AN INVESTIGATION INTO THE METHODOLOGY OF MINI-BUS TAXI DATA COLLECTION AS PART OF THE CURRENT PUBLIC TRANSPORT RECORD:

A CASE STUDY OF STELLENBOSCH IN THE WESTERN CAPE

Prepared by:

HANIEFA GAIBE

(PLKHAN001)

Prepared for:

DR. M VANDERSCHUREN

UNIVERSITY OF CAPE TOWN

In partial fulfilment of the requirements of the degree of:

MSc Engineering: Civil Engineering

MAY 2009

ACKNOWLEDGEMENTS

I wish to acknowledge and thank those individuals who contributed to this thesis:

My colleagues at Pendulum Consulting and my employers, Ms Zaida Tofie and Ms Lynne Pretorius whose assistance, advice and support aided me in the completion of this thesis.

The representatives of the Stellenbosch and Kayamandi Taxi Associations, who assisted with the organisation of the on-board surveys, with a special thanks to the taxi owners and drivers for allowing the surveyors on board their vehicles.

My supervisor, Dr. Marianne Vanderschuren, for her wisdom, valuable insights and understanding, through this research.

A very special thanks to my mother, my daughter and especially my husband, who has always believed in me and stood by me and whose continued love and support I value the most.

DECLARATION

I know the meaning of plagiarism and declare that all the work in the document, save for that which is properly acknowledged, is my own.

…… ……

Haniefa Gaibe Date

EXECUTIVE SUMMARY

The Cape Winelands District Municipality in Stellenbosch, Cape Town, commissioned Pendulum Consulting to undertake a planning study for a public transport tourism service in their area. The project entails the preparation of a Business Plan to incorporate the existing taxi industry in Stellenbosch in providing tourism transport, as part of their current services.

In order to plan this service, it was necessary to have accurate information on the current public transport services in the town, such as passenger demands, minibus taxi routes and other operational data. It was, initially, envisioned that the base data from the existing 'Current Public Transport Record' (CPTR) could be utilised to prepare the business plan for this new service, but after reviewing the most recent CPTR, it was observed that it provided insufficient information regarding the en-route passenger and operational data of the minibus taxi industry. Hence, the shortcomings of the CPTR led to the motivation in conducting the on-board taxi surveys on the majority of the minibus taxi services in the Stellenbosch area. The author was responsible for liaising with the taxi industry, planning and overseeing the on-board survey, as well as the data capturing and analysis of the raw surveydata, as part of the tourism project.

The preparation of the CPTR was, in the early 1998, initiated by the National Department of Transport (NDoT) as part of the National Land Transport Interim Arrangements Act -1998, which required certain metropolitan and services councils to prepare a record of public transport operations in their areas of jurisdiction. The National Land Transport Transition Act (NLTTA)-Act 22, which was published in 2000, set out the regulations and requirements pertaining to the information needed to complete the CPTR, (NDoT, 2000).

The main objective of the thesis is to review the current CPTR data collection methodology, with specific reference to the data collection of minibus taxi operations, and to highlight the shortcomings of the methodology, by comparing the latest CPTR data for Stellenbosch, with the results of an on-board taxi survey.

A survey of the literature reveals that there are concerns about the reliability of the CPTR data and that there are gaps that exist in passenger transport data collection in South Africa. Information on routes, fares, rank locations, en-route passenger demand, etc, are identified as some of the shortfalls in the CPTR data. Other challenges include reliable data capturing and administration of the data.

Collecting certain relevant and essential data is time consuming and expensive, in most cases, but despite the costs and difficulties associated with obtaining more reliable qualitative data, the application of certain data collection methodologies and technologies, such as Intelligent Transport Systems (ITS), household surveys and internet systems, offer an important, if not essential, means to improve data collection in South Africa.

The town of Stellenbosch, which is situated approximately 50km from Cape Town, was chosen as the study area for this investigation, as it has an on-going planning focus on transport related projects in the area. The main reason for selecting Stellenbosch as the study area was the size of the town and ability to conduct on-board taxi surveys on practically all the taxi routes in the area. The total population for Stellenbosch was recorded to be 117 705 in the 2001 census results, with an average projected population for 2006 estimated to be 135 874.

In order to understand the full passenger demand on the minibus taxi services in the area, at both the ranks and en-route, a method involving on-board surveys was adopted to undertake the data collection component of the project. The survey involved a surveyor on-board the taxi, capturing both boarding and alighting passenger volumes, along the route. Global Positioning System (GPS) technology was incorporated to identify boarding and alighting locations and to assist in recording the route the taxi drove for the survey day. After investigating the available GPS equipment from various suppliers it was found that the *Garmin* hand-held unit and the accompanying software was the most user-friendly.

A total of 76 vehicles, with 757 taxi trips, were surveyed as part of the on-board taxi survey. The analysis of the data indicated a total of 6 768 passengers, of which origin-destination patterns can be retrieved.

The 2004 CPTR/OLS results for Stellenbosch indicates a total of 5 305 passengers on the minibus taxi services, with a supply of 287 vehicles operating between the routes. In order to compare the CPTR results to the on-board survey, a growth rate of 2% per annum, as indicated in the 1996-2001 census data, was applied to project the CPTR results for 2008. This projected an estimated 5 746 passengers expected in 2008, whereas the on-board survey results recorded a total of 6 768 passengers, an increase of more than 1 000 passengers.

A comparison between the routes stipulated in the taxi operator's permit and the route that is actually travelled, was undertaken for all routes. The results indicated that taxis are currently deviating from their registered routes. The on-board survey results for most of the routes indicated that the majority of taxis were not conforming to their permit requirements, which provides a detailed route description for each registered route.

A rank survey analysis, of the on-board survey results, was undertaken to identify the proportion of passengers that utilise the taxi rank, when compared to passengers boarding and alighting en-route. The analysis indicate that for the shorter distance trips, less than 30% of the total daily passengers were recorded at the ranks, which indicates that *more than 70% of the passengers are missed, if boarding and alighting on-route is not recorded*. For the longer distance routes, more than 50% of passengers were recorded boarding and alighting at the ranks.

Although taxi services operate on a demand basis, and do not have fixed stops along the route, passengers have begun to informally assemble at specific points, which have become typical boarding locations. The CPTR results do not provide these locations, as surveys are not conducted en-route.

The 2004 OLS rank survey information shows an average of 40 passengers per vehicle per day, while the on-board survey is showing roughly twice as many, with an average of 89 passengers per vehicle per day.

The main conclusion that can be drawn is that the results provided in the CPTR are incomplete and does not reflect the actual passenger demand on the majority of minibus taxi routes in Stellenbosch.

Lessons learnt through the on-board survey process included, a critical need to have good relationships with the taxi associations. Interactions need to be continuous, rather than trying to establish contact only when surveys need to be undertaken. Pre-planning is also a vital component of the survey, together with the training of the surveyors. Furthermore, it is essential that each surveyor undertake a pilot survey to ensure that they understand the process and to identify possible problems, which could potentially occur while conducting a survey.

The decision made regarding the survey method to be used, is based on the type of information required. It is, therefore, emphasised that the requirements of the CPTR and the importance of it's results to the transport planning industry should guide the data collection methodology.

Collecting on-board data is time consuming and expensive, even on relatively low volume routes. Hence, it is unlikely that a complete fleet of taxis will be surveyed in other areas. Because of time and cost elements, the amount of data collected will be limited and the number of taxis surveyed will be relatively small. For large areas with big taxi fleets it is recommended that on-board surveys be conducted on a sample of the taxis on each route as a representation of the full fleet.

Due to limited time, this investigation only focuses on minibus taxi data collection. Further investigations are required to identify the success of such a methodology to collect information on other modes of public transport services in South Africa.

Further investigations into the utilisation of ITS applications, such as fare collection systems and GPS technologies, be undertaken.

The CPTR information is an important planning tool, but in recent years there have been concerns about the validity of the information. The proposed on-board survey methodology has the potential to greatly improve the information supplied on public transport systems, which is used to provide guidance on future transport planning and an evaluation of current services.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

APC	:	Automatic Passenger Counters
AVL	:	Automatic Vehicle Locator
BRT	:	Bus Rapid Transit
CCTV	:	Closed Circuit Television
CMC	:	Cape Metropolitan Council
CPTR	:	Current Public Transport Record
CWDM	:	Cape Winelands District Municipality
FTA	:	Federal Transit Agency
GIS	:	Global Information System
GPS	:	Global Positioning System
GSM	:	Global System for Mobile
IR	:	Infra-red
ITP	:	Integrated Transport Plan
ITS	:	Intelligent Transport Systems
LTP	:	Land Transport Plan
LTPS	:	Land Transport Permit System
NDoT	:	National Department of Transport
NHTS	:	National Household Travel Survey
NLTTA	:	National Land Transport Transition Act
NMT	:	Non-motorised transport
NTD	:	National Transit Database
O-D	:	Origin-Destination
OLB	:	Operating Licensing Board
OLS	:	Operating Licence Strategy
PTP	:	Public Transport Plan
RatPlan	:	Rationalisation Plan
SATC	:	South African Transport Conference

INTRODUCTION

1.1 Overview of Study

The Cape Winelands District Municipality in Stellenbosch, Cape Town, commissioned Pendulum Consulting to undertake a planning study for a public transport tourism service in their area. The town of Stellenbosch was identified as a suitable area for a pilot study. It is envisioned that once the concept for the service has been confirmed and a working example has been prepared, similar services could be rolled out to the rest of the District and, potentially, throughout South Africa. The project entails the preparation of a Business Plan to incorporate the existing taxi industry in Stellenbosch in providing tourism transport as part of their current services. A project methodology overview for the public transport tourism project is shown in Figure 1.1. In order to plan this type of service it was necessary to have accurate information on the current public transport services in the town, both formal and informal services.

The existing commuter public transport services in Stellenbosch are provided through local taxi associations that provide on-demand service for a number of routes from and to a few central locations. It was, initially, envisioned that the base data from the existing Current Public Transport Record (CPTR), which summarises this local taxi supply for the Cape Winelands District Municipality, could be utilised to prepare the business plan for this new Public Transport Tourism Service. The most recent CPTR was prepared for Cape Winelands District in 2003, but provided insufficient information regarding the en-route passenger boarding-alighting and the origin-destination (O-D) patterns, which is required to understand the extent of the vehicle utilisation and passenger demand.

The shortcomings of the CPTR in providing detailed passenger information led to the motivation in conducting the on-board taxi surveys. This on-board taxi survey was then identified as a requirement to complete the operational plan for the public transport tourism service and ultimately the business plan. The author was responsible for liaising with the taxi industry, planning and overseeing the on-board survey, as well as the data capturing and analysis of the raw survey data as indicated by the red block in Figure 1.1.

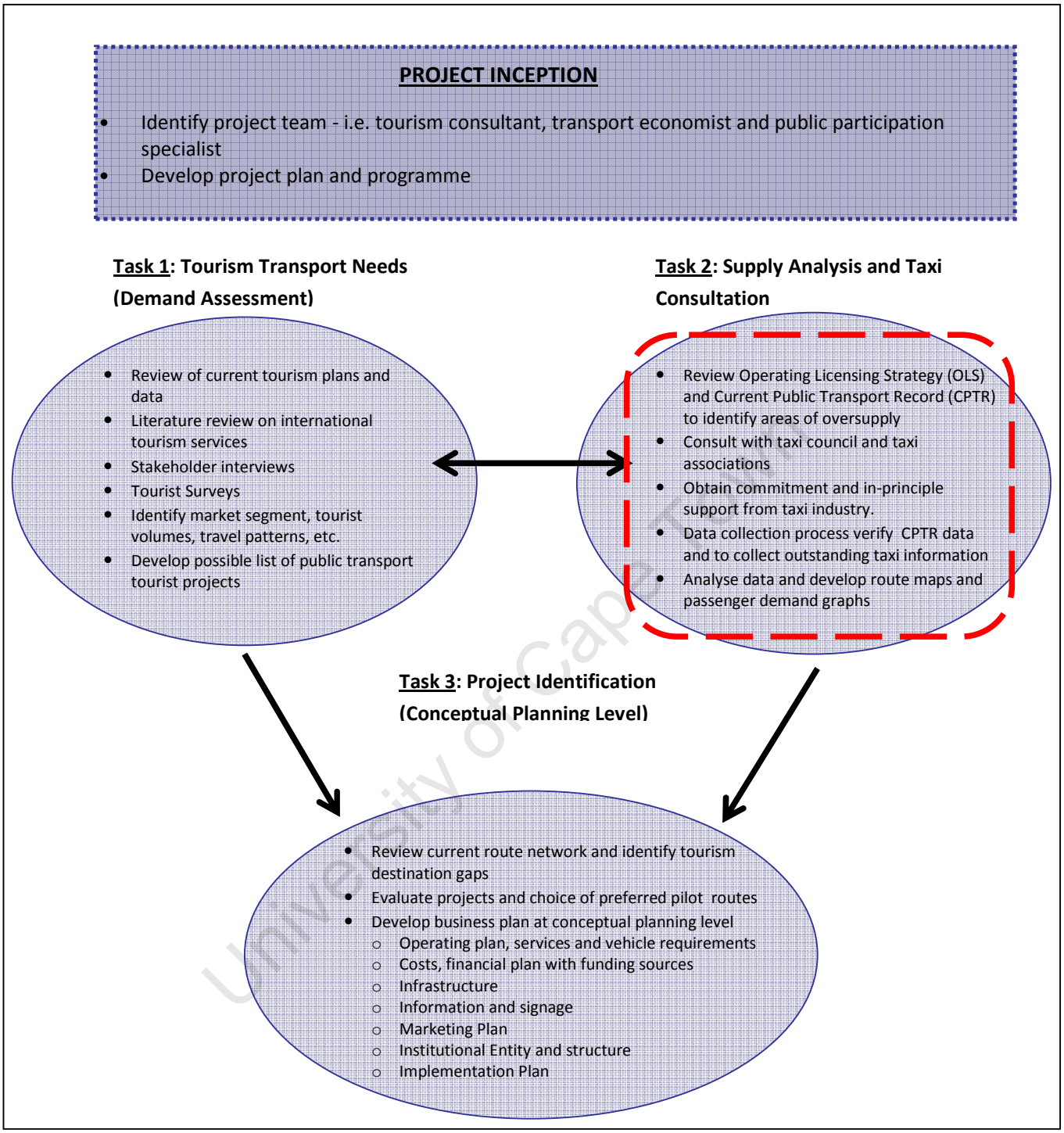


Figure 1.1: Tourism Project Methodology

1.2 Background

1.2.1 Public transport in the Western Cape

Historically public transport systems in the Western Cape were served by rail, bus and the tram. These systems provided excellent services and most of the historic land use was structured around the public transport systems. However, the implementation of the *Group Areas Act,* (CMC, 1998) resulting from the Apartheid Government in the late 1940's, forced major changes to the public transport system and the land use structure around it and, since the late 1970's, there has been a major decline in these systems (CMC, 1999). The *Group Areas Act* led to urban sprawl with low income, poor communities being formed on the outskirts of Cape Town, far from facilities and places of opportunities. Factors, such as a lack of investment in new public transport infrastructure, increase in crime, insufficient law enforcement and unsupportive land use planning resulted in a decline in the ability of the existing public transport system to adequately service all communities. This also resulted in the increase of private vehicle travel, as people found this a safer and more convenient mode of travel.

