | R503 138.10 |

| Scenario | | | S5 | S6 | S7 | S8 |
|---|---|---|---|---|---|---|
| $AI_Q$ | | From Mangwele | 69% | 69% | 69% | 69% |
| | | From Sane | 79% | 79% | 79% | 79% |
| $A_{TR}$ Public Transport | | From Mangwele | 66% | 98% | 100% | 85% |
| | | From Sane | 5% | 54% | 95% | 40% |
| $A_{TR}$ Walking | | From Mangwele | 32% | 2% | 0% | 14% |
| | | From Sane | 95% | 46% | 5% | 60% |
| Savings | Public Transport | From Mangwele | R(31 677.66) | R56 156.26 | R62 621.21 | R19 744.48 |
| | | From Sane | R(193 569.28) | R12 625.27 | R188 518.40 | R(46 686.96) |
| | Walking | From Mangwele | R4 089.99 | R250.33 | R(22.70) | R1 813.64 |
| | | From Sane | R535 639.00 | R250 138.86 | R6 594.53 | R332 263.48 |
| | Clinic Savings Mangwele | | R(27 587.67) | R56 406.59 | R62 598.51 | R21 558.12 |
| | Clinic Savings Sane | | R342 069.72 | R262 764.13 | R195 112.92 | R285 576.52 |
| | Total Clinic | | R314 482.05 | R319 170.72 | R257 711.44 | R307 134.65 |
| | Total Education | | R234 121.31 | R234 121.31 | R234 121.31 | R234 121.31 |
| | Total Savings | | R548 603.36 | R553 292.02 | R491 832.74 | R541 255.95 |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION TRANSPORT SP RESULTS

| Household No. | Option | STU HH | SEC FEM | PRI FEM | PRI MAL | SEC MAL | INC GRP | WT | PTCST | MODE ( 0 = walk, 1 = PT) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 1 | 3 | 0 | 2 | 1 | 0 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 3 | 0 | 2 | 1 | 0 | 2 | 120 | R10.00 | 0 |
| | Option 3 | 3 | 0 | 2 | 1 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 0 | 2 | 1 | 0 | 2 | 60 | R15.00 | 0 |
| 1 | Option 5 | 3 | 0 | 2 | 1 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 3 | 0 | 2 | 1 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 0 | 2 | 1 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 0 | 2 | 1 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 0 | 2 | 1 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 4 | 2 | 0 | 2 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | R15.00 | 1 |
| 2 | Option 5 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 4 | 2 | 0 | 2 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 4 | 2 | 0 | 2 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 1 | 0 | 1 | 0 | 4 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | R15.00 | 1 |
| 3 | Option 5 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | R10.00 | 1 |
| | Option 6 | 2 | 1 | 0 | 1 | 0 | 4 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 1 | 0 | 4 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | R15.00 | 0 |
| | Option 1 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 1 | 0 | 0 | 0 | 1 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | R15.00 | 0 |
| 4 | Option 5 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 1 | 0 | 0 | 0 | 1 | 2 | 120 | R15.00 | 0 |
| | Option 7 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 1 | 0 | 0 | 0 | 1 | 2 | 120 | R5.00 | 0 |
| | Option 9 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 3 | 2 | 1 | 0 | 0 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 3 | 2 | 1 | 0 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 3 | 2 | 1 | 0 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 2 | 1 | 0 | 0 | 2 | 60 | R15.00 | 1 |
| 5 | Option 5 | 3 | 2 | 1 | 0 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 3 | 2 | 1 | 0 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 2 | 1 | 0 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 2 | 1 | 0 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 2 | 1 | 0 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 0 | 2 | 0 | 0 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 2 | 0 | 2 | 0 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 0 | 2 | 0 | 0 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 2 | 0 | 2 | 0 | 0 | 2 | 60 | R15.00 | 1 |
| 6 | Option 5 | 2 | 0 | 2 | 0 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 2 | 0 | 2 | 0 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 0 | 2 | 0 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 0 | 2 | 0 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 0 | 2 | 0 | 0 | 2 | 30 | R15.00 | 1 |
| | Option 1 | 4 | 0 | 1 | 2 | 1 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 4 | 0 | 1 | 2 | 1 | 2 | 120 | R10.00 | 0 |
| | Option 3 | 4 | 0 | 1 | 2 | 1 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 4 | 0 | 1 | 2 | 1 | 2 | 60 | R15.00 | 0 |
| 7 | Option 5 | 4 | 0 | 1 | 2 | 1 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 4 | 0 | 1 | 2 | 1 | 2 | 120 | R15.00 | 0 |
| | Option 7 | 4 | 0 | 1 | 2 | 1 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 4 | 0 | 1 | 2 | 1 | 2 | 120 | R5.00 | 0 |
| | Option 9 | 4 | 0 | 1 | 2 | 1 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 1 | 0 | 1 | 0 | 4 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | R15.00 | 0 |
| 8 | Option 5 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | R10.00 | 0 |
| | Option 6 | 2 | 1 | 0 | 1 | 0 | 4 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 1 | 0 | 4 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | R15.00 | 0 |
| | Option 1 | 3 | 0 | 1 | 2 | 0 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 3 | 0 | 1 | 2 | 0 | 2 | 120 | R10.00 | 1 |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION TRANSPORT SP RESULTS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 3 | 3 | 0 | 1 | 2 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 0 | 1 | 2 | 0 | 2 | 60 | R15.00 | 0 |
| 9 | Option 5 | 3 | 0 | 1 | 2 | 0 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 3 | 0 | 1 | 2 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 0 | 1 | 2 | 0 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 3 | 0 | 1 | 2 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 0 | 1 | 2 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 1 | 1 | 0 | 0 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 1 | 1 | 0 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 1 | 1 | 0 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 1 | 1 | 0 | 0 | 2 | 60 | R15.00 | 0 |
| 10 | Option 5 | 2 | 1 | 1 | 0 | 0 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 2 | 1 | 1 | 0 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 1 | 1 | 0 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 1 | 1 | 0 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 1 | 1 | 0 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 0 | 0 | 2 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | R15.00 | 0 |
| 11 | Option 5 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 2 | 0 | 0 | 2 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 0 | 0 | 2 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 3 | 1 | 0 | 2 | 1 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 3 | 1 | 0 | 2 | 1 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 3 | 1 | 0 | 2 | 1 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 3 | 1 | 0 | 2 | 1 | 2 | 60 | R15.00 | 1 |
| 12 | Option 5 | 3 | 1 | 0 | 2 | 1 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 3 | 1 | 0 | 2 | 1 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 1 | 0 | 2 | 1 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 1 | 0 | 2 | 1 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 1 | 0 | 2 | 1 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 1 | 1 | 0 | 0 | 3 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 1 | 1 | 0 | 0 | 3 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 1 | 1 | 0 | 0 | 3 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 1 | 1 | 0 | 0 | 3 | 60 | R15.00 | 1 |
| 13 | Option 5 | 2 | 1 | 1 | 0 | 0 | 3 | 60 | R10.00 | 1 |
| | Option 6 | 2 | 1 | 1 | 0 | 0 | 3 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 1 | 1 | 0 | 0 | 3 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 1 | 1 | 0 | 0 | 3 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 1 | 1 | 0 | 0 | 3 | 30 | R15.00 | 0 |
| | Option 1 | 6 | 2 | 0 | 3 | 1 | 1 | 30 | R5.00 | 1 |
| | Option 2 | 6 | 2 | 0 | 3 | 1 | 1 | 120 | R10.00 | 1 |
| | Option 3 | 6 | 2 | 0 | 3 | 1 | 1 | 30 | R10.00 | 0 |
| | Option 4 | 6 | 2 | 0 | 3 | 1 | 1 | 60 | R15.00 | 1 |
| 14 | Option 5 | 6 | 2 | 0 | 3 | 1 | 1 | 60 | R10.00 | 1 |
| | Option 6 | 6 | 2 | 0 | 3 | 1 | 1 | 120 | R15.00 | 1 |
| | Option 7 | 6 | 2 | 0 | 3 | 1 | 1 | 60 | R5.00 | 1 |
| | Option 8 | 6 | 2 | 0 | 3 | 1 | 1 | 120 | R5.00 | 1 |
| | Option 9 | 6 | 2 | 0 | 3 | 1 | 1 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 0 | 0 | 2 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | R15.00 | 1 |
| 15 | Option 5 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 2 | 0 | 0 | 2 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 0 | 0 | 2 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 3 | 0 | 1 | 1 | 1 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 3 | 0 | 1 | 1 | 1 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 3 | 0 | 1 | 1 | 1 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 0 | 1 | 1 | 1 | 2 | 60 | R15.00 | 1 |
| 16 | Option 5 | 3 | 0 | 1 | 1 | 1 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 3 | 0 | 1 | 1 | 1 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 0 | 1 | 1 | 1 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 0 | 1 | 1 | 1 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 0 | 1 | 1 | 1 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 1 | 0 | 1 | 0 | 5 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 1 | 0 | 1 | 0 | 5 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 1 | 0 | 1 | 0 | 5 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 1 | 0 | 1 | 0 | 5 | 60 | R15.00 | 1 |
| 17 | Option 5 | 2 | 1 | 0 | 1 | 0 | 5 | 60 | R10.00 | 1 |
| | Option 6 | 2 | 1 | 0 | 1 | 0 | 5 | 120 | R15.00 | 0 |
| | Option 7 | 2 | 1 | 0 | 1 | 0 | 5 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 1 | 0 | 5 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 1 | 0 | 1 | 0 | 5 | 30 | R15.00 | 0 |
| | Option 1 | 3 | 1 | 1 | 1 | 0 | 2 | 30 | R5.00 | 0 |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION TRANSPORT SP RESULTS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 2 | 3 | 1 | 1 | 1 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 3 | 1 | 1 | 1 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 1 | 1 | 1 | 0 | 2 | 60 | R15.00 | 0 |
| 18 | Option 5 | 3 | 1 | 1 | 1 | 0 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 3 | 1 | 1 | 1 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 1 | 1 | 1 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 1 | 1 | 1 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 1 | 1 | 1 | 0 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 1 | 0 | 0 | 0 | 1 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | R15.00 | 0 |
| 19 | Option 5 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 1 | 0 | 0 | 0 | 1 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 1 | 0 | 0 | 0 | 1 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 2 | 0 | 1 | 0 | 1 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 2 | 0 | 1 | 0 | 1 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 0 | 1 | 0 | 1 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 2 | 0 | 1 | 0 | 1 | 2 | 60 | R15.00 | 1 |
| 20 | Option 5 | 2 | 0 | 1 | 0 | 1 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 2 | 0 | 1 | 0 | 1 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 0 | 1 | 0 | 1 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 0 | 1 | 0 | 1 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 0 | 1 | 0 | 1 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 3 | 1 | 0 | 1 | 1 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 3 | 1 | 0 | 1 | 1 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 3 | 1 | 0 | 1 | 1 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 1 | 0 | 1 | 1 | 2 | 60 | R15.00 | 0 |
| 21 | Option 5 | 3 | 1 | 0 | 1 | 1 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 3 | 1 | 0 | 1 | 1 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 1 | 0 | 1 | 1 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 1 | 0 | 1 | 1 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 1 | 0 | 1 | 1 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 1 | 1 | 0 | 0 | 0 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 1 | 1 | 0 | 0 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 1 | 1 | 0 | 0 | 0 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 1 | 1 | 0 | 0 | 0 | 2 | 60 | R15.00 | 1 |
| 22 | Option 5 | 1 | 1 | 0 | 0 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 1 | 1 | 0 | 0 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 1 | 1 | 0 | 0 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 1 | 1 | 0 | 0 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 1 | 1 | 0 | 0 | 0 | 2 | 30 | R15.00 | 1 |
| | Option 1 | 2 | 0 | 0 | 2 | 0 | 3 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 0 | 0 | 2 | 0 | 3 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 0 | 0 | 2 | 0 | 3 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 0 | 0 | 2 | 0 | 3 | 60 | R15.00 | 0 |
| 23 | Option 5 | 2 | 0 | 0 | 2 | 0 | 3 | 60 | R10.00 | 0 |
| | Option 6 | 2 | 0 | 0 | 2 | 0 | 3 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 0 | 0 | 2 | 0 | 3 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 0 | 0 | 2 | 0 | 3 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 0 | 0 | 2 | 0 | 3 | 30 | R15.00 | 0 |
| | Option 1 | 1 | 0 | 0 | 1 | 0 | 4 | 30 | R5.00 | 0 |
| | Option 2 | 1 | 0 | 0 | 1 | 0 | 4 | 120 | R10.00 | 1 |
| | Option 3 | 1 | 0 | 0 | 1 | 0 | 4 | 30 | R10.00 | 0 |
| | Option 4 | 1 | 0 | 0 | 1 | 0 | 4 | 60 | R15.00 | 0 |
| 24 | Option 5 | 1 | 0 | 0 | 1 | 0 | 4 | 60 | R10.00 | 0 |
| | Option 6 | 1 | 0 | 0 | 1 | 0 | 4 | 120 | R15.00 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 7 | 1 | 0 | 0 | 1 | 0 | 4 | 60 | R5.00 | 1 |
| | Option 8 | 1 | 0 | 0 | 1 | 0 | 4 | 120 | R5.00 | 1 |
| | Option 9 | 1 | 0 | 0 | 1 | 0 | 4 | 30 | R15.00 | 0 |
| 25 | Option 1 | 1 | 0 | 0 | 1 | 0 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 1 | 0 | 0 | 1 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 1 | 0 | 0 | 1 | 0 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 1 | 0 | 0 | 1 | 0 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 1 | 0 | 0 | 1 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 1 | 0 | 0 | 1 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 1 | 0 | 0 | 1 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 1 | 0 | 0 | 1 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 1 | 0 | 0 | 1 | 0 | 2 | 30 | R15.00 | 0 |
| 25 | Option 1 | 1 | 0 | 1 | 0 | 0 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 1 | 0 | 1 | 0 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 1 | 0 | 1 | 0 | 0 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 1 | 0 | 1 | 0 | 0 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 1 | 0 | 1 | 0 | 0 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 1 | 0 | 1 | 0 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 1 | 0 | 1 | 0 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 1 | 0 | 1 | 0 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 1 | 0 | 1 | 0 | 0 | 2 | 30 | R15.00 | 1 |
| 26 | Option 1 | 5 | 1 | 2 | 0 | 1 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 5 | 1 | 2 | 0 | 1 | 2 | 120 | R10.00 | 0 |
| | Option 3 | 5 | 1 | 2 | 0 | 1 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 5 | 1 | 2 | 0 | 1 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 5 | 1 | 2 | 0 | 1 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 5 | 1 | 2 | 0 | 1 | 2 | 120 | R15.00 | 0 |
| | Option 7 | 5 | 1 | 2 | 0 | 1 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 5 | 1 | 2 | 0 | 1 | 2 | 120 | R5.00 | 0 |
| | Option 9 | 5 | 1 | 2 | 0 | 1 | 2 | 30 | R15.00 | 0 |
| 28 | Option 1 | 2 | 1 | 0 | 0 | 1 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 2 | 1 | 0 | 0 | 1 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 1 | 0 | 0 | 1 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 2 | 1 | 0 | 0 | 1 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 2 | 1 | 0 | 0 | 1 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 2 | 1 | 0 | 0 | 1 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 1 | 0 | 0 | 1 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 0 | 1 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 1 | 0 | 0 | 1 | 2 | 30 | R15.00 | 1 |
| 29 | Option 1 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 4 | 2 | 0 | 2 | 0 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 4 | 2 | 0 | 2 | 0 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 4 | 2 | 0 | 2 | 0 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | R15.00 | 0 |