In response to inadequate bus services and unsafe rail systems, the taxi service was established. Taxi services first started as metered sedan taxis, which offered shared services between lower income residential areas and suburban railway stations (CMC, 1999). In 1978 the National Department of Transport (NDoT), due to an increase in the demand for such services, allowed taxi operators to change from 5-seater sedan vehicles to 9-seater vans and in 1987 it was recommended that the 15-seater minibus vehicles be used to provide this service.

According to a study conducted by Liebenberg and Stander in 1992 short shuttle-type services proved to be very successful even when competing with subsidised bus services. "*Although government attempted to limit the competition between buses and taxis by restricting the supply of permits, there was rapid growth in the number of pirate taxis"* (Liebenberg & Stander, 1992). Minibus taxi operators in the Western Cape grouped themselves into associations, usually operating on a fixed group of routes, determined by their route permits. The main problems and issues surrounding the minibus taxi industry in the early years are still prevelant today. These are:

- illegal 'pirate' taxis which, operate without permits,
- violence between rival operators,

- operators not adhering to permit regulations and deviate off their routes,
- taxis competing with the bus services on many routes by providing direct services to main destinations, and
- drivers not adhering to traffic laws and often driving unroadworthy vehicles due to inadequate law enforcement.

All these factors have made it difficult for government to formalise and regulate the minibus taxi industry.

1.2.2 Current Public Transport Record

In any country or city public transport is a basic necessity for most people. It affects the economic well-being of communities and links people to places of opportunity by providing access to economic, social, educational and recreational activities. When public transport fails to meet the needs of the community, it becomes a source of great personal hardship and economic loss (CMC, 1998). It is with this in mind that the importance of a good public transport system cannot be overemphasised. This importance has been recognised by all levels of government, which led to the formulation of the White Paper on National Transport Policy, which outlined the need for the the CPTR to be prepared by municipalities and service councils.

The preparation of the CPTR was, in the early 1998, initiated by the National Department of Transport as part of the National Land Transport Interim Arrangements Act -1998, which required certain metropolitan and services councils to prepare a record of public transport operations in their areas of jurisdiction. The formulation of the CPTR was intended to kick-start passenger transport planning and policies in a number of the larger metropolitan areas in South Africa as outlined in the White Paper on National Transport Policy (Department of Transport, 1996). The National Land Transport Transition Act (NLTTA)-Act 22, which was published in 2000, set out the regulations and requirements pertaining to the information needed to complete the CPTR.

According to the national requirements the CPTR should be the basis of the transport plans, as set out in the NLTTA, which includes an Operating Licences Strategy (OLS), Rationalisation Plan (Rat Plan), Public Transport Plan (PTP) and an Integrated Transport Plan (ITP). The requirements and format of the CPTR is specified in the TPR2: *Transitional information requirements for public*

transport - 1997, which was published as a legal requirement in the Government Gazette in 1998 and was included as part of the NLTTA, Section 23 of the Act (Department of Transport, 2001).

Information about all three modes of commuter public transport i.e. rail, bus and minibus taxi is required in the CPTR, as well as information on metered taxi facilities. In essence the CPTR deals with existing public transport demand, i.e. passenger ridership volumes, in relation to the supply of services on all modes of public transport. The CPTR is intended to provide input for the preparation of an OLS by guiding planning authorities with regards to making suitable recommendations to the Licensing Board in terms of applications for public transport permits. The CPTR also enables planning authorities to develop strategies for the short to medium term and prioritise projects for the rationalisation and improvement of existing services (Department of Transport, 2001).

Based on practical experience and observations regarding the data collection process for the formulation of CPTRs a number of critical issues are often raised regarding the extent and quality of the information provided in the CPTR. For this reason, the research and investigation undertaken within this thesis presents an overall review of the current data collection methodology for developing and updating the CPTR for municipal cities. The main focus is placed on the data collection for minibus taxi (referred to as *taxi* hereafter) operations. An on-board taxi survey was conducted to investigate an alternative method for data collection on taxis and the results are discussed here in.

1.2.3 The importance of public transport data collection

A city's growth and the need to meet mobility requirements places a huge demand on public transport systems. In order to adapt to these increasing needs and to serve these demands, current systems, some of which are old and in need of upgrading, must expand it's service area, increase service frequency and improve efficiency. Transport research and data collection is necessary to solve operating problems, to adapt appropriate new technologies and to introduce innovative solutions to the public transport system. The collection of public transport passenger and travel data is also important in providing data inputs for transport planning, decision making and policy formulation. Public transport data is essential to gain a complete picture of all trips within a certain area and how travel patterns change over time. Such data also provides input into current public transport services and can be used to plan the future transport needs of people.

Knowing detailed information about how public transport systems are performing and how many passengers utilise these services can provide planners with the tools needed to optimise the system to rider's needs. Accurate data on public transport systems has the potential to allow transport planners to use today's data to improve tomorrow's service.

1.3 Hypothesis and Objective

Hypothesis:

The current CPTR data collection methodology for minibus taxis does not provide a true representation of the actual passenger utilisation levels.

Objective:

The main objective of the thesis is to review the current CPTR data collection methodology, with specific reference to the data collection of taxi operations, and to compare the results of the CPTR with the data recorded from on-board taxi surveys. This thesis aims to:

i. review the methodology for CPTR data collection as indicated in the NLTTA,

ii. highlight the shortcomings of the current method in collecting data for taxis,

iii. conduct on-board taxi surveys with the use of a Global Positioning System (GPS) device as an alternative method for data collection, and provide results for the current taxi operations in the study area,

iv. compare the results of the on-board survey with the CPTR information and make recommendations based on the comparison, and

v. provide suggestions for collecting quantitative taxi and passenger information for both en-route and at taxi ranks such as passenger volumes, route descriptions, passenger origin-destination pairs, etc.

The objective is not to replace the current methodology; but to investigate if the information in the CPTR represents the current operations and demand in the taxi industry by using an alternative method to collect taxi data.

1.4 Research Approach

The research approach adopted for this investigation is set out below. The steps taken to carry out the investigation are:

1. A review of current legislation, policy documents and guidelines. These included:
    - The White Paper on National Transport Policy (NDoT, 1996),
    - The National Land Transport Transition Act (NDoT, 2000),
    - Cape Metropolitan Transport Plan: *Moving Ahead* (CMC, 1998),
    - National Household Travel Survey (NDoT, 2005),
    - Rural Transport Strategy for South Africa (NDoT, 2007), and
    - Bus Rapid Transit Planning Guideline (Institute for Transportation and Development Policy, 2007).
2. A literature review of the current methodologies in public transport data collection (nationally and internationally), and previous data collection methodology research and investigations carried out by transport practioners. These included research papers presented at transport conferences or carried out as part of transport planning projects. International data collection methodologies included research on the internet and discussions with international transport consultants.
3. Determining a suitable study area to conduct an alternative method for passenger data collection based on current taxi operations. The study area needed to be small enough for this scale of study but, at the same time, large enough to be able to see the impact of the using an alternative method, to that which was used in the CPTR report. This meant that there had to be an existing CPTR for the area to use for comparison purposes.
4. It was decided to undertake on-board taxi surveys using GPS technology as a potential alternative method for taxi data collection. These surveys were carried out during weekdays on most taxis in the study area. For the purposes of the public transport tourism project, on-board surveys proved to the best method to provide the results needed as part of the business plan, i.e. passenger volumes, route verification, passenger O-D patterns and travel time. The method is further discussed in Chapter 4.

5. Analysing and summarising the data collected from the on-board survey per route. The analysis and results of the data is provided in Chapter 5.

6. Comparing the data from the on-board taxi surveys with the latest CPTR information for the study area to determine and validate the accuracy of the CPTR data.

7. Concluding and recommending based on the findings of the on-board survey.

1.5 Scope and Limitations

On-board taxi surveys were carried out as an alternative method for collecting taxi data and were undertaken in the town of Stellenbosch, in the Western Cape. The scope of the study area only included taxi routes originating from the town of Stellenbosch and serving main residential areas or farm destinations, not more than 20km from the centre of town. The surveys were carried out during September and October 2008. Due to the close proximity of Stellenbosch University it is expected that many students utilise public transport, especially minibus taxi services, in the area to commute around town. The last term classes for Stellenbosch University ended on 24 October 2008 and exams commenced from 28 October to 12 December 2008 with university and school holidays thereafter. This meant that surveys undertaken during this period would not reflect the full demand on the minibus taxi services. This led to a time constraint for the data collection period, which meant that any errors or problems encountered during the survey period could not be rectified afterwards.

The difficulty in the availability of survey equipment and the high costs for purchasing equipment meant that only a limited number of taxis could be surveyed per day. This is further discussed in Chapter 4.

The latest CPTR results available for the town of Stellenbosch is contained in the 2003 Cape Winelands District Municipality CPTR, with certain major routes updated in 2004 as part of the OLS. Currently an update of the 2003 CPTR is being carried out, but Stellenbosch has not been updated as yet. Due to time constraints the 2003 and 2004 results are, therefore, used as base data in this report.

1.6 Layout of the Report

The first chapter provides an overview and purpose of the project, as well as the approach adopted for the research. A background to the public transport and the legislative requirements of the CPTR is also provided, by highlighting the importance of collecting public transport data. The scope and limitations of the research are identified. The national legislation, which outlines the requirements and methodology of CPTR data collection, is investigated in Chapter 2. In this chapter, national experiences with CPTR data collection are highlighted, as well as the current challenges faced in South Africa with the data collection methodology and the reliability of the data. A review is carried out of various public transport data collection techniques, that are being undertaken both locally and internationally. The background to the study area, i.e. Stellenbosch, is presented in Chapter 3, by providing information and operational data on the current taxi services in Stellenbosch and the demographic profile of the area.

The on-board survey methodology and approach is discussed in Chapter 4, providing a detailed description of the steps followed, from planning, through to the capturing and analysis of the data. The problems encountered and lessons learnt from this survey process are highlighted at the end of the chapter. The analysis and findings of the data, in Chapter 5, illustrates the categories of information that was obtained from the on-board survey, and the analysis of the passenger and route data. The comparison of the results in Chapter 6, interrogates the on-board survey results, by comparing it to the 2004 CPTR results, which was projected to represent 2008 data. A comparison between the passenger demand, routes travelled versus route allocation, and rank analysis is presented. The chapter ends off with a comparison between the on-board survey methodology and the CPTR methodology, by highlighting the advantages and disadvantages of each method. The final chapter provides the findings of the research and highlights the lessons learnt through this process. Recommendations are provided, based on the findings and conclusions of this thesis.

REVIEW OF NATIONAL AND INTERNATIONAL PRACTICES

2.1 National Legislation

The main purpose of a CPTR, as set out in the NLTTA (NDoT, 2000) is to provide input for the preparation of an OLS and to present an overview of current public transport services by reporting on passenger demand and current supply, as well as providing an inventory of facilities in the area. The contents and methodology for a CPTR is set out in the NLTTA, of which the outputs are as follows:

- Description of routes,
- Route coding system,
- Capacity utilisation per route,
- Waiting time per route during the peak hour,
- Registration numbers of observed vehicles per route,
- Description of ranks / termini,
- Rank/termini capacity utilisation in peak hour, and
- User needs and preferences.

2.1.1 Current CPTR methodology

Table 2.1 is extracted from the NLTTA and describes the data collection and survey procedures for preparing a CPTR, with the focus on taxi data collection. The data collection methodology, in most cases, consists of either the recording of a field observation (e.g. vehicle registration numbers or vehicle capacities) or actual count of vehicles and passengers. In the case of measuring waiting times, user needs and preferences, where required, only a sample of the passengers needs to be surveyed (NDoT, 2001). The pro-forma of typical survey forms are provided in Annexure A.

Table 2.1: CPTR data collection methodology and survey procedures

Data being collected	Methodology	Source	Time period
1. Route descriptions	• Meetings and discussions with taxi associations and compare with descriptions in Land Transport Permits (make spot check where necessary)	• Operating Licensing Board (OLB) • Taxi Associations	N/A
2. Coding of routes	• Confirm interpretation of coding system • Apply coding system	• Provincial Department of Transport	N/A
3. Service capacity and capacity utilisation	• List rank/termini/other major boarding points • Discuss passenger volumes in relation to available capacity with taxi associations • Select places where surveys need to be carried out • Prepare survey programme, survey forms and do man-power planning • Execute surveys for each route and record: - Vehicle registration number - Vehicle capacity - Number of passengers boarding vehicles - Fares	• For each route, one survey point is selected based on observations of vehicle occupancies	For commuter services : • Morning peak hour, if inbound trip is most critical • Afternoon peak hour only, if passenger volumes expected to be higher than in the morning • Tuesday, Wednesday or Thursday of typical week during the middle of the month For long-distance services : • Afternoon peak hour of typical Friday during the middle of the month. For rural areas: • Highest peak hour typically experienced any time on a busy weekday
4. Rank/termini capacity and capacity utilisation	• Identify ranks/or other major boarding points • Inventory of capacity of rank i.t.o. no. of loading bays per destination, and the no. of holding bays • Survey of capacity utilisation • Record maximum no. of stationary vehicles per destination that are in the process of loading • Record maximum no. of stationary vehicles utilising the holding area	• All ranks and holding areas to be surveyed	For commuter and metered taxi services : • Surveys of loading activities should be done in either the morning or the afternoon peak hour, which ever is the most critical • Surveys of the use of holding areas should be done in the most critical time period in the off-peak. • Tuesday, Wednesday or Thursday of a typical week during the middle of the month. For long-distance services : • Afternoon peak hour of typical Friday during the middle of the month. For rural areas: • Highest peak hour typically experienced any time on a busy weekday.

5. Waiting times	• Determine the no. of observations, given the passenger numbers and the guidelines on sampling as given in the NLTTA. • Determine waiting times of selected sample through either direct measurement, or through interviews.	• At all ranks and termini, and by destination where observations indicate large variations in queue lengths.	• Either the morning or afternoon
6. Public transport operations	• Consider and list data requirements • Identify sources and collect data • Manipulate data into the required format	• Primarily from public transport operators	• To be co-ordinated with other meetings and contacts with operators and associations
7. Comprehensive user needs and preferences surveys	• Determine the no. of interviews, given the passenger numbers and the guidelines on sampling as given in the NLTTA. • Prepare survey form and plan surveys i.t.o. manpower needs and programme • Execute surveys.	• At all ranks and termini.	• Could be both or either the morning and/or afternoon peak hour/period.

Source: Department of Transport: NLTTA, 2000

2.1.2 Key challenges with CPTR data collection and capturing

A number of transport researchers and practitioners have recently identified research opportunities and gaps that exist in passenger transport data collection in South Africa. A few of these contributions are cited in this section under the relevant subheadings. It is through the contribution of these authors that the study illustrates the dire need for more accurate public transport research and data collection in South Africa.

In their papers, presented at the Southern African Transport Conference (SATC), Moodley (2005) and Cameron (2005) both identified key challenges and shortfalls in the CPTR data collection and capturing processes. Moodley (2005) highlighted the experiences encountered while preparing the CPTR and OLS for eThekwini Transport Authority in Durban where he discussed the limitations of the CPTR information in preparing the OLS. Cameron (2005) carried out a critical evaluation of the CPTR methodology with reference to the problems experienced in the preparation of the 2003 Bonjanala Platinum District Municipality CPTR (situated in the North West Province of South Africa). The experienced challenges and shortfalls in the various CPTR applications are (Moodley, 2005 and Cameron, 2005):

- Information on routes, fares, rank locations, vehicle details, etc were received from operators prior to conducting the CPTR counts, but on the survey day operations varied from what was described by the operators. For example, additional routes had to be added to the database following the survey and/or routes did not appear on the survey day. This is mainly, due to the informal nature of the taxi industry in most areas.
- Survey data capture and "cleaning" was a major task requiring long hours and dedication from the capturing staff. Due to the magnitude of this exercise erroneous link selections, capturing of rank coordinates and various errors in the GIS network were, for example, were common occurrences.
- Incorrect interpretation of terminology and definitions were a stumbling block in the data collection and capturing process.

- Taxi counts were mainly conducted at the ranks, at both the origins and destinations. Little is known, or has been collected, regarding the "between-rank" demand or vehicle utilisation. This can result in undercounting of the potential taxi demand.
- Different methods and techniques were used to collect data in different areas, as well as during different times. For example some municipal areas undertook only peak hour counts, while others undertook 12 hour counts. This leads to inconsistencies when wanting to compare the data.
- The absence of information for off-peak or weekend capacity utilisation or on-route demand information has made it difficult to undertake revenue estimations in the taxi industry, which is required for the NDoT taxi recapitalisation revenue estimations.
- Service providers who were awarded the tender for developing the CPTR are sometimes not qualified in transport or planning and had no experience in undertaking transport surveys.

Cameron (2005) questions the methodology currently adopted in South Africa for the completion of the CPTRs and the consequent use of these records in policy and decision making. He recommends research to be undertaken to assess the potential of new technology for efficient data collection based on scientific reasoning.

2.2 Comparison between Travel Survey Estimates of Passengers and the CPTR

In 2005, Cameron of *TRC Africa (Pty) Ltd* carried out an investigation where he compared the national census data and the National Household Travel Survey (NHTS) passenger estimates with the information presented in the municipal CPTRs. This study was carried out as part of the Western Cape Provincial Government's report for the *Public Transport Improvement Programme.* Cameron (2005) comments how comparisons between the census, the NHTS and the CPTR have revealed that the CPTR specifications may have resulted in an undercount of the number of taxi passengers. The comparative figures are illustrated in Table 2.2.

Table 2.2: Comparison between Census, NHTS and CPTR passenger estimates

DISTRICT	CENSUS 2001 (Trips to work & education)	NHTS A.M. PEAK 2003 (Trips to work & education)	CPTR A.M. PEAK 2000-2001 *2004-2005	DIFFERENCE NHTS & CPTR
West Coast	7 622	7 630	3 021	4 609
Boland	22 728	39 486	2 159	37 327
Overberg	No information available from PTPs			
Eden				
Central Karoo				
Cape Town	185 000	281 508	152 000 *120 922	129 508 *160 586

Source: Cameron, 2005

The comparisons indicate that the 2001 CPTR results, for the City of Cape Town, shows the highest difference of about 130 000 passengers regarded as being undercounted in the CPTR when compared to the NHTS, and similarly around 160 000 passengers when comparing the 2005 CPTR. Table 2.3, also extracted from the report, shows comparisons of the different modes of travel, as measured by the census, the NHTS and CPTR for Cape Town.

Table 2.3: Comparison of Census, NHTS and CPTR passenger trips (AM Peak hour)

Mode of Travel	Census 2001	NHTS 2003	CPTR 2000/01	Under count
Train %	11.9	13.2	13	
No.	195 570	252 783	248 837	3 946
Bus %	7.2	7.4	2	
No.	118 328	141 711	41 000	100 711
Taxi %	11.3	14.7	8	
No.	185 710	281 508	152 000	129 508
Car %	33.8	32.6	N/A	
No.	555 485	624 296	N/A	
Walk %	33.5	29.1	N/A	
No.	550 555	557 271	N/A	
Other %	2.3	3	N/A	
No.	37 799	57 451	N/A	

Source: Cameron, 2005

The comparison in Table 2.3 shows the difference between the Census and NHTS on the one hand and the CPTR on the other. Cameron highlights the differences between the bus and taxi counts and indicates that the low CPTR passenger counts are due to the fact that the CPTR only counted passengers at terminals, interchanges and ranks. Passengers boarding and alighting on the road would not have been counted. He also argues that in a city of 3 million people it is inconceivable that only 41 000 people make use of the buses and 152 000 uses taxis in the morning peak hour. He concludes that the rail, bus and taxi undercount of 234 165 passengers seriously questions the validity of the CPTR as a planning tool.

2.3 Transport Data Collection Techniques

There are a number of transport data collection methodologies used in different countries to collect various forms of travel data, such as passenger volumes, passenger O-D information, public transport infrastructure and route information. The input requirements for the various methodologies of data collection has not changed significantly over the past years. the quantities, analysis procedure and presentation of the data, however, has changed as a result of changing policies, operational concerns and capabilities resulting from new technologies. From international comparisons of transport data collection techniques, vast methodological differences are observed between countries. These differences range from the definition of a "trip", i.e. daily mobility versus long distance trips, to the time period of data collection processes. This section aims to investigate various data collection techniques used nationally and internally, by looking at the methodology and the associated output of each technique.

2.3.1 Intelligent Transport Systems

Transport practitioners have started to realise the benefits of using the emerging and evolving technologies, known as Intelligent Transport Systems (ITS), of solutions to help meet the many challenges placed on reliable data collection. ITS uses advanced information processing (computers) technology, which allow information on transport systems – both vehicles and infrastructure – and real-time road conditions to be collected, processed and disseminated for improved data collection.

ITS applications vary in applied technologies from basic management systems, such as car navigation, traffic signal control systems, variable message signs along roadways and automatic number plate recognition to monitoring applications, such as speed cameras, CCTV systems and automatic counting systems. Examples of ITS technologies that can be used for data collection on transport systems are:

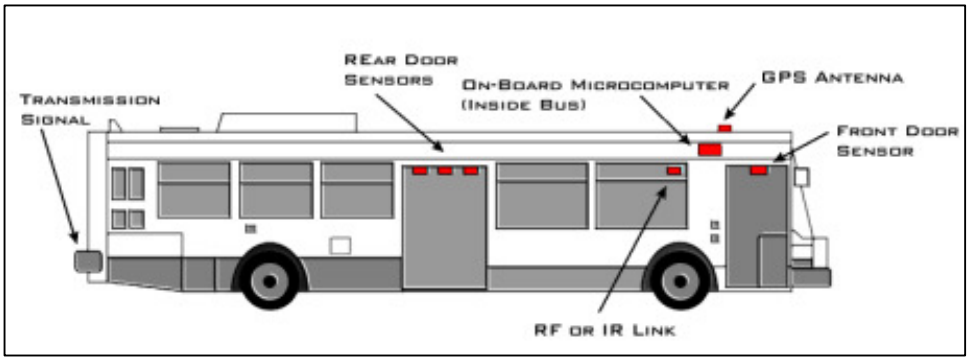
- Automatic passenger counters (APC),
- Global Positioning System (GPS) technology,
- Fare collection systems,
- Cellular data on vehicles, and
- Inductive loops.

Automatic passenger counters

A paper presented by Letshwiti (2004) at the SATC explores the possibilities of collecting most of the CPTR data electronically. Letshwiti realises that collecting CPTR data manually, is time consuming and subject to errors and inaccuracy. The research involved a market survey to establish the need for APC techniques, as well as a field trial using the available technology. The following is a list of passenger counters categorised according to principle technologies:

- Manual (turnstiles),
- Infrared (IR) beams,
- Infrared optic sensors,
- Low ultrasonic frequency sensors,
- Treadle mats (load cells), and
- Video cameras.

As part of this investigation, a field trial was undertaken using infrared sensors on the City of Johannesburg's Metrobus, with sensors placed on the top of the door. Figure 2.1 shows the various components of a typical APC system and the location of each component.



Source: INFODEV

Figure 2.1: Various components of APC system

The market survey included one-on-one meetings with consultants, municipalities and operators involved in data collection of passenger information. The outcome of this research showed that there is a need for automated passenger counting systems. Letshwiti (2004) realised that the primary objective of the CPTR information is to provide the status quo of public transport operations, in terms of passenger volumes, route location, infrastructure characteristics and capacity utilisation. Therefore, only technologies, which involved data collection intended for transport planning purposes were investigated and not technology involving ticketing and fare collection or driver monitoring.

The *Infodev* (infrared sensor) technology was tested in the field survey and was installed on a vehicle after receiving permission from the service operator and operated on selected routes. The cost of installing the system was estimated at R28 000 per bus. It was observed that the passengers did not notice the presence of the sensors, however, bus drivers were unhappy with the installation of the system, as they felt that they were being monitored.

Two alternative methods were used to verify the counts done by the *Infodev* system and to check the accuracy of the technology. These included manual counts and the use of a portable video camera to check passenger volumes. According to Letshwiti the tests indicated that the accuracy level was at 99%. This accuracy level was obtained using 3 sensors per door, with one sensor being used the accuracy level reduced to 95%, which is still acceptable. The conclusions reached from this study indicated the need for automatic passenger counting for transport planning purposes and that system developers and service operators are willing to participate.

To get more reliable and relevant data from the APC system, the vehicle also has to be fitted with an Automated Vehicle Location (AVL) system. The AVL system is, usually, based on GPS technology. Table 2.4 shows an example of the APC output (together with an AVL system), which was converted to an Excel file. The output provides information on route number, stop number, time of day, direction of travel, number of passengers getting on and off at a specific stop, the longitude and latitude of the stop, the stop ID and name and the difference in distance between the physical stop and where the bus actually stopped. Figure 2.2 shows images of the control room that receives real-time information from the AVL system, which allows monitoring and tracking of the vehicle at all times.

Route	Stop	Stop_ID	Time	Day	Dir	Block	On	Off	Lat	Long	Delta	Surveys	Stop Name
101	3100	10163100	540	1	6	1	0	0	30.2084	(81.6834)	472.7500	4	N.A.S. HOSPITAL NASH
101	3100	10163100	640	2	6	1	2	0	30.2089	(81.6828)	211.8333	6	N.A.S. HOSPITAL NASH
101	3100	10163100	717	1	6	2	1	0	30.2089	(81.6826)	165.0000	2	N.A.S. HOSPITAL NASH
101	3100	10163100	740	1	6	1	1	0	30.2089	(81.6827)	193.8333	6	N.A.S. HOSPITAL NASH
101	3100	10163100	840	2	6	1	1	0	30.2090	(81.6830)	327.0000	7	N.A.S. HOSPITAL NASH
101	3100	10163100	920	1	6	2	0	0	30.2090	(81.6827)	197.5000	2	N.A.S. HOSPITAL NASH
101	3100	10163100	940	1	6	1	4	0	30.2089	(81.6826)	206.3333	6	N.A.S. HOSPITAL NASH
101	3100	10163100	1044	2	6	1	0	0	30.2088	(81.6832)	336.8333	6	N.A.S. HOSPITAL NASH
101	3100	10163100	1120	1	6	2	0	0	30.2088	(81.6829)	202.0000	2	N.A.S. HOSPITAL NASH

Source: NTD Handbook, 2003

Table 2.4: APC output example in Excel format

Source: NTD Handbook, 2003

Figure 2.2: AVL control room

Fare Collection Systems

In countries where Bus Rapid Transit (BRT) systems are used, the collection of public transport data is aided by the use of ITS applications, for example in Curitiba, Brazil, reports regarding passenger volumes, vehicle utilisation, travel times, passenger O-D information, etc can be requested directly from the BRT operating company (discussions with local transport planning firm, *LOGIT*, in Brazil). Passenger volumes are tracked via the fare collection system and ticket sales. Vehicles are tracked via AVL technology and passenger O-D information can be derived based on the smart card technology adopted on most BRT systems, which allows passengers to

enter and exist the BRT system, thereby recording the origin and destination of each passenger trip.

Smart cards contain information that can be extracted by a card reader. These cards have an integrated circuit chip, a central processing unit and an operating system (NCTR, 2003). The reader is built into the fare collection unit and activates the card to identify the passenger and it can record the location of the boarding or alighting point, which is stored on the processing unit and can be retrieved afterwards by the BRT operating company. Figure 2.3 illustrates some examples of electronic fare collection systems where passengers can load money onto their smart cards to allow access onto BRT systems. The disadvantage of using these systems are related to mechanical/equipment problems, such as money getting jammed into the machine, aging coin mechanisms, difficulty in reading smart cards, overloaded vaults and reliability of the unit to correctly record the time and date when trips are made. The maintenance of these systems constitutes the biggest part of the running costs.

Source: NTD handbook, 2003 and Pendulum Consulting

Figure 2.3: Examples of electronic fare collection units and passenger entry points

Cellphone technology

In 2005 a study was conducted by Krygsman and Schmitz (Krygsman et al, 2005), exploring the use of cellphone technology in collecting travel data for various modes of transport. The authors stated that the current methodology to collect travel behaviour patterns, involving household surveys and activity – based travel questionnaires, can be difficult to undertake and complete, in developing countries, in particular, due to lower levels of literacy and limited funding. The sudy involved tracking individuals over a two-day period, making use of cellphone technologies, using GPS and Global System for Mobile (GSM) communication and location – based services.

The use of these technologies provided an opportunity to utilise existing hardware and software, already in use by studied individuals (Krygsman et al, 2005). A sample size of 83 individuals were tracked via their cellphones. According to Krygsman, for each individual a spatial location was determined every five minutes by sending a "signal" to the cellphone which recorded the time and the individual's geographic position in latitude and longitude (Krygsman et al, 2005). The methodology and approach followed in the study included:

- Obtaining permission from study participant to track their cellphones,
- Obtaining the home location of all respondents via a questionnaire and mapping this location in GIS,
- The cellphone was tracked via the GSM network, which received a signal from the phone at constant intervals, as long the cellphone is switched on,
- The service provider received the information and added geographic coordinates and time frames to the data,
- Locational accuracy was dependant on the "catchment" radius of the cellphone towers,
- Information was transferred to a processing unit, which added contextual information to the data, and
- In order to verify the accuracy of the GSM tracked path, selected respondents were requested to complete an activity diary or include GPS technology over the survey period.

Generally, the cellphone tracked path compared well with the GPS tracked path and the activity diaries collected. “In some instances the cellphone records proved more accurate as some respondents omitted short, incidental trips in the activity diaries” (Krygsman, et al, 2005).

The use of cellphone technology to track individuals’ transport activity provides some benefits to respondents, such as low input requirements and not having to recall activities or trips. Other benefits to the industry include, the easy accessibility of cellphones, due to the high market penetration of these systems and the availability of GSM coverage in most areas. According to Krygsman, the utilisation of cellphone technology by the transport planning industry has been slow, with only a few studies in Europe, Japan and the USA and none in the developing world being reported. In Germany, a study was conducted by Kracht (Kracht, 2004) where the use of GPS and GSM technologies in data collection were compared. According to Kracht, GPS technology provides more accurate location information, however, these systems are expensive and complex to use. A case study was conducted in Berlin where both technologies were used in tracking individuals using all transport modes. The problem experienced with cellphone technology is with location accuracy. The accuracy is very dependant on the density of cellphone towers and the quality of the signals in the study area. In urban areas with a higher density of towers (or arials), resolution can be up to 50 – 100 meters. However, in developing countries and in rural areas the accuracy may be considerably less and location data may be poor (Krygsman, 2005).