| | coeff b | s.e. | Wald | p-value | exp(b) | lower | upper |
|---|---|---|---|---|---|---|---|
| Intercept | 0.91454128 | 0.95041424 | 0.92593556 | 0.3359213 | 2.49563021 | 0.38742369 | 16.0758631 |
| STU HH | -4.6767511 | 1.20439136 | 15.07833 | 0.00010314 | 0.00930921 | 0.00087848 | 0.09864898 |
| SEC FEM | 5.19436536 | 1.26674084 | 16.8147124 | 4.1213E-05 | 180.25371 | 15.0533257 | 2158.42005 |
| PRI FEM | 4.54558784 | 1.31423923 | 11.9627562 | 0.00054275 | 94.2157947 | 7.16871396 | 1238.24385 |
| PRI MAL | 3.93128646 | 1.19521146 | 10.8188196 | 0.00100474 | 50.9725094 | 4.89745183 | 530.520116 |
| SEC MAL | 3.59758888 | 1.29650414 | 7.69972558 | 0.00552292 | 36.5100981 | 2.87625027 | 463.446202 |
| INC GRP | -0.5551737 | 0.23516743 | 5.57318566 | 0.01823755 | 0.57397253 | 0.36200638 | 0.91005152 |
| WT | 0.04644181 | 0.00631596 | 54.0679679 | 1.9367E-13 | 1.04753712 | 1.03464954 | 1.06058522 |
| PTCST | -0.1330847 | 0.04256924 | 9.77382513 | 0.00177014 | 0.87539093 | 0.80531733 | 0.9515619 |

| Coeff |
|---|
| 0.91454128 |
| -4.6767511 |
| 5.19436536 |
| 4.54558784 |
| 3.93128646 |
| 3.59758888 |
| -0.5551737 |
| 0.04644181 |
| -0.1330847 |

| | |
|---|---|
| LL0 | -177.01265 |
| LL1 | -109.97908 |

| | |
|---|---|
| Chi-Sq | 134.067138 |
| df | 8 |
| p-value | 4.055E-25 |
| alpha | 0.05 |
| sig | yes |

| | |
|---|---|
| R-Sq (L) | 0.37869366 |
| R-Sq (CS) | 0.40170252 |
| R-Sq (N) | 0.54107295 |

| | |
|---|---|
| Hosmer | 199.347996 |
| df | 223 |
| p-value | 0.87083216 |
| alpha | 0.05 |
| sig | no |

Classification Table

| | Suc-Obs | Fail-Obs | |
|---|---|---|---|
| Suc-Pred | 125 | 27 | 152 |
| Fail-Pred | 28 | 81 | 109 |
| | 153 | 108 | 261 |
| | | | |
| Accuracy | 0.81699346 | 0.75 | 0.78927203 |
| | | | |
| Cutoff | 0.5 | | |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION QUALITY SP RESULTS

| Household No. | Option | STU HH | SEC FEM | PRI FEM | PRI MAL | SEC MAL | INC GRP | CLASS | TEXTBKS | ATTND (0=NO, 1 = YES) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Option 1 | 3 | 0 | 2 | 1 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 3 | 0 | 2 | 1 | 0 | 2 | 60 | 0.33 | 1 |
| | Option 3 | 3 | 0 | 2 | 1 | 0 | 2 | 30 | 0.33 | 1 |
| | Option 4 | 3 | 0 | 2 | 1 | 0 | 2 | 45 | 0.67 | 1 |
| | Option 5 | 3 | 0 | 2 | 1 | 0 | 2 | 45 | 0.33 | 1 |
| | Option 6 | 3 | 0 | 2 | 1 | 0 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 3 | 0 | 2 | 1 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 3 | 0 | 2 | 1 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 3 | 0 | 2 | 1 | 0 | 2 | 30 | 0.67 | 1 |
| 2 | Option 1 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 4 | 2 | 0 | 2 | 0 | 2 | 45 | 0.67 | 1 |
| | Option 5 | 4 | 2 | 0 | 2 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 4 | 2 | 0 | 2 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | 0.67 | 1 |
| 3 | Option 1 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 1 | 0 | 1 | 0 | 4 | 45 | 0.67 | 0 |
| | Option 5 | 2 | 1 | 0 | 1 | 0 | 4 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | 0.67 | 0 |
| | Option 7 | 2 | 1 | 0 | 1 | 0 | 4 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | 0.67 | 0 |
| 4 | Option 1 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | 0.33 | 1 |
| | Option 3 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | 0.33 | 1 |
| | Option 4 | 1 | 0 | 0 | 0 | 1 | 2 | 45 | 0.67 | 1 |
| | Option 5 | 1 | 0 | 0 | 0 | 1 | 2 | 45 | 0.33 | 1 |
| | Option 6 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 1 | 0 | 0 | 0 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | 0.67 | 1 |
| 5 | Option 1 | 3 | 2 | 1 | 0 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 3 | 2 | 1 | 0 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 3 | 2 | 1 | 0 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 3 | 2 | 1 | 0 | 0 | 2 | 45 | 0.67 | 0 |
| | Option 5 | 3 | 2 | 1 | 0 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 3 | 2 | 1 | 0 | 0 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 3 | 2 | 1 | 0 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 3 | 2 | 1 | 0 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 3 | 2 | 1 | 0 | 0 | 2 | 30 | 0.67 | 1 |
| 6 | Option 1 | 2 | 0 | 2 | 0 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 0 | 2 | 0 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 0 | 2 | 0 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 0 | 2 | 0 | 0 | 2 | 45 | 0.67 | 1 |
| | Option 5 | 2 | 0 | 2 | 0 | 0 | 2 | 45 | 0.33 | 1 |
| | Option 6 | 2 | 0 | 2 | 0 | 0 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 2 | 0 | 2 | 0 | 0 | 2 | 45 | 1.00 | 0 |
| | Option 8 | 2 | 0 | 2 | 0 | 0 | 2 | 60 | 1.00 | 0 |
| | Option 9 | 2 | 0 | 2 | 0 | 0 | 2 | 30 | 0.67 | 0 |
| 7 | Option 1 | 4 | 0 | 1 | 2 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 4 | 0 | 1 | 2 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 4 | 0 | 1 | 2 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 4 | 0 | 1 | 2 | 1 | 2 | 45 | 0.67 | 0 |
| | Option 5 | 4 | 0 | 1 | 2 | 1 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 4 | 0 | 1 | 2 | 1 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 4 | 0 | 1 | 2 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 4 | 0 | 1 | 2 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 4 | 0 | 1 | 2 | 1 | 2 | 30 | 0.67 | 0 |
| | Option 1 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | 0.33 | 0 |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION QUALITY SP RESULTS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 4 | 2 | 1 | 0 | 1 | 0 | 4 | 45 | 0.67 | 1 |
| 8 | Option 5 | 2 | 1 | 0 | 1 | 0 | 4 | 45 | 0.33 | 1 |
| | Option 6 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | 0.67 | 1 |
| | Option 7 | 2 | 1 | 0 | 1 | 0 | 4 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 1 | 0 | 4 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 1 | 0 | 1 | 0 | 4 | 30 | 0.67 | 1 |
| | Option 1 | 3 | 0 | 1 | 2 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 3 | 0 | 1 | 2 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 3 | 0 | 1 | 2 | 0 | 2 | 30 | 0.33 | 1 |
| | Option 4 | 3 | 0 | 1 | 2 | 0 | 2 | 45 | 0.67 | 1 |
| 9 | Option 5 | 3 | 0 | 1 | 2 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 3 | 0 | 1 | 2 | 0 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 3 | 0 | 1 | 2 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 3 | 0 | 1 | 2 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 3 | 0 | 1 | 2 | 0 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 0 | 0 | 2 | 0 | 2 | 45 | 0.67 | 0 |
| 10 | Option 5 | 2 | 0 | 0 | 2 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 2 | 0 | 0 | 2 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | 0.67 | 0 |
| | Option 1 | 3 | 1 | 0 | 2 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 3 | 1 | 0 | 2 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 3 | 1 | 0 | 2 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 3 | 1 | 0 | 2 | 1 | 2 | 45 | 0.67 | 1 |
| 11 | Option 5 | 3 | 1 | 0 | 2 | 1 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 3 | 1 | 0 | 2 | 1 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 3 | 1 | 0 | 2 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 3 | 1 | 0 | 2 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 3 | 1 | 0 | 2 | 1 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 2 | 1 | 1 | 0 | 0 | 3 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 1 | 1 | 0 | 0 | 3 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 1 | 1 | 0 | 0 | 3 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 1 | 1 | 0 | 0 | 3 | 45 | 0.67 | 0 |
| 12 | Option 5 | 2 | 1 | 1 | 0 | 0 | 3 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 1 | 1 | 0 | 0 | 3 | 60 | 0.67 | 0 |
| | Option 7 | 2 | 1 | 1 | 0 | 0 | 3 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 1 | 1 | 0 | 0 | 3 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 1 | 1 | 0 | 0 | 3 | 30 | 0.67 | 1 |
| | Option 1 | 6 | 2 | 0 | 3 | 1 | 1 | 30 | 1.00 | 1 |
| | Option 2 | 6 | 2 | 0 | 3 | 1 | 1 | 60 | 0.33 | 0 |
| | Option 3 | 6 | 2 | 0 | 3 | 1 | 1 | 30 | 0.33 | 1 |
| | Option 4 | 6 | 2 | 0 | 3 | 1 | 1 | 45 | 0.67 | 1 |
| 13 | Option 5 | 6 | 2 | 0 | 3 | 1 | 1 | 45 | 0.33 | 1 |
| | Option 6 | 6 | 2 | 0 | 3 | 1 | 1 | 60 | 0.67 | 1 |
| | Option 7 | 6 | 2 | 0 | 3 | 1 | 1 | 45 | 1.00 | 1 |
| | Option 8 | 6 | 2 | 0 | 3 | 1 | 1 | 60 | 1.00 | 1 |
| | Option 9 | 6 | 2 | 0 | 3 | 1 | 1 | 30 | 0.67 | 1 |
| | Option 1 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 0 | 0 | 2 | 0 | 2 | 45 | 0.67 | 1 |
| 14 | Option 5 | 2 | 0 | 0 | 2 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 2 | 0 | 0 | 2 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 0 | 0 | 2 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 0 | 0 | 2 | 0 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 3 | 0 | 1 | 1 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 3 | 0 | 1 | 1 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 3 | 0 | 1 | 1 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 3 | 0 | 1 | 1 | 1 | 2 | 45 | 0.67 | 0 |
| 15 | Option 5 | 3 | 0 | 1 | 1 | 1 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 3 | 0 | 1 | 1 | 1 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 3 | 0 | 1 | 1 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 3 | 0 | 1 | 1 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 3 | 0 | 1 | 1 | 1 | 2 | 30 | 0.67 | 0 |
| | Option 1 | 2 | 1 | 0 | 1 | 0 | 5 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 1 | 0 | 1 | 0 | 5 | 60 | 0.33 | 0 |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION QUALITY SP RESULTS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 3 | 2 | 1 | 0 | 1 | 0 | 5 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 1 | 0 | 1 | 0 | 5 | 45 | 0.67 | 0 |
| 16 | Option 5 | 2 | 1 | 0 | 1 | 0 | 5 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 1 | 0 | 1 | 0 | 5 | 60 | 0.67 | 0 |
| | Option 7 | 2 | 1 | 0 | 1 | 0 | 5 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 1 | 0 | 5 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 1 | 0 | 1 | 0 | 5 | 30 | 0.67 | 0 |
| | Option 1 | 3 | 1 | 1 | 1 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 3 | 1 | 1 | 1 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 3 | 1 | 1 | 1 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 3 | 1 | 1 | 1 | 0 | 2 | 45 | 0.67 | 1 |
| 17 | Option 5 | 3 | 1 | 1 | 1 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 3 | 1 | 1 | 1 | 0 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 3 | 1 | 1 | 1 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 3 | 1 | 1 | 1 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 3 | 1 | 1 | 1 | 0 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 1 | 0 | 0 | 0 | 1 | 2 | 45 | 0.67 | 1 |
| 18 | Option 5 | 1 | 0 | 0 | 0 | 1 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 1 | 0 | 0 | 0 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 1 | 0 | 0 | 0 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 1 | 0 | 0 | 0 | 1 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 2 | 0 | 1 | 0 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 0 | 1 | 0 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 0 | 1 | 0 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 0 | 1 | 0 | 1 | 2 | 45 | 0.67 | 0 |
| 19 | Option 5 | 2 | 0 | 1 | 0 | 1 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 0 | 1 | 0 | 1 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 2 | 0 | 1 | 0 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 0 | 1 | 0 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 0 | 1 | 0 | 1 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 3 | 1 | 0 | 1 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 3 | 1 | 0 | 1 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 3 | 1 | 0 | 1 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 3 | 1 | 0 | 1 | 1 | 2 | 45 | 0.67 | 0 |
| 20 | Option 5 | 3 | 1 | 0 | 1 | 1 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 3 | 1 | 0 | 1 | 1 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 3 | 1 | 0 | 1 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 3 | 1 | 0 | 1 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 3 | 1 | 0 | 1 | 1 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 1 | 1 | 0 | 0 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 1 | 1 | 0 | 0 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 1 | 1 | 0 | 0 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 1 | 1 | 0 | 0 | 0 | 2 | 45 | 0.67 | 1 |
| 21 | Option 5 | 1 | 1 | 0 | 0 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 1 | 1 | 0 | 0 | 0 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 1 | 1 | 0 | 0 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 1 | 1 | 0 | 0 | 0 | 2 | 60 | 1.00 | 0 |
| | Option 9 | 1 | 1 | 0 | 0 | 0 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 2 | 0 | 0 | 2 | 0 | 3 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 0 | 0 | 2 | 0 | 3 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 0 | 0 | 2 | 0 | 3 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 0 | 0 | 2 | 0 | 3 | 45 | 0.67 | 1 |
| 22 | Option 5 | 2 | 0 | 0 | 2 | 0 | 3 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 0 | 0 | 2 | 0 | 3 | 60 | 0.67 | 1 |
| | Option 7 | 2 | 0 | 0 | 2 | 0 | 3 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 0 | 0 | 2 | 0 | 3 | 60 | 1.00 | 1 |
| | Option 9 | 2 | 0 | 0 | 2 | 0 | 3 | 30 | 0.67 | 1 |
| | Option 1 | 1 | 0 | 0 | 1 | 0 | 4 | 30 | 1.00 | 1 |
| | Option 2 | 1 | 0 | 0 | 1 | 0 | 4 | 60 | 0.33 | 0 |
| | Option 3 | 1 | 0 | 0 | 1 | 0 | 4 | 30 | 0.33 | 1 |
| | Option 4 | 1 | 0 | 0 | 1 | 0 | 4 | 45 | 0.67 | 1 |
| 23 | Option 5 | 1 | 0 | 0 | 1 | 0 | 4 | 45 | 0.33 | 0 |
| | Option 6 | 1 | 0 | 0 | 1 | 0 | 4 | 60 | 0.67 | 0 |
| | Option 7 | 1 | 0 | 0 | 1 | 0 | 4 | 45 | 1.00 | 1 |
| | Option 8 | 1 | 0 | 0 | 1 | 0 | 4 | 60 | 1.00 | 0 |
| | Option 9 | 1 | 0 | 0 | 1 | 0 | 4 | 30 | 0.67 | 1 |
| | Option 1 | 1 | 0 | 0 | 1 | 0 | 2 | 30 | 1.00 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Option 2 | 1 | 0 | 0 | 1 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 1 | 0 | 0 | 1 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 1 | 0 | 0 | 1 | 0 | 2 | 45 | 0.67 | 1 |
| 24 | Option 5 | 1 | 0 | 0 | 1 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 1 | 0 | 0 | 1 | 0 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 1 | 0 | 0 | 1 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 1 | 0 | 0 | 1 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 1 | 0 | 0 | 1 | 0 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 1 | 0 | 1 | 0 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 1 | 0 | 1 | 0 | 0 | 2 | 60 | 0.33 | 1 |
| | Option 3 | 1 | 0 | 1 | 0 | 0 | 2 | 30 | 0.33 | 1 |
| | Option 4 | 1 | 0 | 1 | 0 | 0 | 2 | 45 | 0.67 | 1 |
| 25 | Option 5 | 1 | 0 | 1 | 0 | 0 | 2 | 45 | 0.33 | 1 |
| | Option 6 | 1 | 0 | 1 | 0 | 0 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 1 | 0 | 1 | 0 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 1 | 0 | 1 | 0 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 1 | 0 | 1 | 0 | 0 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 5 | 1 | 2 | 0 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 5 | 1 | 2 | 0 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 5 | 1 | 2 | 0 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 5 | 1 | 2 | 0 | 1 | 2 | 45 | 0.67 | 1 |
| 26 | Option 5 | 5 | 1 | 2 | 0 | 1 | 2 | 45 | 0.33 | 1 |
| | Option 6 | 5 | 1 | 2 | 0 | 1 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 5 | 1 | 2 | 0 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 5 | 1 | 2 | 0 | 1 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 5 | 1 | 2 | 0 | 1 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 2 | 1 | 0 | 0 | 1 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 2 | 1 | 0 | 0 | 1 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 2 | 1 | 0 | 0 | 1 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 2 | 1 | 0 | 0 | 1 | 2 | 45 | 0.67 | 1 |
| 27 | Option 5 | 2 | 1 | 0 | 0 | 1 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 2 | 1 | 0 | 0 | 1 | 2 | 60 | 0.67 | 0 |
| | Option 7 | 2 | 1 | 0 | 0 | 1 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 2 | 1 | 0 | 0 | 1 | 2 | 60 | 1.00 | 0 |
| | Option 9 | 2 | 1 | 0 | 0 | 1 | 2 | 30 | 0.67 | 1 |
| | Option 1 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | 1.00 | 1 |
| | Option 2 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | 0.33 | 0 |
| | Option 3 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | 0.33 | 0 |
| | Option 4 | 4 | 2 | 0 | 2 | 0 | 2 | 45 | 0.67 | 1 |
| 28 | Option 5 | 4 | 2 | 0 | 2 | 0 | 2 | 45 | 0.33 | 0 |
| | Option 6 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | 0.67 | 1 |
| | Option 7 | 4 | 2 | 0 | 2 | 0 | 2 | 45 | 1.00 | 1 |
| | Option 8 | 4 | 2 | 0 | 2 | 0 | 2 | 60 | 1.00 | 1 |
| | Option 9 | 4 | 2 | 0 | 2 | 0 | 2 | 30 | 0.67 | 1 |

| | *coeff b* | *s.e.* | *Wald* | *p-value* | *exp(b)* | *lower* | *upper* |
|---|---|---|---|---|---|---|---|
| Intercept | -0.615 | 0.83904785 | 0.5375751 | 4.63E-01 | 0.54054045 | 0.104 | 2.799 |
| INC GRP | -0.487 | 0.2048386 | 5.64692084 | 1.75E-02 | 0.61461261 | 0.411 | 0.918 |
| CLASS | -0.047 | 0.01468615 | 10.1877452 | 1.41E-03 | 0.95420608 | 0.927 | 0.982 |
| TEXTBKS | 6.801 | 0.81887486 | 68.9802519 | 9.95E-17 | 898.846252 | 180.575 | 4474.175 |

| *Coeff* |
|---|
| -0.6151858 |
| -0.4867631 |
| -0.0468756 |
| 6.801112 |

| | |
|---|---|
| *LL0* | -170.45104 |
| LL1 | -106.4219 |
| Chi-Sq | 128.058295 |
| df | 3 |
| p-value | 1.4174E-27 |
| alpha | 0.05 |
| sig | yes |
| R-Sq (L) | 0.37564538 |
| R-Sq (CS) | 0.39840321 |
| R-Sq (N) | 0.53730738 |
| Hosmer | 19.3212672 |
| df | 43 |
| p-value | 0.99930877 |
| alpha | 0.05 |
| sig | no |

Classification Table

| | Suc-Obs | Fail-Obs | |
|---|---|---|---|
| Suc-Pred | 129 | 29 | 158 |
| Fail-Pred | 20 | 74 | 94 |
| | 149 | 103 | 252 |
| Accuracy | 0.86577181 | 0.7184466 | 0.80555556 |
| Cutoff | 0.5 | | |