2.3.2 Household surveys

A household survey involves a trained interviewer, who visits a selected household, which forms part of the sample designed for the whole survey, and invites members to complete either a travel diary or a questionnaire, recording their travel behaviour for a set period or for the day before. Most household surveys collect detailed information on the key travel characteristics of each participating household and each member, in the form of an interview based or a set questionnaire. In addition individuals, and sometimes children, could also be asked to complete a seven day travel diary, allowing travel patterns to be linked to individual household characteristics. Unfortunately, travel diaries are not always accurate. This could be attributed to respondents not completing it correctly, or not being able to recall all activities. There is also

resistance to using travel diaries, mainly because of the effort and money required to complete them and the risk of providing data that could make respondents vulnerable to crime. Travel diaries can be particularly difficult to administer and complete in developing countries, such as South Africa, due to lower levels of literacy, language barriers and limited funding.

In the case of the Ministry of Transport in New Zealand households are selected using the Census zoning as a basis. Selected households in the zone are sent a letter describing the survey and advising that a surveyor will visit them. Every year about 2 200 households are invited to take part and over a five to seven year cycle every household in the zone will be invited to participate in the survey. The survey team then moves to another zone and the process will start over again (Ministry of Transport: New Zealand, 1999).

Designing a suitable questionnaire for household surveys entails detailed planning of questions to be asked. Attention must also be given to its length. Long questionnaires could induce respondent fatigue and errors could arise from inattention, refusal to partake or incomplete answers. Other factors, which should be taken into account when designing the questionnaire include, the order in which questions are asked, the appearance of the questionnaire and its physical size and format. For high quality data to be collected, interviewers must be carefully trained and must have good interviewer techniques, such as how to conduct an interview in a professional manner and how to avoid influencing responses (Richardson, 1995).

A household survey has the advantage of face-to-face interaction, which can increase cooperation rates and make it possible for respondents to get immediate clarification. Other advantages of conducting household surveys or requesting travel diaries include providing insight into aspects, such as (Ministry of Transport: New Zealand, 1999):

- Trends in personal travel (number of trips undertaken, car ownership, driving licence holding and time spent travelling),
- Trip purpose (purpose of trip by age and gender and extra mural activity transport versus commuter transport),

- Socio-economic conditions and accessibility (access to private car, effects of income level on transport mode choice, frequency of use of public transport and non-motorised transport facilities and mobility difficulties), and
- Car occupancy and annual car mileage (lift clubs and distance to workplace).

The use of household surveys provides a better understanding of the utilisation of public transport facilities, made by different sectors of the population based on socio-economic conditions and trends in these patterns of demand. The results of household surveys are used extensively by transport planners, planning authorities and academics.

Many major countries and cities have adopted this methodology to collect data on transport and travel behaviour.

International Context

Australia

The New South Wales Household Travel Survey was conducted in three annual sessions from June 1997 – June 2000. It was a continuous survey over a 12 month period, of which 3 500 households were selected annually. Respondents were notified by mail prior to the survey. Data was collected via 24-hour travel diaries, which were completed through a face-to-face interview. In the analysis, data was weighted to represent the latest population estimates. This minimised the influence of sampling variability from one 36 month period to the next and so maximised the reliability of the data (Australian DoT, 2005).

USA

According to an investigation carried out by the South African Department of Transport (NDoT, 2005) where international experiences in household surveys were consulted, the USA conducts travels surveys every five to six years. The sample for the latest survey (2001) was a list-assisted random digit dialling telephone number sample of 26 038 households. Data was collected via a household interview and a personal interview the using computer-assisted personal interview technique. Odometer readings were also collected twice for each vehicle owned by household

members, once around the time of the personal interview and again two months later. Although cash incentives were used with both the pre-interview letter and the travel diary mailing, the response rate was only 41%.

South African context

In 2003 the Department of Transport undertook a National Household Travel Survey (NHTS) in South Africa. The sample covered, approximately, 50 000 households within the district and local municipalities of the nine provinces. Personal interviews were held with selected individual members (workers and learners) of each household in which respondents were asked to recall their travel activities which they undertook on the day before the interview.

The purpose of the NHTS was to gain insight into the travel patterns and travel choices of individuals from different demographics gropus, and to use the data as a basis for transport research, planning and policy formulation. Other objectives of the NHTS also included (NDoT, 2005):

- Assistance with targeting public transport subsidies,
- Identifying disadvantaged regions for investments in transport infrastructure,
- Ascertaining the cost of public transport for various households and to assess their affordability for mobility,
- Gaining insight into transport problems and to assess customer attitude towards transport services, and
- Determining the extent of accessibility to opportunities.

The general experience, that can also be observed in the South African context, is that household surveys are expensive and the quality and accuracy of the data is hugely dependant on good planning and constant monitoring, to check the execution of the interviews. This method of collecting data requires some form of intelligence from both the interviewer and respondent, which is regarded as a major obstacle in developing countries, such as South Africa. From a transport planning point of view, household surveys often lacks an adequate sample size when needed at a suburb level.

2.3.3 Internet Systems

In the United States (US) it is a legislative requirement for all public transport agencies to submit public transport data to the state and local governments. This database of public transport information is referred to as the National Transit Database (NTD). The NTD program was established by the State's Government to be the nation's primary source for information and statistics on all public transport systems in the US. The NTD comprises of data reported by more than 600 public transport agencies across the US (Federal Transit Administration, 2008). Data is analysed and compiled into reports published by the Federal Transit Administration (FTA) and made available on the NTD program website The database includes all modes of public transport utilised on local and regional routes. This includes private and public buses, heavy and light rails, ferryboats and van pool services, as well as services for special needs passengers and taxi services operated under contract to a public transport agency. The data provided by public transport agencies include (FTA, 2008):

- Operational characteristics – such as vehicle revenue hours and miles, unlinked passenger trips and passenger mile,
- Service characteristics – such as service reliability and safety,
- Capital revenues and assets – such as sources and uses of capital, fleet size and age, and
- Financial operating statistics – such as revenues, federal and local funding, costs.

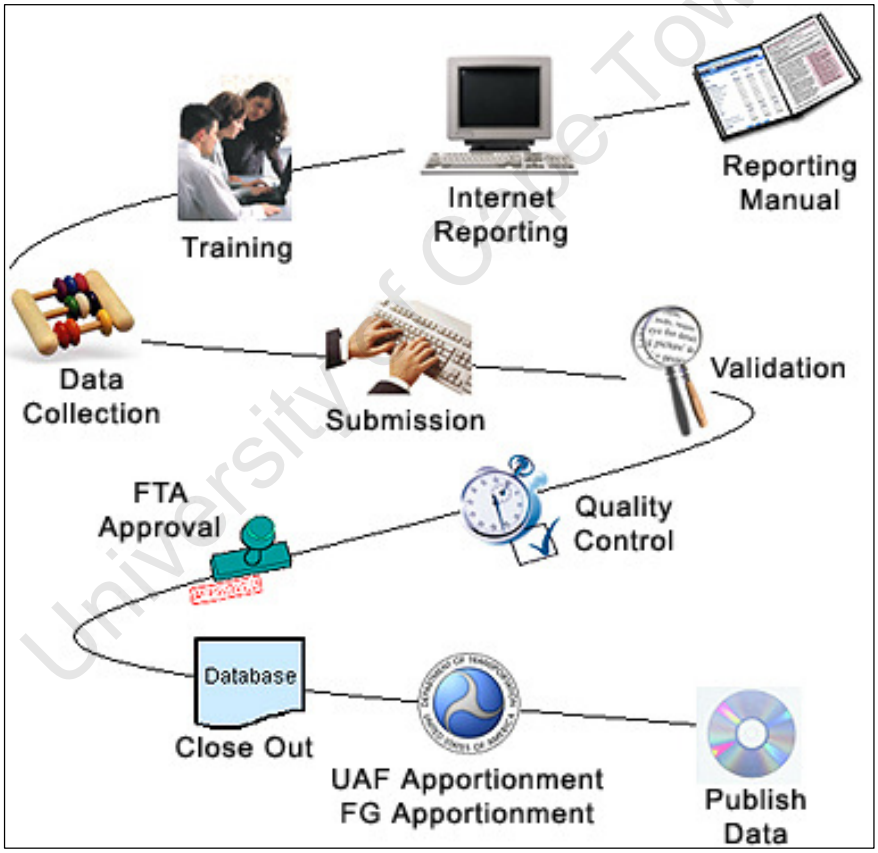
The NTD process

A reporting manual is made available to all public transport agencies required to report data on the operations of their services. This manual provides forms and instructions on how to provide data to the NTD. The FTA also conducts in-house training for small groups of transport agencies on how to complete the required forms, as well as, validation analyst training for in-house staff.

The data is completed on-line, via the NTD, website by transport agencies. All required forms are completed using Internet Reporting, which is accessible from the NTD website. User names and passwords are provided to all transit agencies. The data is then subjected to an extensive review

and validation process by FTA staff and approved for inclusion into the annual report of public transport operations in the country.

Transit agencies, who do not submit completed reports by the due date (usually the last working day of the month), stand a chance of being declared inelligible by the FTA to receive government grants during an entire fiscal year. The NTD report consists of a series of forms that collect data providing the FTA with monthly trends in ridership and service supplied throughout the year. Due to security issues, only registered transit agencies can access the data forms and reports. Figure 2.4 shows a detailed flow diagram of the NTD process, (FTA, 2008).



Source: www.ntdprogram.gov

Figure 2.4: NTD process flow diagram

2.3.4 Manual Surveys

An example of a manual survey, used for public transport data collection, is a visual occupancy survey. The objective of the occupancy survey is to measure the frequency of road based public transport modes and to determine the typical occupancies over a period of time, which is determined by the results required from the survey i.e. AM or PM peak period, weekday or weekend. The survey locations are determined, based on the site conditions and requirements, as stipulated by the client or project. At each survey location, where an occupancy survey will be conducted, the surveyor will record per bus or taxi the occupation of the vehicle and do this in time intervals of usually 15 minutes. Often these surveys are conducted where the surveyors are required to accurately estimate the actual numbers of occupants. This requires training and accuracy. The training, typically, requires the surveyor to make an estimate of the occupancy and then boards the bus or taxi to count the actual passengers. The following accuracy is typically required from a surveyor (Pendulum Consulting, 2008):

- In a sample of 20 vehicles, the difference between the sum of the visual estimate and the sum of the actual occupancy should be less than 4%, and
- The standard deviation of the difference between the estimation and the actual occupancy should be less than 8% of the average occupancy.

Due to complexities in certain areas, and the difficulties to actually board a vehicle directly after an occupancy estimate, another method for the occupancy surveys, which require less intense training, can be used. This method involves also an estimate of the occupancy but in categories and not the actual number of occupants. The following are typical categories of surveys (Pendulum Consulting, 2008):

- Vehicle almost empty (if the vehicle is totally empty, it must be recorded),
- Vehicle with some passengers (25% of seats used),
- Vehicle with average number of passengers (50% of seats used),
- Vehicle with almost all passengers seated (75% of seats used),
- Vehicle with all passengers seated (100% of seats used), and

- Vehicle with all seats used and some passengers standing.

Table 2.5 illustrates the typical occupancy classifications to be used for both buses and taxis and the number of passengers for each vehicle in each class.

Table 2.5: Occupancy code and number of passengers by vehicle and class

Class	Range	Number of passengers	
		Bus	Taxi
0	0%	0	0
A	25%	<=16	<=3
B	50%	<=32	<=6
C	75%	<=48	<=8
D	100%	<=64	<=12
E	>100%	>64	>12

Source: Pendulum Consulting, 2008

The logistics for this type of survey includes the printing forms, coaching the surveyors, distributing the surveyors to the survey locations, collecting the data, verifying the data collection and recovery of the data for analysis. A typical data collection survey form for the field work is included in Annexure B. The form also includes the forms for aggregating and collating the data. It is essential that the surveyors are familiar with the survey forms and how to complete them before starting the surveys.

The heading of all forms should be completed before the start of the survey. Figure 2.5 shows an example of a completed heading.

Figure 2.5: Visual occupancy form header

Visual Occupancy Survey

Survey Station:	1000	Road Name:	Rhodes Drive
Suvey Station Code:	1023	Day:	29/02/2008
Direction:	N-S	Weather:	rain

The form should also be completed using the codes for each class. After each 15 minute interval, the surveyor should draw a line under the entries. Figure 2.6 shows an example of a completed form. The time entered in the time column is the start of the time period of each survey time range.

Figure 2.6: Completed Occupancy Survey Form

Time	Taxis	Buses
06:00	A-B-0-C-D-E	B-C-D-E-A-0
06:15	B-C-D-E-A-0	A-B-0-C-D-E
06:30	A-A-B-B-C-C-C-D-A-A-E-E-E	A-B-C-D-A
06:45	B-C-E-E-E-E-E-E-A-B-C-0	D-E-D-C-B-D
07:00	A-A-B-B-C-C-C-D-A-A-E-E-E-D-E-D-D-E-B-A-B-C-D-E-0-A-B-E-C-D-E	A-B-C-D-E-0-A-B-E-C-D-E

Source: Pendulum Consulting, 2008

On completion of the survey the surveyor transfers the recorded occupancies to the data recovery form. This form is included in Annexure B. The surveyor counts the number of classes for each vehicle type and adds this to the appropriate column of the form. Figure 2.7 shows an example of the data extracted from the survey form shown in Figure 2.6. The data collected by the classified traffic counts are entered in the last column.

After all the forms are completed they are stored in a spreadsheet for analysis. The data recuperation form could be entered directly in the spreadsheet. After inputting all the data in the spreadsheet, it must be checked. A minimum of 20% needs to be checked and if there are errors on more than 10% of these forms then all the forms must be checked.

Figure 2.7: Data Recovery

Data Recuperation

Survey Station:	1000	Road Name:	Rhodes Drive
Survey Station Code:	1023	Day:	29/02/2008
Direction:	N-S	Weather:	rain

Taxis

Time	0	A	B	C	D	E	Counts
06:00	1	1	1	1	1	1	8
06:15	1	1	1	1	1	1	7
06:30	0	4	2	3	1	3	16
06:45	1	1	2	2	0	6	12
07:00	1	6	4	4	6	8	31

Buses

Time	0	A	B	C	D	E	Counts
06:00	1	1	1	1	1	1	6
06:15	1	1	1	1	1	1	6
06:30	0	2	1	1	1	0	5
06:45	0	0	1	0	3	1	5
07:00	1	2	2	2	2	3	12

Source: Pendulum Consulting, 2008

This type of survey was used in Cape Town to update the existing Emme/2 model, as part of the planning for the City of Cape Town's BRT operational plan. Even though the model has been extensively calibrated in the past based on road based traffic volumes, the operational planning team identified a need to more accurately establish the current public transport travel patterns. Since the Emme/2 model is based on the morning peak hour, these surveys were completed between 6am and 10am on a typical weekday morning at 18 sites across the city and on a Saturday at 3 sites, which were identified by the project team (Pendulum Consulting, 2008).