APPENDIX C

FL NEMVUMONI - 18899048
HEALTHCARE TRANSPORT SP RESULTS

| Household No. | Option | HH | INC GRP | WT | PTCST | MODE ( 0 = walk, 1 = PT) |
|---|---|---|---|---|---|---|
| | Option 1 | 5 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 1 |
| 1 | Option 5 | 5 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 5 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 9 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 9 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 9 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 9 | 2 | 60 | R15.00 | 0 |
| 2 | Option 5 | 9 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 9 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 9 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 9 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 9 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 7 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 7 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 7 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 7 | 2 | 60 | R15.00 | 1 |
| 3 | Option 5 | 7 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 7 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 7 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 7 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 7 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 9 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 9 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 9 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 9 | 2 | 60 | R15.00 | 1 |
| 4 | Option 5 | 9 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 9 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 9 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 9 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 9 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 5 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 0 |
| 5 | Option 5 | 5 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 5 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 6 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 6 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 6 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 6 | 2 | 60 | R15.00 | 0 |
| 6 | Option 5 | 6 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 6 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 6 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 6 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 6 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 5 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 1 |
| 7 | Option 5 | 5 | 2 | 60 | R10.00 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 5 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 7 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 7 | 2 | 120 | R10.00 | 0 |
| | Option 3 | 7 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 7 | 2 | 60 | R15.00 | 0 |
| 8 | Option 5 | 7 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 7 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 7 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 7 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 7 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 6 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 6 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 6 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 6 | 2 | 60 | R15.00 | 1 |
| 9 | Option 5 | 6 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 6 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 6 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 6 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 6 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 6 | 3 | 30 | R5.00 | 0 |
| | Option 2 | 6 | 3 | 120 | R10.00 | 1 |
| | Option 3 | 6 | 3 | 30 | R10.00 | 0 |
| | Option 4 | 6 | 3 | 60 | R15.00 | 0 |
| 10 | Option 5 | 6 | 3 | 60 | R10.00 | 0 |
| | Option 6 | 6 | 3 | 120 | R15.00 | 1 |
| | Option 7 | 6 | 3 | 60 | R5.00 | 1 |
| | Option 8 | 6 | 3 | 120 | R5.00 | 1 |
| | Option 9 | 6 | 3 | 30 | R15.00 | 0 |
| | Option 1 | 7 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 7 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 7 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 7 | 2 | 60 | R15.00 | 1 |
| 11 | Option 5 | 7 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 7 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 7 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 7 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 7 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 5 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 0 |
| 12 | Option 5 | 5 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 5 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 6 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 6 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 6 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 6 | 2 | 60 | R15.00 | 1 |
| 13 | Option 5 | 6 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 6 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 6 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 6 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 6 | 2 | 30 | R15.00 | 0 |
| | Option 1 | 7 | 3 | 30 | R5.00 | 0 |
| | Option 2 | 7 | 3 | 120 | R10.00 | 1 |
| | Option 3 | 7 | 3 | 30 | R10.00 | 0 |
| | Option 4 | 7 | 3 | 60 | R15.00 | 1 |
| 14 | Option 5 | 7 | 3 | 60 | R10.00 | 1 |
| | Option 6 | 7 | 3 | 120 | R15.00 | 1 |
| | Option 7 | 7 | 3 | 60 | R5.00 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Option 8 | 7 | 3 | 120 | R5.00 | 1 |
| | Option 9 | 7 | 3 | 30 | R15.00 | 0 |
| 15 | Option 1 | 8 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 8 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 8 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 8 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 8 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 8 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 8 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 8 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 8 | 2 | 30 | R15.00 | 0 |
| 16 | Option 1 | 5 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 5 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 5 | 2 | 30 | R15.00 | 0 |
| 17 | Option 1 | 7 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 7 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 7 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 7 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 7 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 7 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 7 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 7 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 7 | 2 | 30 | R15.00 | 0 |
| 18 | Option 1 | 6 | 5 | 30 | R5.00 | 1 |
| | Option 2 | 6 | 5 | 120 | R10.00 | 1 |
| | Option 3 | 6 | 5 | 30 | R10.00 | 1 |
| | Option 4 | 6 | 5 | 60 | R15.00 | 0 |
| | Option 5 | 6 | 5 | 60 | R10.00 | 0 |
| | Option 6 | 6 | 5 | 120 | R15.00 | 1 |
| | Option 7 | 6 | 5 | 60 | R5.00 | 1 |
| | Option 8 | 6 | 5 | 120 | R5.00 | 1 |
| | Option 9 | 6 | 5 | 30 | R15.00 | 0 |
| 19 | Option 1 | 8 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 8 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 8 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 8 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 8 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 8 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 8 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 8 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 8 | 2 | 30 | R15.00 | 0 |
| 20 | Option 1 | 4 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 4 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 4 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 4 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 4 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 4 | 2 | 120 | R15.00 | 0 |
| | Option 7 | 4 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 4 | 2 | 120 | R5.00 | 0 |
| | Option 9 | 4 | 2 | 30 | R15.00 | 0 |
| 21 | Option 1 | 5 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 5 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Option 9 | 5 | 2 | 30 | R15.00 | 0 |
| 22 | Option 1 | 5 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 5 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 5 | 2 | 30 | R15.00 | 0 |
| 23 | Option 1 | 2 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 2 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 2 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 2 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 2 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 2 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 2 | 2 | 60 | R5.00 | 0 |
| | Option 8 | 2 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 2 | 2 | 30 | R15.00 | 0 |
| 24 | Option 1 | 3 | 4 | 30 | R5.00 | 0 |
| | Option 2 | 3 | 4 | 120 | R10.00 | 1 |
| | Option 3 | 3 | 4 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 4 | 60 | R15.00 | 0 |
| | Option 5 | 3 | 4 | 60 | R10.00 | 0 |
| | Option 6 | 3 | 4 | 120 | R15.00 | 1 |
| | Option 7 | 3 | 4 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 4 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 4 | 30 | R15.00 | 0 |
| 25 | Option 1 | 9 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 9 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 9 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 9 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 9 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 9 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 9 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 9 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 9 | 2 | 30 | R15.00 | 0 |
| 26 | Option 1 | 9 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 9 | 2 | 120 | R10.00 | 0 |
| | Option 3 | 9 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 9 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 9 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 9 | 2 | 120 | R15.00 | 0 |
| | Option 7 | 9 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 9 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 9 | 2 | 30 | R15.00 | 0 |
| 27 | Option 1 | 7 | 2 | 30 | R5.00 | 1 |
| | Option 2 | 7 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 7 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 7 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 7 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 7 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 7 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 7 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 7 | 2 | 30 | R15.00 | 1 |
| 28 | Option 1 | 3 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 3 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 3 | 2 | 30 | R10.00 | 0 |
| | Option 4 | 3 | 2 | 60 | R15.00 | 0 |
| | Option 5 | 3 | 2 | 60 | R10.00 | 0 |
| | Option 6 | 3 | 2 | 120 | R15.00 | 0 |
| | Option 7 | 3 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 3 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 3 | 2 | 30 | R15.00 | 0 |

APPENDIX C

FL NEMVUMONI - 18899048
HEALTHCARE TRANSPORT SP RESULTS

| | | | | | | |
|---|---|---|---|---|---|---|
| 29 | Option 1 | 5 | 2 | 30 | R5.00 | 0 |
| | Option 2 | 5 | 2 | 120 | R10.00 | 1 |
| | Option 3 | 5 | 2 | 30 | R10.00 | 1 |
| | Option 4 | 5 | 2 | 60 | R15.00 | 1 |
| | Option 5 | 5 | 2 | 60 | R10.00 | 1 |
| | Option 6 | 5 | 2 | 120 | R15.00 | 1 |
| | Option 7 | 5 | 2 | 60 | R5.00 | 1 |
| | Option 8 | 5 | 2 | 120 | R5.00 | 1 |
| | Option 9 | 5 | 2 | 30 | R15.00 | 1 |

| | *coeff b* | *s.e.* | *Wald* | *p-value* | *exp(b)* | *lower* | *upper* |
|---|---|---|---|---|---|---|---|
| Intercept | -1.668 | 0.50478201 | 10.9215881 | 9.51E-04 | 0.18858719 | 0.0701 | 0.5072 |
| WT | 0.051 | 0.00655933 | 60.5506777 | 7.17E-15 | 1.052366 | 1.0389 | 1.0660 |
| PTCST | -0.125 | 0.04108436 | 9.29846515 | 2.29E-03 | 0.88224974 | 0.8140 | 0.9562 |

| *Coeff* |
|---|
| -1.6681948 |
| 0.05104097 |
| -0.1252801 |

| | |
|---|---|
| LL0 | -178.55759 |
| LL1 | -115.69333 |
| Chi-Sq | 125.728503 |
| df | 2 |
| p-value | 4.9935E-28 |
| alpha | 0.05 |
| sig | yes |
| R-Sq (L) | 0.3520671 |
| R-Sq (CS) | 0.38227901 |
| R-Sq (N) | 0.51281655 |
| Hosmer | 5.91496551 |
| df | 7 |
| p-value | 0.54971284 |
| alpha | 0.05 |
| sig | no |

Classification Table

| | Suc-Obs | Fail-Obs | |
|---|---|---|---|
| Suc-Pred | 120 | 25 | 145 |
| Fail-Pred | 28 | 88 | 116 |
| | 148 | 113 | 261 |
| Accuracy | 0.81081081 | 0.77876106 | 0.79693487 |
| Cutoff | 0.5 | | |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION QUALITY SP RESULTS

| Household No. | Option | HH | INC GRP | DOC | WAITt ( 0 = t < 2 hours) | ATTND (0 = NO, 1 = YES) |
|---|---|---|---|---|---|---|
| 1 | Option 1 | 5 | 2 | 30 | 0 | 1 |
| | Option 2 | 5 | 2 | 3 | 1 | 1 |
| | Option 3 | 5 | 2 | 7 | 1 | 1 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 1 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |
| 2 | Option 1 | 9 | 2 | 30 | 0 | 1 |
| | Option 2 | 9 | 2 | 3 | 1 | 1 |
| | Option 3 | 9 | 2 | 7 | 1 | 1 |
| | Option 4 | 9 | 2 | 3 | 0 | 1 |
| | Option 5 | 9 | 2 | 30 | 1 | 0 |
| | Option 6 | 9 | 2 | 7 | 0 | 1 |
| 3 | Option 1 | 7 | 2 | 30 | 0 | 0 |
| | Option 2 | 7 | 2 | 3 | 1 | 0 |
| | Option 3 | 7 | 2 | 7 | 1 | 0 |
| | Option 4 | 7 | 2 | 3 | 0 | 1 |
| | Option 5 | 7 | 2 | 30 | 1 | 0 |
| | Option 6 | 7 | 2 | 7 | 0 | 1 |
| 4 | Option 1 | 9 | 2 | 30 | 0 | 0 |
| | Option 2 | 9 | 2 | 3 | 1 | 1 |
| | Option 3 | 9 | 2 | 7 | 1 | 1 |
| | Option 4 | 9 | 2 | 3 | 0 | 1 |
| | Option 5 | 9 | 2 | 30 | 1 | 0 |
| | Option 6 | 9 | 2 | 7 | 0 | 1 |
| 5 | Option 1 | 5 | 2 | 30 | 0 | 0 |
| | Option 2 | 5 | 2 | 3 | 1 | 0 |
| | Option 3 | 5 | 2 | 7 | 1 | 0 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 0 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |
| 6 | Option 1 | 6 | 2 | 30 | 0 | 0 |
| | Option 2 | 6 | 2 | 3 | 1 | 0 |
| | Option 3 | 6 | 2 | 7 | 1 | 0 |
| | Option 4 | 6 | 2 | 3 | 0 | 1 |
| | Option 5 | 6 | 2 | 30 | 1 | 0 |
| | Option 6 | 6 | 2 | 7 | 0 | 1 |
| 7 | Option 1 | 5 | 2 | 30 | 0 | 1 |
| | Option 2 | 5 | 2 | 3 | 1 | 0 |
| | Option 3 | 5 | 2 | 7 | 1 | 0 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 0 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |
| 8 | Option 1 | 7 | 2 | 30 | 0 | 0 |
| | Option 2 | 7 | 2 | 3 | 1 | 0 |
| | Option 3 | 7 | 2 | 7 | 1 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | Option 4 | 7 | 2 | 3 | 0 | 1 |
| | Option 5 | 7 | 2 | 30 | 1 | 0 |
| | Option 6 | 7 | 2 | 7 | 0 | 1 |
| 9 | Option 1 | 6 | 2 | 30 | 0 | 0 |
| | Option 2 | 6 | 2 | 3 | 1 | 0 |
| | Option 3 | 6 | 2 | 7 | 1 | 0 |
| | Option 4 | 6 | 2 | 3 | 0 | 1 |
| | Option 5 | 6 | 2 | 30 | 1 | 0 |
| | Option 6 | 6 | 2 | 7 | 0 | 1 |
| 10 | Option 1 | 6 | 3 | 30 | 0 | 0 |
| | Option 2 | 6 | 3 | 3 | 1 | 0 |
| | Option 3 | 6 | 3 | 7 | 1 | 0 |
| | Option 4 | 6 | 3 | 3 | 0 | 1 |
| | Option 5 | 6 | 3 | 30 | 1 | 0 |
| | Option 6 | 6 | 3 | 7 | 0 | 1 |
| 11 | Option 1 | 7 | 2 | 30 | 0 | 0 |
| | Option 2 | 7 | 2 | 3 | 1 | 1 |
| | Option 3 | 7 | 2 | 7 | 1 | 0 |
| | Option 4 | 7 | 2 | 3 | 0 | 1 |
| | Option 5 | 7 | 2 | 30 | 1 | 0 |
| | Option 6 | 7 | 2 | 7 | 0 | 1 |
| 12 | Option 1 | 5 | 2 | 30 | 0 | 0 |
| | Option 2 | 5 | 2 | 3 | 1 | 0 |
| | Option 3 | 5 | 2 | 7 | 1 | 0 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 0 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |
| 13 | Option 1 | 6 | 2 | 30 | 0 | 0 |
| | Option 2 | 6 | 2 | 3 | 1 | 1 |
| | Option 3 | 6 | 2 | 7 | 1 | 1 |
| | Option 4 | 6 | 2 | 3 | 0 | 1 |
| | Option 5 | 6 | 2 | 30 | 1 | 0 |
| | Option 6 | 6 | 2 | 7 | 0 | 1 |
| 14 | Option 1 | 7 | 3 | 30 | 0 | 1 |
| | Option 2 | 7 | 3 | 3 | 1 | 1 |
| | Option 3 | 7 | 3 | 7 | 1 | 1 |
| | Option 4 | 7 | 3 | 3 | 0 | 1 |
| | Option 5 | 7 | 3 | 30 | 1 | 1 |
| | Option 6 | 7 | 3 | 7 | 0 | 1 |
| 15 | Option 1 | 8 | 2 | 30 | 0 | 0 |
| | Option 2 | 8 | 2 | 3 | 1 | 0 |
| | Option 3 | 8 | 2 | 7 | 1 | 0 |
| | Option 4 | 8 | 2 | 3 | 0 | 1 |
| | Option 5 | 8 | 2 | 30 | 1 | 0 |
| | Option 6 | 8 | 2 | 7 | 0 | 0 |
| 16 | Option 1 | 5 | 2 | 30 | 0 | 0 |
| | Option 2 | 5 | 2 | 3 | 1 | 0 |
| | Option 3 | 5 | 2 | 7 | 1 | 0 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 0 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |

EDUCATION QUALITY SP RESULTS

| | | | | | | |
|---|---|---|---|---|---|---|
| 17 | Option 1 | 7 | 2 | 30 | 0 | 0 |
| | Option 2 | 7 | 2 | 3 | 1 | 0 |
| | Option 3 | 7 | 2 | 7 | 1 | 0 |
| | Option 4 | 7 | 2 | 3 | 0 | 1 |
| | Option 5 | 7 | 2 | 30 | 1 | 0 |
| | Option 6 | 7 | 2 | 7 | 0 | 1 |
| 18 | Option 1 | 6 | 5 | 30 | 0 | 0 |
| | Option 2 | 6 | 5 | 3 | 1 | 0 |
| | Option 3 | 6 | 5 | 7 | 1 | 0 |
| | Option 4 | 6 | 5 | 3 | 0 | 1 |
| | Option 5 | 6 | 5 | 30 | 1 | 0 |
| | Option 6 | 6 | 5 | 7 | 0 | 1 |
| 19 | Option 1 | 8 | 2 | 30 | 0 | 0 |
| | Option 2 | 8 | 2 | 3 | 1 | 1 |
| | Option 3 | 8 | 2 | 7 | 1 | 1 |
| | Option 4 | 8 | 2 | 3 | 0 | 1 |
| | Option 5 | 8 | 2 | 30 | 1 | 0 |
| | Option 6 | 8 | 2 | 7 | 0 | 1 |
| 20 | Option 1 | 4 | 2 | 30 | 0 | 1 |
| | Option 2 | 4 | 2 | 3 | 1 | 1 |
| | Option 3 | 4 | 2 | 7 | 1 | 1 |
| | Option 4 | 4 | 2 | 3 | 0 | 1 |
| | Option 5 | 4 | 2 | 30 | 1 | 1 |
| | Option 6 | 4 | 2 | 7 | 0 | 1 |
| 21 | Option 1 | 5 | 2 | 30 | 0 | 1 |
| | Option 2 | 5 | 2 | 3 | 1 | 1 |
| | Option 3 | 5 | 2 | 7 | 1 | 0 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 1 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |
| 22 | Option 1 | 5 | 2 | 30 | 0 | 1 |
| | Option 2 | 5 | 2 | 3 | 1 | 0 |
| | Option 3 | 5 | 2 | 7 | 1 | 0 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 0 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |
| 23 | Option 1 | 2 | 2 | 30 | 0 | 1 |
| | Option 2 | 2 | 2 | 3 | 1 | 0 |
| | Option 3 | 2 | 2 | 7 | 1 | 1 |
| | Option 4 | 2 | 2 | 3 | 0 | 1 |
| | Option 5 | 2 | 2 | 30 | 1 | 1 |
| | Option 6 | 2 | 2 | 7 | 0 | 1 |
| 24 | Option 1 | 3 | 4 | 30 | 0 | 0 |
| | Option 2 | 3 | 4 | 3 | 1 | 1 |
| | Option 3 | 3 | 4 | 7 | 1 | 0 |
| | Option 4 | 3 | 4 | 3 | 0 | 1 |
| | Option 5 | 3 | 4 | 30 | 1 | 0 |
| | Option 6 | 3 | 4 | 7 | 0 | 1 |
| 25 | Option 1 | 9 | 2 | 30 | 0 | 0 |
| | Option 2 | 9 | 2 | 3 | 1 | 1 |
| | Option 3 | 9 | 2 | 7 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 25 | Option 4 | 9 | 2 | 3 | 0 | 1 |
| | Option 5 | 9 | 2 | 30 | 1 | 0 |
| | Option 6 | 9 | 2 | 7 | 0 | 1 |
| 26 | Option 1 | 9 | 2 | 30 | 0 | 1 |
| | Option 2 | 9 | 2 | 3 | 1 | 0 |
| | Option 3 | 9 | 2 | 7 | 1 | 0 |
| | Option 4 | 9 | 2 | 3 | 0 | 1 |
| | Option 5 | 9 | 2 | 30 | 1 | 1 |
| | Option 6 | 9 | 2 | 7 | 0 | 1 |
| 27 | Option 1 | 7 | 2 | 30 | 0 | 0 |
| | Option 2 | 7 | 2 | 3 | 1 | 0 |
| | Option 3 | 7 | 2 | 7 | 1 | 0 |
| | Option 4 | 7 | 2 | 3 | 0 | 1 |
| | Option 5 | 7 | 2 | 30 | 1 | 0 |
| | Option 6 | 7 | 2 | 7 | 0 | 1 |
| 28 | Option 1 | 3 | 2 | 30 | 0 | 1 |
| | Option 2 | 3 | 2 | 3 | 1 | 1 |
| | Option 3 | 3 | 2 | 7 | 1 | 1 |
| | Option 4 | 3 | 2 | 3 | 0 | 1 |
| | Option 5 | 3 | 2 | 30 | 1 | 1 |
| | Option 6 | 3 | 2 | 7 | 0 | 1 |
| 29 | Option 1 | 5 | 2 | 30 | 0 | 1 |
| | Option 2 | 5 | 2 | 3 | 1 | 1 |
| | Option 3 | 5 | 2 | 7 | 1 | 1 |
| | Option 4 | 5 | 2 | 3 | 0 | 1 |
| | Option 5 | 5 | 2 | 30 | 1 | 1 |
| | Option 6 | 5 | 2 | 7 | 0 | 1 |

| | *coeff b* | *s.e.* | *Wald* | *p-value* | *exp(b)* | *lower* | *upper* |
|---|---|---|---|---|---|---|---|
| Intercept | 2.627 | 0.440 | 35.6272563 | 2.39E-09 | 13.8292294 | | |
| DOC | -0.082 | 0.017 | 22.9352579 | 1.68E-06 | 0.92145301 | 0.891 | 0.953 |
| WAITt ( 0 = t | -2.236 | 0.413 | 29.2999197 | 6.20E-08 | 0.10684731 | 0.048 | 0.240 |

| | |
|---|---|
| LL0 | -118.65779 |
| LL1 | -88.884404 |
| Chi-Sq | 59.546765 |
| df | 2 |
| p-value | 1.1738E-13 |
| alpha | 0.05 |
| sig | yes |
| R-Sq (L) | 0.25091807 |
| R-Sq (CS) | 0.28981003 |
| R-Sq (N) | 0.38935493 |
| Hosmer | 16.9056065 |
| df | 4 |
| p-value | 0.0020163 |
| alpha | 0.05 |

Classification Table

| | Suc-Obs | Fail-Obs | |
|---|---|---|---|
| Suc-Pred | 81 | 35 | 116 |
| Fail-Pred | 19 | 39 | 58 |
| | 100 | 74 | 174 |
| Accuracy | 0.81 | 0.52702703 | 0.68965517 |
| Cutoff | 0.5 | | |