2.4 Résumé

For transport authorities and planners to be able to encourage the use of public transport infrastructure, an understanding of the current situation and transport system is essential. This knowledge begins with collecting data to measure and monitor travel behaviour. Collecting certain relevant and essential data is time consuming and expensive, in most cases. Despite the costs and difficulties associated with obtaining more reliable qualitative data, the application of various methodologies and technologies, as discussed in this chapter, offers an important, if not essential, means to improve data collection in South Africa.

STUDY AREA

3.1 Background

The town of Stellenbosch was chosen as the study area for this investigation. The main reason for selecting Stellenbosch as the study area was the size of the town and ability to conduct on-board taxi surveys on practically all the taxi routes in the area. Stellenbosch also has an on-going planning focus on transport related projects in the area, for example the development of a non-motorised transport (NMT) plan for the town, together with a parking plan, the potential incorporation of the tourism industry with public transport and the construction of a formal taxi rank in the town centre currently underway.

Stellenbosch, located in the Western Cape, was founded in 1697 and is situated approximately 50km from Cape Town, refer to locality map in Figure 3.1. It is one of three rural municipalities abutting the metropolitan area of the City of Cape Town (CNdV Africa, 2005). Stellenbosch is synonymous with the oldest wine route in the country, which draws wine-lovers and tourists from around the world. Stellenbosch is an area where great wealth in the form of wine estates, well renowned hotels, spas and well maintained suburbs exist side by side with impoverished farm workers, displaced farm dwellers, unemployed and poor household dwellings in underdeveloped townships situated beyond the main industrial, commercial and places of leisure (Stellenbosch Municipality, 2007).

The town of Stellenbosch also contains the internationally renowned Stellenbosch University, which had a total of 23 439 students enrolled in 2007 (Stellenbosch Municipality, 2007). Stellenbosch includes the towns of Cloetesville, Kayamandi, Jamestown, Klapmuts, Pniel and Franschhoek. The minibus taxi is the dominant mode of public transport between the towns, servicing both commuters and long distance passengers. There is no public transport bus service in Stellenbosch. There are currently three registered taxi associations in the area:

- Stellenbosch Taxi Association,
- Kayamandi Taxi Association, and
- Franschhoek Taxi Association.

Stellenbosch falls under the jurisdiction of the Cape Winelands District Municipality (CWDM), which is defined as a planning authority and, in terms of legislation, is required to prepare the transport plans as set out in the NLTTA in liaison with the local municipalities within the district. According to the OLS there are 72 minibus taxi routes listed on the Land Transport Permit System (LTPS) for the Stellenbosch Municipality, which mainly serve commuters travelling within towns or between towns within the municipality (Cape Winelands District Municipality, 2004). The minibus taxi operations also provide services for farm workers commuting to farms along the main routes. The routes and rank facilities are discussed in detail in Section 3.2.2. Stellenbosch is also served by rail with the station located approximately 1.1km from the centre of town.

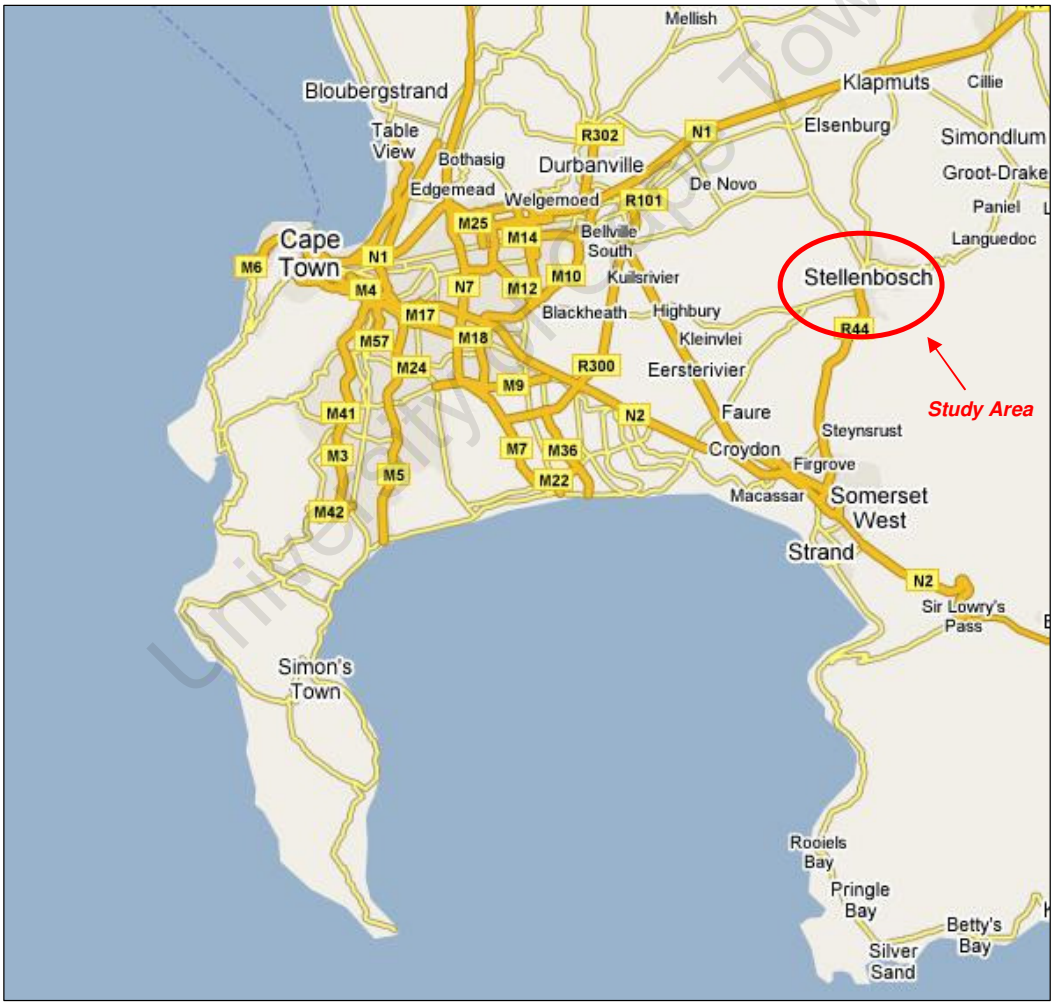
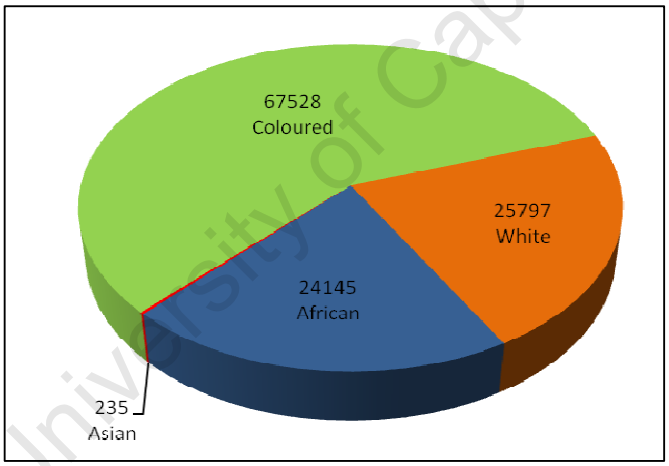


Figure 3.1: Locality Plan

3.2 Demographic Profile of Stellenbosch

In 2007, Professor H.L. Zietsman undertook a comprehensive analysis of the 2001 census database for the town of Stellenbosch, in order to understand the recent changes and trends in the demographic structure of the population in the town. He attempted to update the 2001 data to extrapolate current trends, by applying projection and estimation techniques. The study used the 1970 to 2001 census data to project the total population of Stellenbosch to 2006. The methodology involved using a regression equation and a geometric growth formula.

According to Zietsman, a ratio technique was applied to the total population figures obtained by the projection method to compute disaggregated values for different population groups. The ratio between the 1996 - 2001 (5-year) values were applied to the 2001 values to obtain 2006 (5-year) estimates based on the assumption that trends measured between 1996 and 2001 remain unchanged (Zietsman, 2007).



Source: Statistics South Africa

Figure 3.2: 2001 census results per population group

Zietsman indicated that Stellenbosch's population growth rate is estimated to be 2% per annum, but due to large in-migrations by the African population a growth rate of 9.3% is observed in this population group when comparing the 1996 to 2001 census data. The total population for Stellenbosch was recorded to be 117 705 in the 2001 census results, with a breakdown of the population groups indicated in Figure 3.2 (Zietsman, 2007). By applying the calculated growth rate per population group to the 2001 census, the average projected population for 2006 is estimated

to be 135 874, which equates to 2% per annum, refer to Table 3.1 for the estimated results per population group. The 2001 census data also recorded 8 145 people utilising the taxi services in Stellenbosch (Statistics South Africa, 2001).

Table 3.1: Growth rates and projected population per population group for 2006

Population Group	Geometric Rate	Projected Data 2006		
	% Annual Growth Rate	**Linear**	**Geometric**	**Average**
African	9.3	26 285	37 665	31 975
Coloured	1.4	76 595	72 396	74 496
Asian	2.1	306	261	283
White	0.7	31 534	26 707	29 121
Total	2.0	134 720	137 028	135 874

Source: Zietsman, 2007

3.2 Cape Winelands District Municipality

The Cape Winelands District Municipality (CWDM), one of the 5 district municipalities in the Western Cape, covers an area of 22 288 km^2 with an estimated population of 629 488 (CWDM, 2007). It comprises of 5 local municipalities and a District Management Area namely:

- Breede River/Winelands Municipality,
- Breede Valley Municipality,
- Drakenstein Municipality,
- Stellenbosch Municipality,
- Witzenberg Municipality, and
- Cape Winelands District Management Area.

Figure 3.3 indicates the extent of the municipal boundaries within the CWDM.

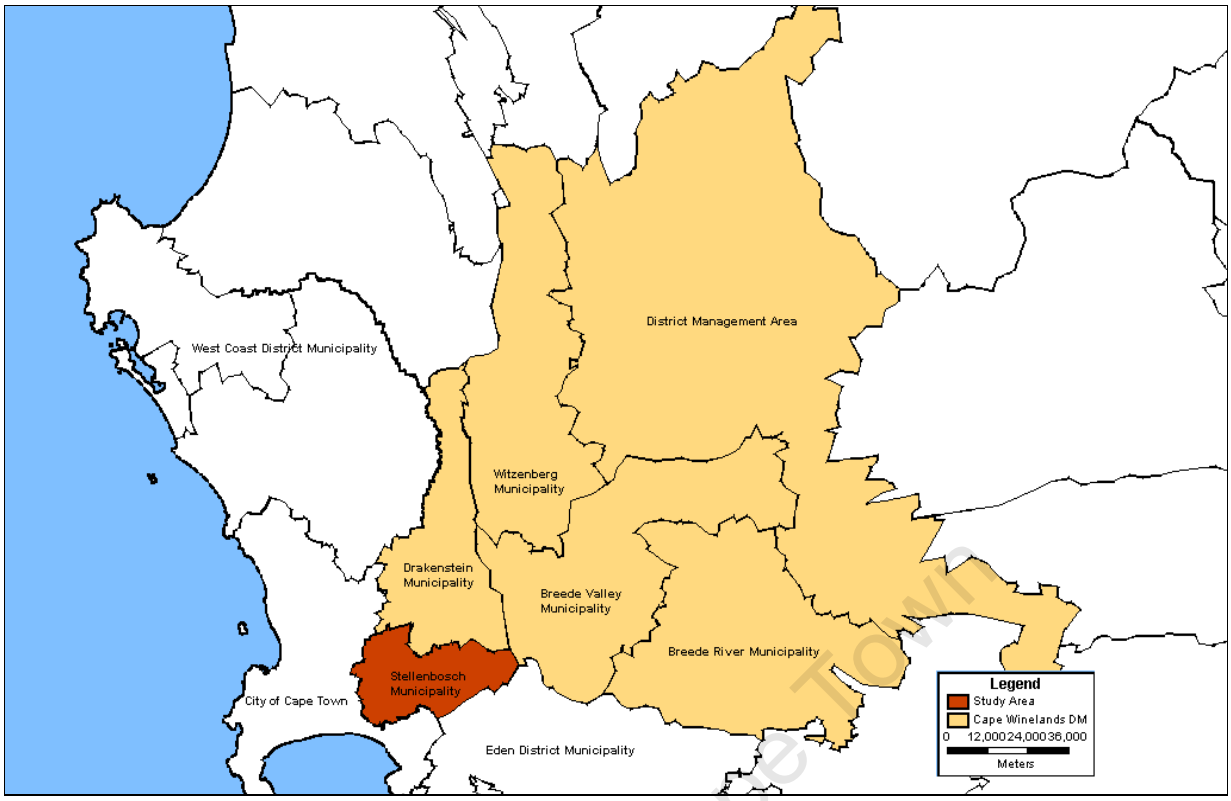


Figure 3.3: CWDM Municipal boundaries

The population in the CWDM, in terms of race, is predominantly coloured (65%). Other population groups in the District are (Statistics South Africa, 2001):

- 19% are Black,
- 15% are White, and
- 0,2 % are Indian or Asian.

Table 3.2 shows the population breakdown per municipality based on the 2001 census data.

Table 3.2: CWDM population per Municipality

Municipality	Total Population
Breede River Municipality	81 171
Breede Valley Municipality	146 028
Drakenstein Municipality	194 417
Stellenbosch Municipality	117 705
Witzenberg Municipality	83 567
Cape Winelands District Management Area	6 500
Total	**629 488**

Source: Statistics South Africa

The data in Table 3.2 indicates that the population of Stellenbosch makes up about 20% of the total CWDM population.

3.2.1 Cape Winelands as a Rural Municipality

The Provincial Spatial Development Framework of the Western Cape defines rural areas as *all land outside of urban areas as demarcated by urban edge*s (CNdV Africa, 2005). All the municipalities, which form part of the CWDM, are regarded as rural municipalities, as they contain many hectares of farming and agricultural land. In terms of rural passenger transport, small and micro-enterprises are performing a large role in transporting people. In most rural areas the so-called "bakkie" sector and animal-drawn carts now form the main service provider in most rural farm areas. The connection to towns, clinics and other facilities are mainly provided by taxi operators.

As part of the tourism project, a survey was conducted by *Edge Tourism Solutions,* in 2007, where farm owners in the Stellenbosch area were interviewed about farm worker transport, to understand the demand for taxi services. The results of the interviews among 23 farms indicated, that 61% of farm owners provide staff transport for farm workers mostly in the form of "bakkies" or heavy vehicles.

3.2.2 CWDM CPTR methodology

The methodology for the data collection component of the CPTR is discussed in the 2004 OLS for the CWDM. The CPTR was completed in March 2003. The methodology initially involved the undertaking of surveys of public transport services and facilities, as part of an inventory of public transport in the area, which formed the basis for the data collection for the CPTR. The CPTR surveys were undertaken between November 2002 and March 2003, with the exclusion of the December/January holiday period. The surveys for Stellenbosch were conducted in February 2003 and were carried out during a weekday (not a Monday or Friday) and a Saturday. The hours were from 6am to 6pm on the weekday and 6am to 2pm on a Saturday. The taxi data was collected at major ranks and boarding points at both work/town centre end and residential end. These locations were agreed upon at meetings with the local taxi industry and taxi associations prior to the surveys being carried out. The following information was recorded during the surveys (Cape Winelands District Municipality, 2003):

- identification of the routes operated,
- number of trips per route,
- boarding and alighting passengers,
- number of special needs passengers,
- passenger waiting times,
- identification of major facilities,
- utilisation of facilities,
- facilities provided at ranks, such as shelters, toilets, etc,
- identification of rail stations, and
- rail passengers boarding and alighting.