APPENDIX C

FL NEMVUMONI - 18899048
EDUCATION QUALITY SP RESULTS

| | |
|---|---|
| sig | yes |

APPENDIX C

FL NEMVUMONI - 18899048
GPS LOG

| Index (k) | Time | Leg Distance (m) | Cummulative distance (m) | Leg Speed (km/h) | Leg Time | Elevation (m) | Leg Course | Position |
|---|---|---|---|---|---|---|---|---|
| 1 | 2016/07/28, 11:26 AM | 36 | 36 | 12 | 00:00:11 | 763 | 294° true | S22 47.140 E30 13.912 |
| 2 | 2016/07/28, 11:26 AM | 1 | 37 | 5 | 00:00:01 | 763 | 298° true | S22 47.132 E30 13.892 |
| 3 | 2016/07/28, 11:26 AM | 58 | 95 | 21 | 00:00:10 | 762 | 293° true | S22 47.132 E30 13.892 |
| 4 | 2016/07/28, 11:26 AM | 106 | 201 | 38 | 00:00:10 | 759 | 282° true | S22 47.120 E30 13.860 |
| | | 49 | 250 | 36 | | | | |
| 5 | 2016/07/28, 11:27 AM | 52 | 302 | 36 | 00:00:10 | 757 | 279° true | S22 47.108 E30 13.800 |
| 6 | 2016/07/28, 11:27 AM | 72 | 374 | 32 | 00:00:08 | 753 | 279° true | S22 47.099 E30 13.742 |
| 7 | 2016/07/28, 11:27 AM | 99 | 473 | 36 | 00:00:10 | 749 | 279° true | S22 47.092 E30 13.701 |
| | | 27 | 500 | 27 | | | | |
| 8 | 2016/07/28, 11:27 AM | 47 | 547 | 27 | 00:00:10 | 742 | 277° true | S22 47.084 E30 13.643 |
| 9 | 2016/07/28, 11:27 AM | 65 | 612 | 15 | 00:00:16 | 745 | 277° true | S22 47.079 E30 13.600 |
| 10 | 2016/07/28, 11:28 AM | 76 | 688 | 17 | 00:00:16 | 748 | 277° true | S22 47.075 E30 13.562 |
| 11 | 2016/07/28, 11:28 AM | 76 | 764 | 21 | 00:00:13 | 756 | 277° true | S22 47.069 E30 13.518 |
| 12 | 2016/07/28, 11:28 AM | 115 | 879 | 38 | 00:00:11 | 758 | 278° true | S22 47.064 E30 13.475 |
| | | 71 | 950 | 45 | | | | |
| 13 | 2016/07/28, 11:28 AM | 91 | 1041 | 45 | 00:00:13 | 755 | 279° true | S22 47.056 E30 13.408 |
| 14 | 2016/07/28, 11:28 AM | 175 | 1216 | 52 | 00:00:12 | 752 | 281° true | S22 47.042 E30 13.315 |
| 15 | 2016/07/28, 11:29 AM | 34 | 1250 | 30 | 00:00:04 | 747 | 292° true | S22 47.025 E30 13.214 |
| 16 | 2016/07/28, 11:29 AM | 6 | 1256 | 20 | 00:00:01 | 747 | 297° true | S22 47.018 E30 13.196 |
| 17 | 2016/07/28, 11:29 AM | 33 | 1289 | 17 | 00:00:07 | 747 | 302° true | S22 47.017 E30 13.193 |
| 18 | 2016/07/28, 11:29 AM | 60 | 1349 | 17 | 00:00:13 | 745 | 311° true | S22 47.007 E30 13.177 |
| 19 | 2016/07/28, 11:29 AM | 51 | 1400 | 15 | 00:00:12 | 742 | 298° true | S22 46.986 E30 13.151 |
| 20 | 2016/07/28, 11:29 AM | 5 | 1405 | 16 | 00:00:01 | 738 | 277° true | S22 46.973 E30 13.124 |
| 21 | 2016/07/28, 11:29 AM | 5 | 1410 | 17 | 00:00:01 | 738 | 277° true | S22 46.973 E30 13.121 |
| 22 | 2016/07/28, 11:29 AM | 4 | 1414 | 16 | 00:00:01 | 737 | 277° true | S22 46.972 E30 13.119 |
| 23 | 2016/07/28, 11:29 AM | 5 | 1419 | 19 | 00:00:01 | 737 | 277° true | S22 46.972 E30 13.116 |
| 24 | 2016/07/28, 11:29 AM | 5 | 1424 | 17 | 00:00:01 | 737 | 278° true | S22 46.972 E30 13.113 |
| 25 | 2016/07/28, 11:29 AM | 5 | 1429 | 17 | 00:00:01 | 737 | 277° true | S22 46.971 E30 13.110 |
| 26 | 2016/07/28, 11:29 AM | 53 | 1482 | 14 | 00:00:14 | 737 | 277° true | S22 46.971 E30 13.107 |
| | | 68 | 1550 | 22 | | | | |
| 27 | 2016/07/28, 11:30 AM | 5 | 1555 | 22 | 00:00:12 | 729 | 277° true | S22 46.967 E30 13.077 |
| 28 | 2016/07/28, 11:30 AM | 84 | 1639 | 38 | 00:00:08 | 726 | 277° true | S22 46.963 E30 13.035 |
| 29 | 2016/07/28, 11:30 AM | 26 | 1665 | 10 | 00:00:09 | 728 | 272° true | S22 46.957 E30 12.986 |
| 30 | 2016/07/28, 11:30 AM | 52 | 1717 | 16 | 00:00:12 | 731 | 272° true | S22 46.957 E30 12.971 |
| 31 | 2016/07/28, 11:30 AM | 73 | 1790 | 16 | 00:00:16 | 736 | 272° true | S22 46.956 E30 12.940 |
| 32 | 2016/07/28, 11:31 AM | 50 | 1840 | 15 | 00:00:12 | 740 | 273° true | S22 46.954 E30 12.898 |
| | | 10 | 1850 | 18 | | | | |
| 33 | 2016/07/28, 11:31 AM | 54 | 1904 | 18 | 00:00:13 | 744 | 272° true | S22 46.953 E30 12.868 |
| 34 | 2016/07/28, 11:31 AM | 57 | 1961 | 16 | 00:00:13 | 748 | 272° true | S22 46.952 E30 12.831 |
| 35 | 2016/07/28, 11:31 AM | 43 | 2004 | 12 | 00:00:13 | 753 | 272° true | S22 46.950 E30 12.797 |
| 36 | 2016/07/28, 11:31 AM | 54 | 2058 | 14 | 00:00:14 | 757 | 272° true | S22 46.949 E30 12.772 |
| 37 | 2016/07/28, 11:32 AM | 93 | 2151 | 33 | 00:00:10 | 762 | 272° true | S22 46.948 E30 12.740 |
| | | 49 | 2200 | 30 | | | | |
| 38 | 2016/07/28, 11:32 AM | 52 | 2252 | 30 | 00:00:12 | 759 | 272° true | S22 46.946 E30 12.686 |
| 39 | 2016/07/28, 11:32 AM | 33 | 2285 | 15 | 00:00:08 | 758 | 272° true | S22 46.944 E30 12.627 |
| 40 | 2016/07/28, 11:32 AM | 83 | 2368 | 21 | 00:00:14 | 755 | 272° true | S22 46.943 E30 12.608 |
| 41 | 2016/07/28, 11:32 AM | 17 | 2385 | 16 | 00:00:04 | 749 | 273° true | S22 46.941 E30 12.560 |
| 42 | 2016/07/28, 11:32 AM | 4 | 2389 | 14 | 00:00:01 | 749 | 273° true | S22 46.940 E30 12.549 |
| 43 | 2016/07/28, 11:32 AM | 4 | 2393 | 16 | 00:00:01 | 748 | 271° true | S22 46.940 E30 12.547 |
| 44 | 2016/07/28, 11:32 AM | 81 | 2474 | 27 | 00:00:11 | 748 | 272° true | S22 46.940 E30 12.545 |
| 45 | 2016/07/28, 11:33 AM | 80 | 2554 | 32 | 00:00:09 | 745 | 272° true | S22 46.938 E30 12.497 |
| 46 | 2016/07/28, 11:33 AM | 69 | 2623 | 21 | 00:00:12 | 740 | 272° true | S22 46.937 E30 12.451 |
| 47 | 2016/07/28, 11:33 AM | 41 | 2664 | 14 | 00:00:11 | 735 | 270° true | S22 46.935 E30 12.410 |
| 48 | 2016/07/28, 11:33 AM | 9 | 2673 | 17 | 00:00:02 | 732 | 270° true | S22 46.935 E30 12.386 |
| | | 27 | 2700 | 25 | | | | |
| 49 | 2016/07/28, 11:33 AM | 49 | 2749 | 25 | 00:00:11 | 731 | 269° true | S22 46.935 E30 12.381 |
| 50 | 2016/07/28, 11:33 AM | 34 | 2783 | 15 | 00:00:08 | 728 | 284° true | S22 46.936 E30 12.336 |
| 51 | 2016/07/28, 11:34 AM | 53 | 2836 | 15 | 00:00:13 | 734 | 288° true | S22 46.932 E30 12.317 |
| 52 | 2016/07/28, 11:34 AM | 25 | 2861 | 22 | 00:00:04 | 738 | 296° true | S22 46.923 E30 12.287 |
| 53 | 2016/07/28, 11:34 AM | 76 | 2937 | 23 | 00:00:12 | 739 | 309° true | S22 46.917 E30 12.274 |
| 54 | 2016/07/28, 11:34 AM | 42 | 2979 | 14 | 00:00:11 | 738 | 312° true | S22 46.891 E30 12.240 |
| 55 | 2016/07/28, 11:34 AM | 40 | 3019 | 13 | 00:00:11 | 735 | 312° true | S22 46.876 E30 12.222 |
| | | 31 | 3050 | 16 | | | | |
| 56 | 2016/07/28, 11:34 AM | 32 | 3082 | 16 | 00:00:14 | 729 | 307° true | S22 46.862 E30 12.205 |
| 57 | 2016/07/28, 11:35 AM | 94 | 3176 | 38 | 00:00:09 | 727 | 292° true | S22 46.842 E30 12.175 |
| 58 | 2016/07/28, 11:35 AM | 141 | 3317 | 46 | 00:00:11 | 723 | 274° true | S22 46.823 E30 12.124 |
| 59 | 2016/07/28, 11:35 AM | 30 | 3347 | 27 | 00:00:04 | 715 | 292° true | S22 46.818 E30 12.042 |