An illustration of the data capture sheet, as part of the CPTR surveys, is provided in Annexure A.

Cordon counts were also conducted along some routes at certain locations. However, due to the high speeds travelled by the taxis, only the registration numbers could be recorded. The purpose of the cordon count was to confirm if the taxi was travelling on the correct route and to check illegal taxi movements. It was not possible to undertake on-route passenger counts, as the surveyors would have to stop the taxi and taxi drivers were not willing to do so. The results of the cordon counts are not presented in the CPTR and were only used to verify taxi routes.

3.2.3 CPTR minibus taxi information for Stellenbosch

Taxi operations in Stellenbosch are essentially informal in structure and are mainly demand driven. A formal taxi rank was recently constructed in the town of Stellenbosch, with taxis taking occupancy of the rank in January, 2009, refer to Figure 3.4. At the time of conducting the on-board survey, the existing taxi facilities were mainly operating from parking areas and/or embayments in the town; these are listed in the CWDM OLS at follows, refer to Figure 3.7 for locations of ranking facilities:

- Bergzicht holding area,
- Bergzicht rank (informal rank),
- Blom Street rank (Die Braak) (parking facility, refer to Figure 3.5),
- Merriman rank (embayment in Merriman Street), and
- Stelmark rank (parking area at Pick 'n Pay, refer to Figure 3.6).

New Bergzicht Taxi Rank located on c/o Merriman and Bird Streets with temporary (informal) facility in background

Figure 3.4: New Bergzicht taxi rank

Die Braak taxi rank located on Blom Street

Figure 3.5: Blom Street taxi facility

Informal taxi rank at Stelmark shopping centre (Pick 'n Pay parking area)

Figure 3.6: Stelmark taxi facility

The 2003 CWDM CPTR listed only 26 minibus taxi routes operating during the survey periods, even though the LTPS has 72 routes listed on their records for the Stellenbosch Municipality.

Taxi capacities and utilisation

The number of vehicles operating during various periods of a typical commuter day and the resulting capacities as obtained from the 2003 CPTR for Stellenbosch are listed in Table 3.3.

Table 3.3: Number of vehicles and capacities in 2003 CPTR

	Period of the day			Daily
	AM	Off-peak	PM	
Number of vehicles	124	47	116	287
Capacity	1860	705	1740	4305
Number of passengers	1407	396	1687	3490
% Utilisation	75.6%	56.2%	97.0%	81.1%

Source: CPTR 2003

The survey indicated that much higher utilisation levels are achieved during the PM peak period (97%). Overall, an 81% utilisation level is achieved throughout the day. The results indicate that approximately 20% of the vehicles in Stellenbosch are underutilised.

The activity per facility, in terms of daily vehicle and passenger departures, is presented in Table 3.4 (CWDM, 2003).

Table 3.4: Daily vehicle and passenger departures

	Weekday		Saturday	
Facility	Trips	Passengers	Trips	Passengers
Bergzicht	183	2502	198	2686
Blom inner	176	1502	190	2042
Blom outer	43	362	93	620
Kayamandi	69	498	116	1226
Kayamandi Bridge	10	96	33	474
Merriman	22	229	82	975
Stelmark	12	116	30	317
Total	515	5305	742	8340

Source: CPTR 2003

A total of 5 305 passengers were recorded on a typical commuter day, with more than 8 000 passengers observed on a Saturday. The results show that the Bergzicht taxi rank is the busiest rank in Stellenbosch with a total of 183 trips recorded from the rank and approximately 2 500 passengers observed on a normal commuter day. It is interesting to note that these volumes increase for all services on a Saturday. This indicates that minibus taxi services are well utilised on a Saturday, with an increase of more than 3 000 passengers recorded.

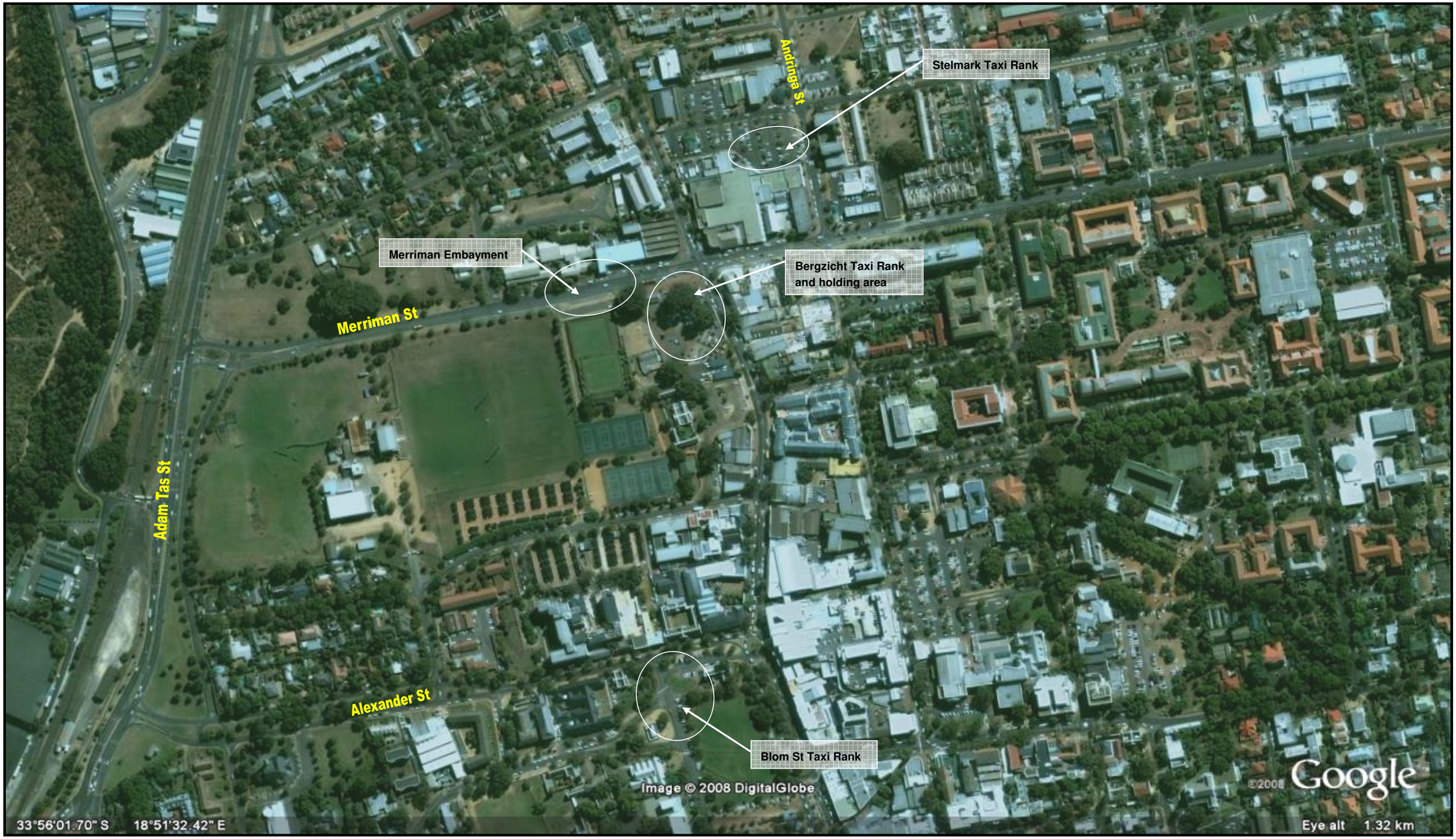
Certain routes from the 2003 CPTR were updated in 2004 as part of the OLS. Operational information for the higher volume routes, as contained in the 2004 OLS, and 2005 PTP, are compared in Table 3.5. It should be noted that the 2004 OLS and the 2005 PTP both quote the same data sources (i.e. surveys that were undertaken from November 2002 until March 2003).

Table 3.5: Operational information for 2004 and 2005

Route no	Route	Rank observed	Period	Source: 2004 OLS			Source:2005 PTP	
				Trips	Pax	No of vehicles observed	Trips	Pax
676, 677	Stellenbosch - Kayamandi	Bergzight	AM	2	29	25	8	121
			PM	17	242		2	28
			Day	50	668		28	378
656 - 661	Stellenbosch - Idasvalley	Bergzight	AM	3	43	11	3	44
			PM	17	252		17	252
			Day	52	734		51	714
665, 666	Stellenbosch - Cloetesville	Bergzight	AM	5	72	18	4	57
			PM	22	334		19	281
			Day	81	1100		78	1055
668	Stellenbosch - Kylemore	Blom Street Outer	AM	2	17	14	0	0
			PM	7	150		0	0
			Day	10	464		0	0
670, 671	Stellenbosch - Jamestown	Blom Street Outer	AM	12	165	20	10	135
			PM	6	72		6	74
			Day	57	618		43	466
669	Stellenbosch - Somerset West	Blom Street Outer	AM	10	145	13	9	131
			PM	4	63		4	63
			Day	32	420		42	546

The results of the surveys show that the Cloetesville route has the biggest demand, with more than 1 000 passengers recorded for the whole day. The comparison shows slight differences between the operational data, per route, even though they are based on the same data source. The 2005 PTP indicates no passengers, or trips, recorded on the Stellenbosch – Kylemore route, whereas the OLS data shows a total of 464 passengers observed on the 10 trips undertaken on the survey day. The conclusion, that can be drawn from Table 3.4 is, that the underlying assumptions that inform the CPTR summaries contained in the 2004 OLS and the 2005 PTP are not clear.

Figure 3.7: Location of taxi rank facilities



Source: Google Earth

ON-BOARD SURVEY METHODOLOGY AND APPROACH

4.1 Introduction to Survey Approach

Efficient and detailed planning is essential before undertaking any survey. The methodology should follow a series of logical steps, which progress toward obtaining results based on the survey objectives. The components (steps) of a typical survey are listed below. The issues that are addressed in each step is provided in Annexure C (Richardson, 1995):

1. Preliminary Planning,
2. Selection of Survey Methodology,
3. Sample Design,
4. Survey Instrument Design,
5. Pilot Survey(s),
6. Execution of Surveys,
7. Data Capture,
8. Data Analysis,
9. Presentation of results, and
10. Tidying up.

In most cases the decision based on which method to use, is a trade-off between costs, quality of survey and client needs. Usually, within a fixed budget, the quality of the survey will automatically control the quantity of data which can be collected. There are two alternative views to this approach, a survey can be designed to collect a greater quantity of low quality data or it can collect a limited amount of higher quality data for a given budget (Richardson, 1995).

4.2 Overview of On-board Survey Process

The preliminary planning stage of this survey included determining the survey objectives, as part of the tourism project, and an investigation into the survey instruments available to undertake the data collection of passenger volumes on key minibus taxi routes in Stellenbosch. Based on the

investigation, it was decided to use GPS technology, due to the Geographic Information System (GIS) format of the results required. GPS equipment was incorporated, to be able to geo-code boarding and alighting points along the route systems. As this was the first time a survey of this nature was conducted, it was necessary to survey **all** taxis on the routes identified, to fully understand the demand on these services. It is the view of the author that the existing 2003 CPTR data was outdated and did not provide all the information required to design then Tourist service. Therefore, it was necessary to survey a 100% sample on the services.

The survey was undertaken as an on-board taxi survey and captured both boarding and alighting and passenger volumes along the route. The methodology of the survey enabled the collection of the following pieces of information:

- Administrative information:
    - Number of taxis per route,
    - Contact details of owners and drivers, and
    - Registration numbers of taxi vehicles for surveyed routes.
- Passenger information:
    - Total daily, hourly, peak and off-peak volumes,
    - Boardings and alightings, and
    - Origin-destination patterns for individual passengers.
- Route information:
    - Actual route travelled per individual taxis,
    - Deviations from OLB registered routes,
    - Travel times,
    - Existing capacity and utilisation on routes per time of day, and
    - Key boarding and alighting locations.

The flow diagram presented in Figure 4.1 shows the survey methodology and the interaction between components for the process. The method for the survey is described in more detail in Section 4.3, but it included the following steps, as shown in Figure 4.1:

- Liaison with the taxi industry to obtain the required buy-in and necessary taxi route and vehicle information.
- Planning and designing the survey:
    - Designing the survey forms,
    - Obtaining the suitable GPS units, and
    - Undertaking a pilot to refine the survey method.
- Collecting the data:
    - Training the surveyors, and
    - Undertaking surveys per route.
- Capturing the data:
    - Preparing suitable capture sheet templates,
    - Capturing survey forms in excel, and
    - Downloading the corresponding spatial information from the GPS units per route.
- Analysis and reporting:
    - Preparing summaries of various items of taxi information,
    - Preparing tables and graphs, and
    - Reporting results.

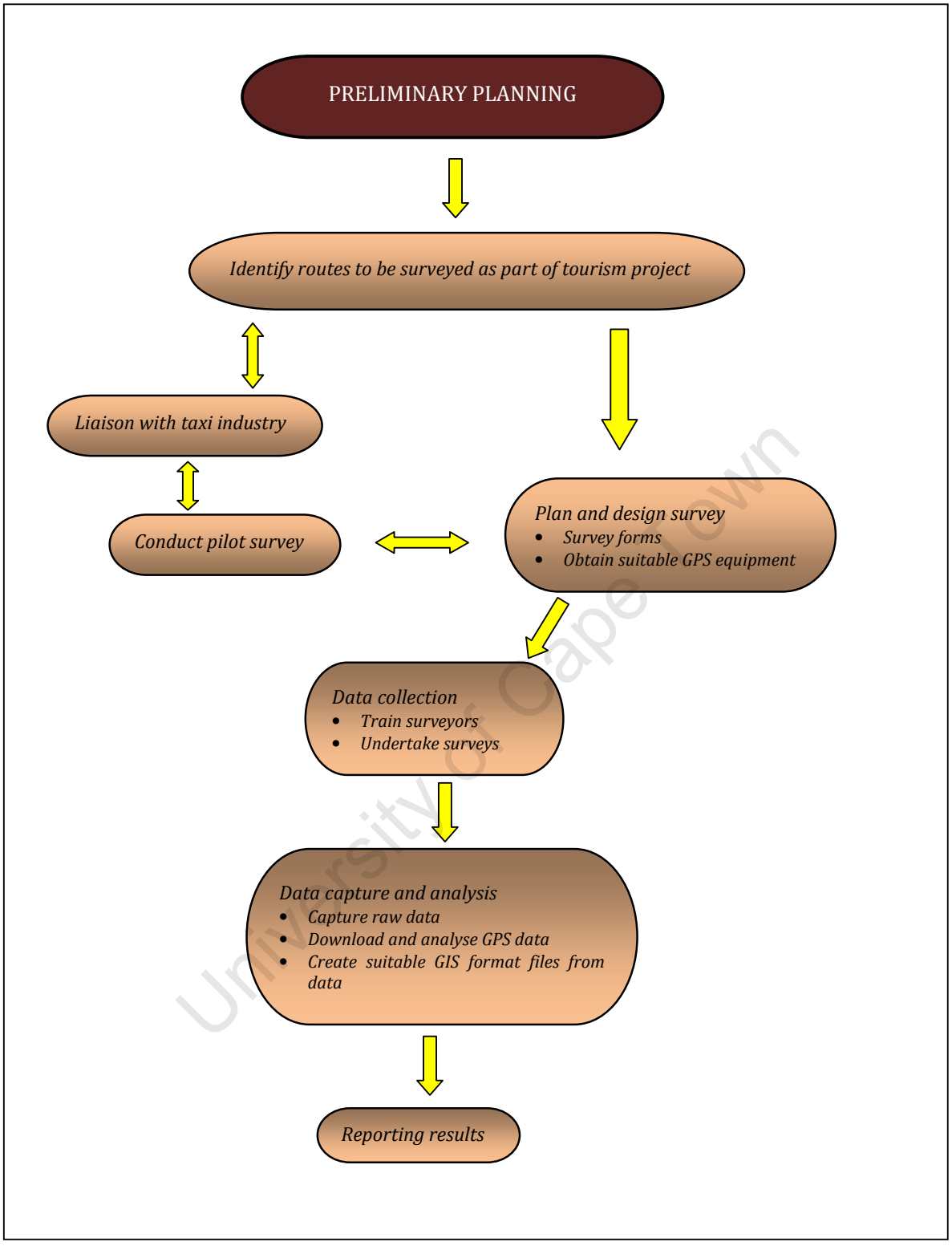


Figure 4.1: Survey methodology flow diagram

The methodology used for the on-board survey, addresses the "gaps" experienced with CPTR data collection and analysis. A comparison of the CPTR and on-board survey data collection methodology is provided in Table 4.1, to indicate the difference between the methodologies and how some of the shortcomings of the CPTR data collection are addressed by the on-board survey.

Table 4.1: CPTR and on-board survey data collection methodology

CURRENT CPTR DATA COLLECTION METHODOLOGY	ON-BOARD SURVEY DATA COLLECTION METHODOLOGY
• Passenger volumes are recorded via rank surveys	• Passenger volumes are recorded via on-board taxi surveys
• Vehicle registration numbers are recorded at the ranks	• Vehicle registration numbers are recorded by the surveyor on-board the specific taxi
• Actual routes travelled are not recorded. Route descriptions are collected via discussions with operators and the OLB, but are not verified	• GPS units track the routes for the whole day and routes are downloaded at the end of the survey day and can be verified against the OLB route descriptions
• Passengers boarding and alighting on-route is not recorded	• All passenger boardings and alightings are recorded, with the time of movement
• Data is analysed from rank survey information only and the CPTR tables are developed from this	• Data is analysed based on the whole day on-board survey and includes passenger movements on-route
• Information on high boarding and alighting locations along the routes are not surveyed or picked up	• High boarding and alighting locations can easily be determined
• Vehicle trips are assumed based on vehicle trips arriving and departing from the ranks	• Actual vehicle trip numbers per vehicle is known, whether it arrives and departs from the rank or not

4.2 Liaison with local taxi associations

It was apparent, at the start of planning the surveys, that the success of the on-board taxi survey was dependant on the co-operation and buy-in of the taxi associations within Stellenbosch. Various meetings and workshops were held with the regional and local taxi associations to discuss the role of the taxi industry within the project, and the level of collaboration required for undertaking the on-board survey data collection process.

The first meeting was held with representatives from the Boland Regional Taxi Council and the local taxi associations, i.e. Stellenbosch Taxi Association (STA) and Kayamandi Taxi Association (KTA) in April 2008. Separate follow up meetings were then held with STA and KTA during July 2008 to obtain detailed information to assist in the data collection process.

Information included among others:

- An overview of the taxi operations in the area (legal and illegal operations),
- Current taxi routes, number of vehicles per route and rank locations,
- Taxi owner and vehicle registration details,
- Permit information,
- Current taxi fares, and
- Contacts for local employment opportunities for survey staff.

The consultation with the taxi associations proved a highly beneficial and essential part of the survey and extremely good co-operation was received.

4.3 Planning and Designing the Survey

4.3.1 Survey form

A suitable survey form was designed in order to obtain the required information. A sample of the survey form is shown in Figure 4.2.

Date and day: _____

GPS Unit Name / No: _____ Surveyor name: _____

Sheet _____ of _____ Route ID and description: _____

Vehicle Registration: _____ Trip No: _____

Start / Departure Time: _____ End / Arrival Time: _____

Departure Point: _____ Arrival Point: _____

Trip Direction: _____

Waypoint No.	Ticket No. boarding/getting on	Ticket No. alighting/getting off

Figure 4.2: Sample blank survey form

The first section of the form contains the required base information to enable the identification of the route and taxi. This includes the following:

- Date (that the survey was carried out),
- Surveyor name,
- Route name,
- GPS unit number (each GPS was tagged to match up capture sheets with GPS information downloaded),
- Trip number (each direction was numbered as a separate trip),
- Vehicle registration number,
- Time and location of departure and arrival points, and
- Trip direction.

The second part of the survey form was provided for the capturing. The passenger information collected was organised by waypoint number. These waypoint numbers are generated by the GPS unit and allows for the GPS longitude-latitude, time and duration of the stop information to be later correlated with the passenger information captured. The form provides for the surveyor to record the corresponding passenger ticket numbers boarding and alighting per waypoint. One trip is defined as a trip between origin and destination, for example from Stellenbosch to Kayamandi is recorded as one trip and from Kayamandi back to Stellenbosch is another trip.

4.3.2 GPS Equipment

The GPS unit was the most complex and expensive piece of equipment, involved in the on-board survey. The survey was based on the premise that each vehicle on each route will have a surveyor with a GPS unit, to track its passenger and route information.

Difficulty was, however, experienced with obtaining the right number of GPS units particularly for the higher volume routes. There are various suppliers of GPS equipment, providing a range of

models, each with their own functions. For the purpose of this survey it was preferable to use a hand-held GPS unit, which allows recording of waypoints, as well as tracking the routes. In addition, software for downloading the waypoints and tracks was required. This type of GPS unit is costly to purchase and there are no organisations locally that rent these types of units. Table 4.2 provides a list of GPS units available in South Africa indicating the availability and approximate cost of each model.

In order to complete a full survey rather than just a sample of taxis per route, the car GPS navigators was utilised, which was available for rent from car rental and cellphone rental companies. However, this GPS model functions more as a navigator guide and is not as simple to record and download the required information. When compared to the hand-held GPS unit, the car unit differs by the following features:

- it does not record or track the route for downloading at the end of the survey,
- it does not create waypoints automatically, points have to be manually inserted as "my locations" and numbers have to be assigned to them,
- it has a built in battery which can only be charged via the car cigarette lighter and via a special desk docking station.

Table 4.2: GPS Manufacturers and model types

Product Manufacturer	Model types and functions	Approximate cost (2008)
Garmin eTrex	• Both car navigation and handheld units available • Most common GPS product in South Africa • Includes own mapping software • Records both routes and waypoints and can be downloaded into GIS format • Average download memory of 64MB	R3 200
Tom Tom	• Does not have handheld model • Does not record routes	R4 500
Magellan Triton	• Most models does not include mapping software • Records both routes and waypoints and can be downloaded into GIS format • Top of the range model includes digital camera • First handheld to feature 1:24,000 high-resolution map details • Built-in electronic compass	R5 000

Audiovox	• Does not have handheld model • Does not record routes	R2 200
Lowrance iFinder	• Fairly new product in South Africa and not easily available in Cape Town, authorised supplier situated at Durban port, South Africa. • Mainly supplies marine industry • Most models not compatible with computers • Does not include mapping software • Average download memory of 128MB	Not available

Source: Cabela's online sales (www.cabelas.com)

It is preferable to use the same unit for all surveyors as it makes training easier, as well as being able to interchange units between surveyors. The use of one type of GPS unit also means that one type of software is required for downloading the waypoints on completion of the survey.

After investigating the available GPS equipment from various suppliers it was found that the *Garmin* hand-held unit and the accompanying software was the most user-friendly. The same software could also be used for the various models of *Garmin* units. The GPS equipment used in this survey is listed in Table 4.3.

It should be noted that GPS units can also be used to track travel over a period of time, i.e. multi-days, thus allowing planners and practioners to be able to capture variability in travel patterns and demand. For the purposes of this study, however, it was not required to identify travel patterns and one day counts were adequate to identify a typical commuter day travel pattern and passenger demand per route.

Table 4.3: List of GPS equipment

GPS unit model	Owner	Number of units
Garmin eTrex Legend HCX (hand-held)	Pendulum Consulting	6
Garmin GPSmap 76CSx (hand-held)	Cape Winelands District Municipality	1
Garmin GPSmap 60CSx (hand-held)	ITS Engineers	1
Garmin GPSmap 60CSx (hand-held)	UCT – Geomatics Department	2
Garmin Quest 2 (car unit)	UCT – Department of Civil Engineering	1
Garmin Nuvi 200W (car unit)	Vodafone Cellucity (rented)	19

The Garmin *Trip and Waypoint Manager* and *MapSource* software was used to download the routes and waypoints.

4.3.3 Pilot survey

A pilot survey is a small-scale trial, prior to the main survey that tests the methodology and approach of the survey. A pilot survey was undertaken as part of the planning process. Since this survey was the first of its kind, it was necessary to test the methodology from data collection, capturing to ensuring that the right type of analysis would be achieved. The pilot survey also allowed for the testing of the GPS equipment and the data collection process. Various modifications were undertaken to the methodology as a result of the pilot which ensured that the on-board taxi survey method was sound and could be duplicated on a larger scale as part of the broader survey.

A pilot survey was undertaken during the Friday PM peak period, in August 2008, on one of the taxis in Stellenbosch to test the equipment and the data collection process. The pilot survey had to prove that one surveyor was able to carry out all data capturing - the passenger ticket number and recording and capturing of the waypoints at the same time. The outcome of the pilot survey allowed for the methodology to be tweaked and confirmed that the GPS equipment, the capture sheet and the survey technique was sound and would generate the required output from the survey and that the survey form did not need any modification.

4.4 Data Collection

The data collection step involves the surveyor on board a specific taxi, on a particular route, for the duration of the day. The surveyor records the geo information for each boarding and alighting passenger. The data collection exercise is described in greater detail below.

4.4.1 Surveyor training

The survey technique is fairly complex and requires the surveyor to undertake a number of activities simultaneously, i.e. hand out the ticket numbers to passengers, keep track of the people getting on and off the vehicle and marking a waypoint on the GPS, while accurately recording all

information. This requires that the surveyors are familiar and fully knowledgeable of the process and know how to use the GPS equipment.

The training of surveyors took place during three separate training sessions, due the variations in the GPS equipment. After being briefed on the project and the data collection process, each surveyor undertook a pilot survey on one taxi during the PM peak period, to ensure that the data collection was understood correctly. After each pilot survey a debriefing session was held to discuss any problems that were encountered during the survey, and to check whether the survey form was completed correctly.

4.4.2 Surveys Undertaken

The survey involved one surveyor sitting on a particular taxi with a GPS unit for the whole day and recording passenger volumes and locations where passengers are boarding and alighting. The GPS unit is used for recording the locations by means of marking waypoints and recording the waypoint number on the survey form. The hand-held GPS units also tracks and records the route travelled by the taxi for the whole day and stores it onto the unit memory for downloading at the end of the survey. When a passenger/s boards the taxi, the surveyor gives a ticket number to the passenger and records the number on the survey form. The location of the boarding point is marked on the GPS unit and the waypoint number is recorded on the survey form, as shown in Figure 4.3. When the passenger/s disembarks the taxi, they hand the ticket back to the surveyor who records the number on the survey form, as well as the corresponding waypoint number at the alighting location. When the taxi has reached its destination, the point is recorded on the GPS unit and survey form and a new survey form is created as part of a new trip for the return journey. Through this method the passenger origin and destination patterns can be observed, as well as the total number of trips a particular taxi completes per day. By recording the departure and arrival times, the average trip duration is also known for a particular route. Refer to Annexure D for an example of the completed survey forms.

Date and day:	**13.10.2008**		
GPS Unit Name / No:	**5**	Surveyor name:	**Francis**
Sheet **1** of **4**	Route ID and description:	**Somerset West KTA**	
Vehicle Registration:	**CL26150**	Trip No:	**1**
Start / Departure Time:	**06H56**	End / Arrival Time:	**07H26**
Departure Point:	**Kayamandi**	Arrival Point:	**Somerset West**
Trip Direction:	**Somerset West**		

Waypoint No.	Ticket No. boarding/getting on	Ticket No. alighting/getting off
001	1-17	
002		6,12,11,5
003		1,4,13,14
004		2
005		3,15,17,7
006		10
007		8
008		16,9

Figure 4.3: Example of captured survey form

4.5 Downloading, capturing and analysis

4.5.1 Downloading method

As mentioned in the Section 4.3.2, the Garmin *Trip and Waypoint Manager* and *MapSource* software was used to download the routes and waypoints. Figure 4.4 indicates an example of the MapSource software download screen, with a map showing the routes and waypoints after it has been downloaded from the GPS unit. The software allows the routes and waypoints to be saved in a gpx exchange format, which can be opened in Microsoft Excel. The excel sheet contains the following information for each waypoint:

- the waypoint number,
- the latitude, longitude and elevation (not needed for this survey but provided by the GPS software), and
- date and time

The excel sheet also allows the routes and waypoints to be downloaded into TransCAD, for planning purposes. Another function in MapSource enables the routes and waypoints to be viewed in Google Earth where the routes can be generated as *shape files*, by saving it as a *kml* file in Google Earth.

4.5.2 Capturing

A team of three data capturers digitised the survey forms into Microsoft Excel, as shown in Figure 4.5. The waypoint data was exported into a spreadsheet format in Microsoft Excel, as discussed in Section 4.5.1. The two spreadsheets were combined in a summary data capture sheet showing the passenger ticket/ID numbers together with their boarding and alighting points and the corresponding times of these points. The associated latitude and longitude coordinates were also included in the summary sheet, as shown in Figure 4.6. These summary sheets were generated for each vehicle per route.