APPENDIX C

FL NEMVUMONI - 18899048
GPS LOG

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 60 | 2016/07/28, 11:35 AM | 6 | 3353 | 23 | 00:00:01 | 713 | 298° true | S22 46.812 E30 12.025 |
| 61 | 2016/07/28, 11:35 AM | 8 | 3361 | 29 | 00:00:01 | 713 | 312° true | S22 46.810 E30 12.022 |
| 62 | 2016/07/28, 11:35 AM | 89 | 3450 | 40 | 00:00:08 | 713 | 312° true | S22 46.807 E30 12.018 |
| 63 | 2016/07/28, 11:35 AM | 33 | 3483 | 20 | 00:00:06 | 712 | 314° true | S22 46.775 E30 11.980 |
| 64 | 2016/07/28, 11:35 AM | 54 | 3537 | 13 | 00:00:15 | 713 | 327° true | S22 46.763 E30 11.966 |
| 65 | 2016/07/28, 11:36 AM | 65 | 3602 | 16 | 00:00:15 | 717 | 324° true | S22 46.739 E30 11.949 |
| 66 | 2016/07/28, 11:36 AM | 75 | 3677 | 27 | 00:00:10 | 722 | 311° true | S22 46.710 E30 11.926 |
| 67 | 2016/07/28, 11:36 AM | 114 | 3791 | 51 | 00:00:08 | 723 | 292° true | S22 46.684 E30 11.893 |
| | | 59 | 3850 | 47 | | | | |
| 68 | 2016/07/28, 11:36 AM | 7 | 3857 | 47 | 00:00:05 | 723 | 288° true | S22 46.661 E30 11.832 |
| 69 | 2016/07/28, 11:36 AM | 9 | 3866 | 32 | 00:00:01 | 721 | 288° true | S22 46.650 E30 11.795 |
| 70 | 2016/07/28, 11:36 AM | 83 | 3949 | 27 | 00:00:11 | 721 | 285° true | S22 46.648 E30 11.790 |
| 71 | 2016/07/28, 11:36 AM | 11 | 3960 | 20 | 00:00:02 | 718 | 281° true | S22 46.636 E30 11.743 |
| 72 | 2016/07/28, 11:36 AM | 84 | 4044 | 34 | 00:00:09 | 717 | 280° true | S22 46.635 E30 11.737 |
| 73 | 2016/07/28, 11:37 AM | 88 | 4132 | 40 | 00:00:08 | 719 | 280° true | S22 46.627 E30 11.689 |
| 74 | 2016/07/28, 11:37 AM | 67 | 4199 | 20 | 00:00:12 | 720 | 278° true | S22 46.619 E30 11.638 |
| 75 | 2016/07/28, 11:37 AM | 98 | 4297 | 39 | 00:00:09 | 719 | 267° true | S22 46.614 E30 11.599 |
| 76 | 2016/07/28, 11:37 AM | 105 | 4402 | 54 | 00:00:07 | 718 | 261° true | S22 46.616 E30 11.542 |
| 77 | 2016/07/28, 11:37 AM | 13 | 4415 | 46 | 00:00:01 | 717 | 242° true | S22 46.625 E30 11.481 |
| 78 | 2016/07/28, 11:37 AM | 14 | 4429 | 51 | 00:00:01 | 715 | 234° true | S22 46.628 E30 11.475 |
| 79 | 2016/07/28, 11:37 AM | 15 | 4444 | 54 | 00:00:01 | 714 | 234° true | S22 46.633 E30 11.468 |
| | | 6 | 4450 | 57 | | | | |
| 80 | 2016/07/28, 11:37 AM | 10 | 4460 | 57 | 00:00:01 | 713 | 234° true | S22 46.638 E30 11.461 |
| 81 | 2016/07/28, 11:37 AM | 72 | 4532 | 43 | 00:00:06 | 713 | 222° true | S22 46.643 E30 11.453 |
| 82 | 2016/07/28, 11:37 AM | 8 | 4540 | 28 | 00:00:01 | 706 | 222° true | S22 46.671 E30 11.425 |
| 83 | 2016/07/28, 11:37 AM | 8 | 4548 | 30 | 00:00:01 | 707 | 222° true | S22 46.675 E30 11.422 |
| 84 | 2016/07/28, 11:37 AM | 6 | 4554 | 21 | 00:00:01 | 706 | 237° true | S22 46.678 E30 11.419 |
| 85 | 2016/07/28, 11:37 AM | 9 | 4563 | 32 | 00:00:01 | 704 | 250° true | S22 46.680 E30 11.416 |
| 86 | 2016/07/28, 11:37 AM | 9 | 4572 | 32 | 00:00:01 | 702 | 250° true | S22 46.681 E30 11.411 |
| 87 | 2016/07/28, 11:37 AM | 8 | 4580 | 29 | 00:00:01 | 701 | 275° true | S22 46.683 E30 11.406 |
| 88 | 2016/07/28, 11:37 AM | 12 | 4592 | 43 | 00:00:01 | 701 | 275° true | S22 46.683 E30 11.402 |
| 89 | 2016/07/28, 11:37 AM | 13 | 4605 | 45 | 00:00:01 | 701 | 277° true | S22 46.682 E30 11.395 |
| 90 | 2016/07/28, 11:37 AM | 42 | 4647 | 50 | 00:00:03 | 700 | 283° true | S22 46.681 E30 11.388 |
| 91 | 2016/07/28, 11:37 AM | 13 | 4660 | 47 | 00:00:01 | 700 | 283° true | S22 46.676 E30 11.364 |
| 92 | 2016/07/28, 11:37 AM | 12 | 4672 | 44 | 00:00:01 | 700 | 283° true | S22 46.675 E30 11.356 |
| 93 | 2016/07/28, 11:38 AM | 9 | 4681 | 32 | 00:00:01 | 700 | 294° true | S22 46.673 E30 11.349 |
| 94 | 2016/07/28, 11:38 AM | 12 | 4693 | 42 | 00:00:01 | 701 | 312° true | S22 46.671 E30 11.344 |
| 95 | 2016/07/28, 11:38 AM | 14 | 4707 | 49 | 00:00:01 | 702 | 312° true | S22 46.667 E30 11.339 |
| 96 | 2016/07/28, 11:38 AM | 13 | 4720 | 46 | 00:00:01 | 702 | 311° true | S22 46.662 E30 11.333 |
| 97 | 2016/07/28, 11:38 AM | 28 | 4748 | 33 | 00:00:03 | 703 | 311° true | S22 46.658 E30 11.328 |
| 98 | 2016/07/28, 11:38 AM | 6 | 4754 | 22 | 00:00:01 | 703 | 312° true | S22 46.648 E30 11.316 |
| 99 | 2016/07/28, 11:38 AM | 15 | 4769 | 18 | 00:00:03 | 703 | 311° true | S22 46.646 E30 11.313 |
| 100 | 2016/07/28, 11:38 AM | 62 | 4831 | 16 | 00:00:14 | 706 | 311° true | S22 46.640 E30 11.306 |
| 101 | 2016/07/28, 11:38 AM | 67 | 4898 | 17 | 00:00:14 | 711 | 311° true | S22 46.618 E30 11.279 |
| 102 | 2016/07/28, 11:38 AM | 89 | 4987 | 27 | 00:00:12 | 712 | 315° true | S22 46.594 E30 11.250 |
| 103 | 2016/07/28, 11:38 AM | 91 | 5078 | 23 | 00:00:14 | 712 | 323° true | S22 46.561 E30 11.213 |
| 104 | 2016/07/28, 11:39 AM | 46 | 5124 | 15 | 00:00:11 | 708 | 323° true | S22 46.521 E30 11.180 |
| 105 | 2016/07/28, 11:39 AM | 66 | 5190 | 27 | 00:00:09 | 704 | 315° true | S22 46.502 E30 11.164 |
| 106 | 2016/07/28, 11:39 AM | 10 | 5200 | 19 | 00:00:02 | 695 | 306° true | S22 46.476 E30 11.137 |
| | | 50 | 5250 | 28 | | | | |
| 107 | 2016/07/28, 11:39 AM | 13 | 5263 | 28 | 00:00:08 | 694 | 298° true | S22 46.473 E30 11.132 |
| 108 | 2016/07/28, 11:39 AM | 143 | 5406 | 34 | 00:00:15 | 694 | 288° true | S22 46.457 E30 11.100 |
| 109 | 2016/07/28, 11:39 AM | 112 | 5518 | 31 | 00:00:13 | 692 | 290° true | S22 46.433 E30 11.020 |
| 110 | 2016/07/28, 11:40 AM | 7 | 5525 | 25 | 00:00:01 | 689 | 280° true | S22 46.412 E30 10.959 |
| 111 | 2016/07/28, 11:40 AM | 103 | 5628 | 31 | 00:00:12 | 688 | 275° true | S22 46.411 E30 10.955 |
| 112 | 2016/07/28, 11:40 AM | 69 | 5697 | 25 | 00:00:10 | 686 | 258° true | S22 46.407 E30 10.894 |
| 113 | 2016/07/28, 11:40 AM | 41 | 5738 | 25 | 00:00:06 | 687 | 253° true | S22 46.415 E30 10.855 |
| 114 | 2016/07/28, 11:40 AM | 8 | 5746 | 28 | 00:00:01 | 689 | 251° true | S22 46.421 E30 10.832 |
| 115 | 2016/07/28, 11:40 AM | 6 | 5752 | 23 | 00:00:01 | 689 | 251° true | S22 46.422 E30 10.827 |
| 116 | 2016/07/28, 11:40 AM | 6 | 5758 | 22 | 00:00:01 | 689 | 250° true | S22 46.424 E30 10.824 |
| 117 | 2016/07/28, 11:40 AM | 6 | 5764 | 22 | 00:00:01 | 690 | 248° true | S22 46.425 E30 10.821 |
| | | 36 | 5800 | 27 | | | | |
| 118 | 2016/07/28, 11:40 AM | 24 | 5824 | 27 | 00:00:08 | 690 | 237° true | S22 46.426 E30 10.817 |
| 119 | 2016/07/28, 11:40 AM | 7 | 5831 | 27 | 00:00:01 | 691 | 230° true | S22 46.444 E30 10.788 |
| 120 | 2016/07/28, 11:40 AM | 7 | 5838 | 25 | 00:00:01 | 692 | 207° true | S22 46.446 E30 10.785 |
| 121 | 2016/07/28, 11:40 AM | 6 | 5844 | 21 | 00:00:01 | 693 | 190° true | S22 46.449 E30 10.783 |
| 122 | 2016/07/28, 11:40 AM | 5 | 5849 | 19 | 00:00:01 | 694 | 188° true | S22 46.452 E30 10.782 |
| 123 | 2016/07/28, 11:40 AM | 6 | 5855 | 21 | 00:00:01 | 695 | 185° true | S22 46.455 E30 10.782 |
| 124 | 2016/07/28, 11:40 AM | 7 | 5862 | 24 | 00:00:01 | 694 | 184° true | S22 46.459 E30 10.782 |
| 125 | 2016/07/28, 11:40 AM | 7 | 5869 | 26 | 00:00:01 | 695 | 184° true | S22 46.462 E30 10.781 |

APPENDIX C

FL NEMVUMONI - 18899048
GPS LOG

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 126 | 2016/07/28, 11:40 AM | 80 | 5949 | 29 | 00:00:10 | 695 | 184° true | S22 46.466 E30 10.781 |
| 127 | 2016/07/28, 11:41 AM | 4 | 5953 | 15 | 00:00:01 | 697 | 184° true | S22 46.509 E30 10.777 |
| 128 | 2016/07/28, 11:41 AM | 4 | 5957 | 15 | 00:00:01 | 696 | 184° true | S22 46.511 E30 10.777 |
| 129 | 2016/07/28, 11:41 AM | 2 | 5959 | 5 | 00:00:01 | 696 | 196° true | S22 46.513 E30 10.777 |
| 130 | 2016/07/28, 11:41 AM | 3 | 5962 | 10 | 00:00:01 | 696 | 279° true | S22 46.514 E30 10.777 |
| 131 | 2016/07/28, 11:41 AM | 5 | 5967 | 18 | 00:00:01 | 696 | 279° true | S22 46.514 E30 10.775 |
| 132 | 2016/07/28, 11:41 AM | 4 | 5971 | 16 | 00:00:01 | 696 | 280° true | S22 46.514 E30 10.772 |
| 133 | 2016/07/28, 11:41 AM | 6 | 5977 | 21 | 00:00:01 | 696 | 280° true | S22 46.513 E30 10.770 |
| 134 | 2016/07/28, 11:41 AM | 37 | 6014 | 22 | 00:00:06 | 696 | 281° true | S22 46.513 E30 10.766 |

Appendix D

FL NEMVUMONI - 18899048
SANE EDUCATION DATA COLLECTION RESULTS

| No.: | HH | School (j) | PRI FEM SCHOOL | SEC FEM SCHOOL | PRI MAL SCHOOL | SEC MAL SCHOOL | Number if stu in HH (STUh) | SANE C (STU/1) | RAMA B STU | TSHI N STU | SANE C WALKING | RAMA B WALKING | TSHI N WALKING | TRV DIST | Travel mode (0 = WALK, 1=PT) | WT | PTCST | INC GROUP | CLASS | TEXTBKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 5 | Sane C | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 42 | 7 | Sane C | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 37 | 5 | Sane C | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 5 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 38 | 5 | Sane C | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 35 | 7 | Sane C | 1 | 0 | 0 | 1 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 7 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 36 | 7 | Sane C | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 34 | 6 | Sane C | 0 | 0 | 1 | 1 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 35 | 5 | Sane C | 0 | 0 | 2 | 2 | 4 | 4 | 0 | 0 | 4 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 61 | 4 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 62 | 4 | Sane C | 1 | 0 | 2 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 31 | 5 | Sane C | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 32 | 5 | Sane C | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 25 | 5 | Sane C | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 26 | 7 | Sane C | 1 | 0 | 2 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 7 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 23 | 1 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 1 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 1 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 24 | 3 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 3 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 3 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 21 | 2 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 2 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 2 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 22 | 3 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 3 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 3 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 43 | 3 | Sane C | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 3 | 24 | 0.5 |
| | 3 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 3 | 36.6 | 1 |
| | 3 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 3 | 28.8571429 | 0.85 |
| 44 | 4 | Sane C | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 39 | 6 | Sane C | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 40 | 5 | Sane C | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 49 | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 50 | 6 | Sane C | 0 | 0 | 3 | 1 | 4 | 4 | 0 | 0 | 4 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 2 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 45 | 5 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 46 | 6 | Sane C | 0 | 0 | 2 | 1 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4 | R 6.36 | 1 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82 | R 6.36 | 1 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 131 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 47 | 6 | Sane C | 1 | 1 | 1 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 48 | 4 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 51 | 7 | Sane C | 3 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 52 | 10 | Rama B | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 24 | 0.5 |
| | 10 | Rama B | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 10 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 53 | 7 | Sane C | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 1 | 24 | 0.5 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 1 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 54 | 8 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 8 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 8 | Tshi N | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 10.91 | 1 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 19 | 6 | Sane C | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 20 | 3 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 3 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 3 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 29 | 5 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 30 | 5 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 27 | 5 | Sane C | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 28 | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 55 | 8 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 5 | 24 | 0.5 |
| | 8 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 5 | 36.6 | 1 |
| | 8 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 5 | 28.8571429 | 0.85 |
| 56 | 6 | Sane C | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 1 | 24 | 0.5 |
| | 6 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 1 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 4 | 5 | Sane C | 1 | 0 | 2 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 57 | 5 | Sane C | 0 | 1 | 1 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 58 | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 5 | 10 | Sane C | 0 | 1 | 3 | 0 | 4 | 4 | 0 | 0 | 4 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 3 | 24 | 0.5 |
| | 10 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 3 | 36.6 | 1 |
| | 10 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 3 | 28.8571429 | 0.85 |
| 6 | 8 | Sane C | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 8 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 8 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 7 | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 8 | 2 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 1 | 24 | 0.5 |
| | 2 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 1 | 36.6 | 1 |
| | 2 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 11 | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |

FL NEMVUMONI - 18899048
SANE EDUCATION DATA COLLECTION RESULTS

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 10 | Sane C | 1 | 0 | 2 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 10 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 10 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 59 | 5 | Sane C | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 60 | 4 | Sane C | 1 | 0 | 2 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 9 | 4 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 10 | 6 | Sane C | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 1 | 14 | Sane C | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 1 | 24 | 0.5 |
| | 14 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 1 | 36.6 | 1 |
| | 14 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 2 | 6 | Sane C | 0 | 1 | 2 | 0 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 3 | 24 | 0.5 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 3 | 36.6 | 1 |
| | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 3 | 28.8571429 | 0.85 |
| 13 | 5 | Sane C | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 14 | 2 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 2 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 2 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 15 | 7 | Sane C | 1 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 1 | 24 | 0.5 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 1 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 10.91 | 0 | 130.92 | R 6.36 | 1 | 28.8571429 | 0.85 |
| 16 | 4 | Sane C | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 17 | 7 | Sane C | 0 | 0 | 1 | 2 | 3 | 3 | 0 | 0 | 3 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 7 | Rama B | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |
| 18 | 7 | Sane C | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 0.35 | 0 | 4.2 | R 6.36 | 2 | 24 | 0.5 |
| | 7 | Rama B | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 2 | 0 | 6.84 | 0 | 82.08 | R 6.36 | 2 | 36.6 | 1 |
| | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10.91 | 0 | 130.92 | R 6.36 | 2 | 28.8571429 | 0.85 |

FL NEMVUMONI - 18899048
SANE HEALTHCARE DATA COLLECTION RESULTS

| | HH | CLINIC NAME | TRAVE DIST | Travel mode (0 = WALK, 1=PT) | WT | PTCST | | WAIT | WAITt | DOC |
|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 42 | 7 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 75 | 0 | 2 |
| 37 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 38 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 35 | 7 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 36 | 7 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 34 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 30 | 0 | 2 |
| 35 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 61 | 4 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 90 | 0 | 2 |
| 62 | 4 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 180 | 1 | 2 |
| 31 | 5 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 30 | 0 | 2 |
| 32 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 25 | 5 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 180 | 1 | 2 |
| 26 | 7 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 90 | 0 | 2 |
| 23 | 1 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 60 | 0 | 2 |
| 24 | 3 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 120 | 1 | 2 |
| 21 | 2 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 120 | 1 | 2 |
| 22 | 3 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 43 | 3 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 30 | 0 | 2 |
| 44 | 4 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 30 | 0 | 2 |
| 39 | 6 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 30 | 0 | 2 |
| 40 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 49 | 4 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 150 | 1 | 2 |
| 50 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 45 | 5 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 180 | 1 | 2 |
| 46 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 90 | 0 | 2 |
| 47 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 180 | 1 | 2 |
| 48 | 4 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 51 | 7 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 15 | 0 | 2 |
| 52 | 10 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 30 | 0 | 2 |
| 53 | 7 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 180 | 1 | 2 |
| 54 | 8 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 120 | 1 | 2 |
| 19 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 150 | 1 | 2 |
| 20 | 3 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 180 | 1 | 2 |
| 29 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 30 | 0 | 2 |
| 30 | 5 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 40 | 0 | 2 |
| 27 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 90 | 0 | 2 |
| 28 | 4 | sTRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 120 | 1 | 2 |
| 55 | 8 | sTRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 60 | 0 | 2 |
| 56 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 3 | 0 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 30 | 0 | 2 |
| 4 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 90 | 0 | 2 |
| 57 | 5 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 90 | 0 | 2 |
| 58 | 4 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 5 | 10 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 180 | 1 | 2 |
| 6 | 8 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 240 | 1 | 2 |
| 7 | 4 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 180 | 1 | 2 |
| 8 | 2 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 180 | 1 | 2 |
| 11 | 4 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 180 | 1 | 2 |
| 12 | 10 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 90 | 0 | 2 |
| 59 | 5 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 30 | 0 | 2 |
| 60 | 4 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 60 | 0 | 2 |
| 9 | 4 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 30 | 0 | 2 |
| 10 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 120 | 1 | 2 |
| 1 | 14 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 360 | 1 | 2 |
| 2 | 6 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 13 | 5 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 14 | 2 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 150 | 1 | 2 |
| 15 | 7 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 60 | 0 | 2 |
| 16 | 4 | STRAIGHT HARDT | 6.8 | 0 | 82 | R | 10.00 | 90 | 0 | 2 |
| 17 | 7 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 150 | 1 | 2 |
| 18 | 7 | STRAIGHT HARDT | 6.8 | 1 | 82 | R | 10.00 | 150 | 1 | 2 |

Appendix D

FL NEMVUMONI - 18899048

MANGWELE EDUCATION DATA COLLECTION RESULTS

| No.: | HH | School of att | PRI FEM | SEC FEM | PRI MAL | SEC MAL | STU SCHOOL | MANG G STU | RAMA B STU | TSHI N STU | SANE C STU | MANG G STU WALKING | RAMA B STU WALKING | TSHI N STU WALKING | SANE C STU WALKING | TRV DIST | Travel mode (0 = WALK, 1=PT) | WT | PTCST | INC GROUP | CLASS | TEXTBKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 | Mang G | 3 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A1 | 6 | Tshi N | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 5 | Mang G | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A2 | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 5 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 9 | Mang G | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 9 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 1 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A3 | 9 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 9 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 9 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 6 | Mang G | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A4 | 6 | Tshi N | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 4 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A5 | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 5 | Mang G | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 4 | 20 | 0.6 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 4 | 36.6 | 1.0 |
| A6 | 5 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 4 | 28.8571429 | 0.85 |
| | 5 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 4 | 24 | 0.5 |
| | 5 | Gogogo | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 4 | 40 | 0.8 |
| | 7 | Mang G | 0 | 0 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A7 | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 7 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 7 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 11 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 3 | 20 | 0.6 |
| | 11 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 3 | 36.6 | 1.0 |
| A8 | 11 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 3 | 28.8571429 | 0.85 |
| | 11 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 3 | 24 | 0.5 |
| | 11 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 1 | 155 | R 6.36 | 3 | 40 | 0.8 |
| | 4 | Mang G | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 1 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A9 | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 4 | Mang G | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 3 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 3 | 36.6 | 1.0 |
| A10 | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 3 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 3 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 3 | 40 | 0.8 |
| | 4 | Mang G | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A11 | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 6 | Mang G | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A12 | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 3 | Mang G | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 3 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A13 | 3 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 3 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 3 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 4 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A14 | 4 | Tshi N | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 4 | Mang G | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A15 | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 3 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 3 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A16 | 3 | Tshi N | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 3 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 3 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 4 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A17 | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 2 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 3 | 20 | 0.6 |
| | 2 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 3 | 36.6 | 1.0 |
| A18 | 2 | Tshi N | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 3 | 28.8571429 | 0.85 |
| | 2 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 3 | 24 | 0.5 |
| | 2 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 3 | 40 | 0.8 |
| | 6 | Mang G | 2 | 0 | 1 | 0 | 3 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 4 | 20 | 0.6 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 4 | 36.6 | 1.0 |
| A19 | 6 | Tshi N | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 16.93 | 0 | 203 | R 6.36 | 4 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 4 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 4 | 40 | 0.8 |
| | 7 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A20 | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 7 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 7 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 6 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A21 | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 5 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 5 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A22 | 5 | Tshi N | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 5 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 5 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 7 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A23 | 7 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 7 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 7 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 4 | Mang G | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A24 | 4 | Tshi N | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 16.93 | 0 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 6 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A25 | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 2 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 2 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A26 | 2 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 2 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 2 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 6 | Mang G | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 6 | Rama B | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 1 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A27 | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 3.7 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 3.7 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A28 | 3.7 | Tshi N | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 16.93 | 1 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 3.7 | Sane C | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 3.7 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 4 | Mang G | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 4 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A29 | 4 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |
| | 4 | Sane C | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 6.32 | 0 | 76 | R 6.36 | 2 | 24 | 0.5 |
| | 4 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 2 | 40 | 0.8 |
| | 6 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 1 | 20 | 0.6 |
| | 6 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 1 | 36.6 | 1.0 |
| A30 | 6 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 1 | 28.8571429 | 0.85 |
| | 6 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R 6.36 | 1 | 24 | 0.5 |
| | 6 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R 6.36 | 1 | 40 | 0.8 |
| | 3 | Mang G | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0 | 3.6 | R 6.36 | 2 | 20 | 0.6 |
| | 3 | Rama B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.86 | 0 | 154 | R 6.36 | 2 | 36.6 | 1.0 |
| A31 | 3 | Tshi N | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.93 | 0 | 203 | R 6.36 | 2 | 28.8571429 | 0.85 |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Sane C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6.32 | 0 | 76 | R | 6.36 | 2 | 24 | 0.5 |
| 3 | Gogogo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.9 | 0 | 155 | R | 6.36 | 2 | 40 | 0.8 |

Appendix D

FL NEMVUMONI - 18899048

MANGWELE HEALTHCARE DATA COLLECTION RESULTS

| No.: | HH | INC GROUP | CLINIC NAME | TRAVE DIST | Travel mode (0 = WALK, 1=PT) | WT | PTCST | WAIT AT CLINC | WAITt | DOC |
|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 6 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 240 | 1 | 2 |
| A2 | 5 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 60 | 0 | 2 |
| A3 | 9 | 2 | STRAIGHT HARDT | 12.82 | 0 | 153.84 | R 10.00 | 240 | 1 | 2 |
| A4 | 6 | 2 | STRAIGHT HARDT | 12.82 | 0 | 153.84 | R 10.00 | 240 | 1 | 2 |
| A5 | 4 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 480 | 1 | 2 |
| A6 | 5 | 4 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 480 | 1 | 2 |
| A7 | 7 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 360 | 1 | 2 |
| A8 | 11 | 3 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 120 | 1 | 2 |
| A9 | 4 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 120 | 1 | 2 |
| A10 | 4 | 3 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 240 | 1 | 2 |
| A11 | 4 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 180 | 1 | 2 |
| A12 | 6 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 180 | 1 | 2 |
| A13 | 3 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 60 | 0 | 2 |
| A14 | 4 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 60 | 0 | 2 |
| A15 | 4 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 60 | 0 | 2 |
| A16 | 3 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 12.00 | 60 | 0 | 2 |
| A17 | 4 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 180 | 1 | 2 |
| A18 | 2 | 3 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 12.00 | 60 | 0 | 2 |
| A19 | 6 | 4 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 180 | 1 | 2 |
| A20 | 7 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 30 | 0 | 2 |
| A21 | 6 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 180 | 1 | 2 |
| A22 | 5 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 12.00 | 120 | 1 | 2 |
| A23 | 7 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 120 | 1 | 2 |
| A24 | 4 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 15.00 | 60 | 0 | 2 |
| A25 | 6 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 30 | 0 | 2 |
| A26 | 2 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 180 | 1 | 2 |

Appendix D

FL NEMVUMONI - 18899048

MANGWELE HEALTHCARE DATA COLLECTION RESULTS

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A27 | 6 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 30 | 0 | 2 |
| A28 | 3.7 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 120 | 1 | 2 |
| A29 | 4 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 12.00 | 60 | 0 | 2 |
| A30 | 6 | 1 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 10.00 | 20 | 0 | 2 |
| A31 | 3 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 12.00 | 120 | 1 | 2 |
| A32 | 3.7 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 12.00 | 120 | 1 | 2 |
| A33 | 3 | 2 | STRAIGHT HARDT | 12.82 | 1 | 153.84 | R 12.00 | 120 | 1 | 2 |