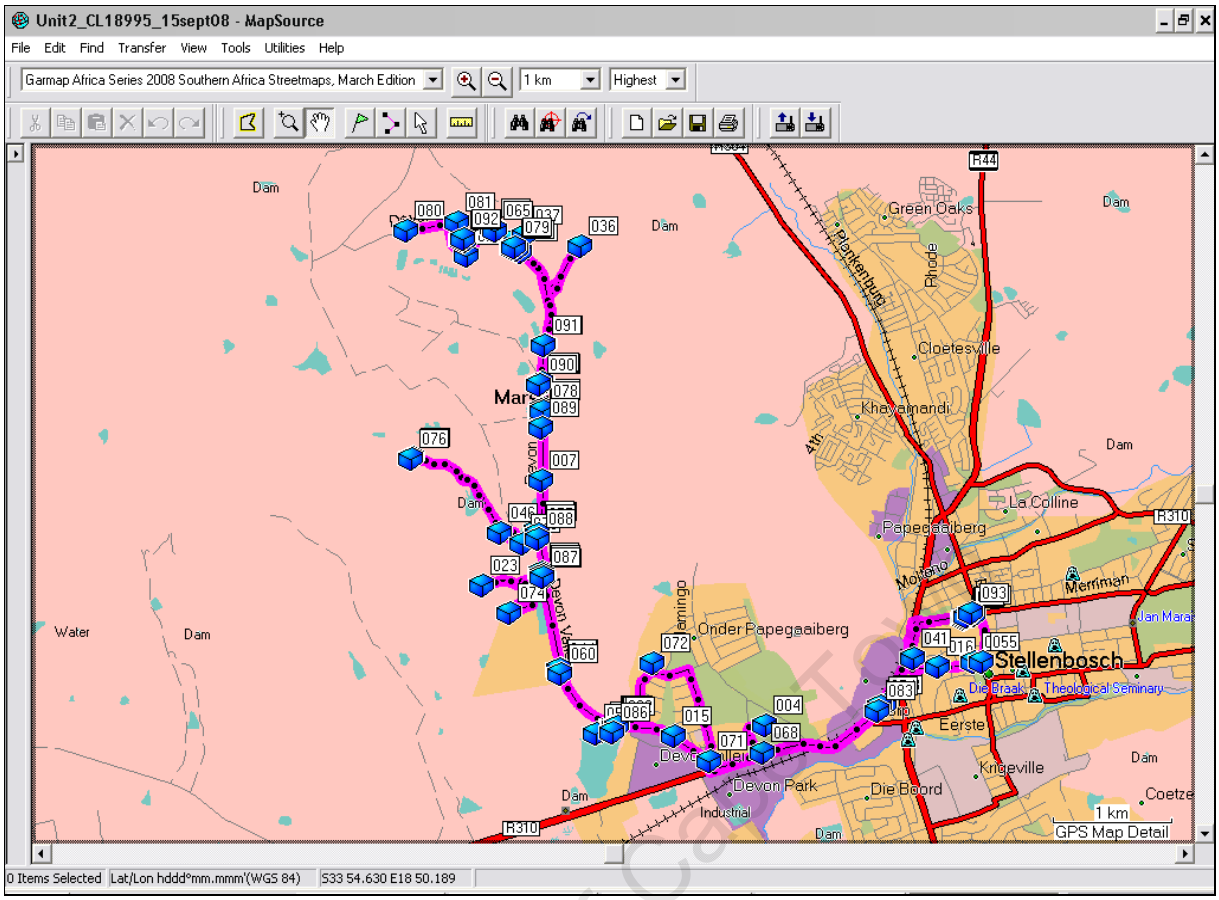


Figure 4.4: Example of GPS Unit Download in MapSource

Route	Trip #	Direction	Passenger ID	Boarding point	Alighting point
11b	1	To Somerset West	1	001	003
11b	1	To Somerset West	2	001	004
11b	1	To Somerset West	3	001	005
11b	1	To Somerset West	4	001	003

Figure 4.5: Example of Capture Sheet

Waypoint no	Date and Time	Latitude	Longitude	Elevation	Boarding	Alighting
001	13-OCT-08 6:56:20	-33.9187078	18.8511785	117.6461182	17	0
002	13-OCT-08 7:04:08	-33.9596109	18.8531773	120.5300293	0	4
003	13-OCT-08 7:05:48	-33.9634572	18.8503661	142.8806152	0	4
004	13-OCT-08 7:08:21	-33.9693971	18.8443484	107.0716553	0	1

Figure 4.6: Example of GPS Data Output Sheet

4.5.3 Analysis

The data collection process involved the collection of passenger and route data per vehicle. The capturing and downloading of this data was also done per vehicle. In most cases, the taxi routes that were surveyed have three or more taxis servicing a particular route, which meant that there was an overlap of the routes and waypoints that were downloaded. When combining the data for all vehicles on a particular route, there are obvious locations that are common boarding and alighting points, due to the high number of waypoints in that area. Another round of data capturing and analysis included the consolidation of these points to indicate the major boarding and alighting locations. In urban areas waypoints within 200m of these locations were also included as part of the major boarding and alighting points and similar within 500m in the rural areas.

4.5.4 Problems encountered and lessons learnt

Preplanning

Good communication with the taxi industry is imperative for the success of the survey. Surveyors encountered very little difficulties in executing the fieldwork, due to the early interaction and co-operation with the taxi associations.

The Kayamandi Taxi Association is essentially informal in structure and operationally unregulated. The services in this area are mainly income driven and, hence, operate on a demand basis. As such, there is very little consistency in the methods of operation along these routes. For example, operations change from time period to time period even within the peaks and then change again to another system during off-peak periods. All changes in routes or operations on the survey day were recorded by the surveyors.

In most cases for both Stellenbosch and Kayamandi taxi operators the first trip provided by taxis in the morning serve as a feeder service from the residential areas to the rank or to the main destination. This meant that taxi drivers would leave from their homes in the morning and serve the residential areas directly before proceeding to the taxi rank. If surveyors met up with the taxis at the taxi ranks the information of this first trip enroute from the taxi driver's home was lost.

Some taxis provide a feeder service from Stellenbosch Station to the town in the morning before they start at the ranks. It was, therefore, necessary to have all the correct contact details of the taxi owners and/or drivers to contact them beforehand to confirm the time and location of their first boarding point on the survey day and to identify where and when the surveyor can board the taxi. Poor communication between the taxi owner and driver led to some problems, where the taxi driver was unaware of the survey, when contacted to confirm the boarding location. This was, however, quickly resolved once the owner was made aware of this.

Even after a detailed pre-planning meeting and discussions with the taxi owners to confirm the routing and the vehicle registration details, the surveyors were occasionally confronted with a completely different method of operation on the survey day, this was especially experienced with the Kayamandi Taxi Association operators. For example, initially the Bellville and Spier routes were included as part of the survey. On the survey day, the Bellville route survey was aborted at 11am, due to a lack of demand along the route. It was observed that this route was only provided if and when required, based on passenger demand. After discussions with the rank marshal it was indicated that this route was more frequent on a Sunday. Similarly, it was observed that taxis from Khayelitsha would provide the service to Spier in Stellenbosch. Other problems encountered included the taxis swapping between routes, due to low passenger demand on it's dedicated route and/or high demand and low supply on another route, due to a taxi having broken down or in for repairs. These movements were all recorded by the surveyor.

At the meetings with the taxi associations it was agreed that the surveyor would pay the taxi driver for the seat taken up on the taxi, at the end of the survey, based on the number of trips that were completed on that day. In order to ensure that the surveyor had sufficient money for the taxi fares, it was necessary to confirm the taxi fare and average number of trips per route beforehand. As the exact number of trips cannot be confirmed with complete accuracy, the total cost for the surveyor's all day seat on the taxi could only be calculated at the end of the day. Extra funds had to be kept ready, to be able to make the required payments to the drivers or the owners. The average cost for taxi fares, per surveyor, amounted to R210 per day, on the more busier routes.

Survey and data capturing

As the surveyors were not familiar with the area, they would often not know when the taxi has reached its destination or when it had turned around. Therefore, it was essential that each surveyor undertook a pilot survey to identify any possible problem or uncertainties in the data collection process.

Furthermore, there are a number of rank facilities and common stops in Stellenbosch, which are known by various names, for example the rank in Blom Street is also known as "*Die Braak*" by the taxi drivers. This resulted in the surveyors recording different names for the same location, which prolonged the data capturing and analysis in order for the results to be consistent.

While capturing the data for the Kayamandi to Somerset West route, it was found that the settings on one of the GPS units was not recording the time. This meant that the actual time the waypoint was created was not recorded on the unit. Since this particular vehicle only did 4 trips on the survey day, it was deemed not necessary to redo the survey, as the data collected on the rest of the 8 vehicles was recorded correctly. For analysis purposes, the time for each waypoint was estimated using the start and end time of the trip, which is recorded by the surveyor on the survey sheet, and the distance between the waypoints.

Some common problems that can be encountered when using GPS technology include loss of signal, duration of battery power, lengthy time required for the GPS unit to connect to the satellites at start up and the high costs involved in purchasing and maintaining the units. The problem of signal loss and strength was not experienced in Stellenbosch, as the area is relatively flat, with no high rise buildings in our study area. On all survey days the weather was clear, with no cloud cover, which could potentially affect the signal strength. As most of the units were rented or borrowed, the costs were kept to a minimum.

SURVEY ANALYSIS AND FINDINGS

5.1 System Overview

According to the GIS information received from Stellenbosch Municipality in 2007 there are currently only 16 (legal) taxi routes on their database (refer to Figure 5.1). Of the 16 routes a total of 10 routes were surveyed as part of this investigation.

Four local commuter services are provided to surrounding residential neighbourhoods or communities, which include:

- Cloetesville,
- Idas Valley,
- Kayamandi,
- Jamestown, and
- Somerset West.

Farm services to outlying areas include:

- Jonkershoek Nature Reserve,
- Vlottenburg and Vlaeberg farms,
- Simonsig and Department of Agricultural in Elsenberg region,
- Devonvale and Bellevue in Koelenhof region, and
- JC Le Roux and other farms in Devon Valley region.

Table 5.1 shows the respective routes and dates the on-board taxi survey was undertaken.

Regional connections, which were not included in the study area, were omitted from this survey. Six routes were excluded from the survey, i.e:

- Stellenbosch to Pniel,
- Stellenbosch to Kylemore,
- Franschhoek to Groendal and Paarl,

- Franschoek to farms,
- Pniel to Paarl, and
- Kayamandi to Bellville.

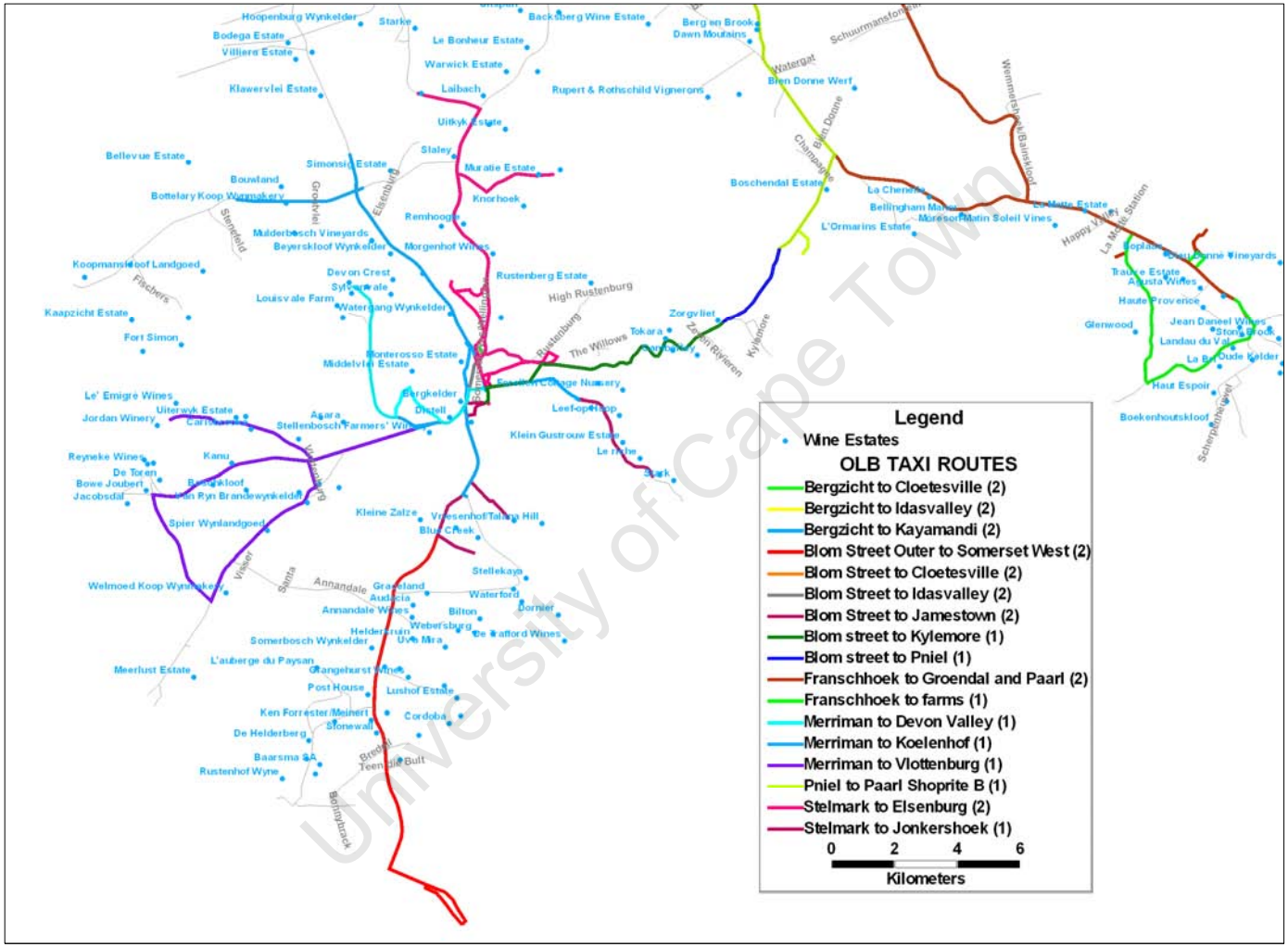
Pniel and Franschoek were excluded from the survey as it was found, from the visitor's survey, that most people do not visit Franschoek on the same day as Stellenbosch. It was then decided that this portion of the service could be designed as a stand-alone public transport service for implementation in the future. Klapmuts is served by Paarl taxi associations and was excluded from this survey as well.

Initially the Kayamandi to Bellville and Kayamandi to Spier (illegal route) routes were to be included in the survey. However, it was found that these routes were carried out by outside taxi associations. These routes were, therefore, not surveyed either.

Table 5.1: List of Taxi Routes Surveyed in Stellenbosch Municipal Area

Route No.	OLB Route Code	Route Name	Surveyed as Part of this study	Date of Survey
1	665	Cloetesville	✓	2008/10/20
2	664	Devon Valley	✓	2008/09/15
3	673,674	Elsenberg	✓	2008/09/15
4	656	Idas Valley	✓	2008/10/21
5	670,671	Jamestown	✓	2008/09/16
6	675	Jonkershoek	✓	2008/09/15
7	676,677	Kayamandi/Bergzicht	✓	2008/10/23
8	662	Koelenhof	✓	2008/09/18
9a	503	Somerset West - STA	✓	2008/09/18
9b	669	Somerset West - KTA	✓	2008/10/13
10	663	Vlottenberg	✓	2008/09/15
11	No permit	Bellville	×	
12	668	Kylemore	×	
13	668	Pniel – Kylemore	×	
14	No permit	Spier	×	
15	873	Franschhoek to farms	×	
16	873	Franschhoek to Groendal and Paarl	×	
17	No permit	Pniel to Paarl	×	
18	661	Idas Valley (from Blom Street)	×	
19	666	Cloetesville (from Blom Street)	×	

Figure 5.1: Overview Map of Taxi Routes in Stellenbosch



Source: Pendulum Consulting

5.2 Categories of Information Obtained

The following information can be obtained or analysed from the on-board taxi surveys:

- Total passengers boarding per taxi per route,
- Passenger travel times,
- Vehicle travel times,
- High boarding and alighting locations whether at ranks or on-route,
- Passenger origin and destination pairs,
- Geo-coded information on all boarding and alighting points,
- Exact routes travelled per taxi and how and when taxis deviate from OLB route,
- Peak and off-peak vehicle utilisation,
- Total time taxis are not utilised i.e. ranking,
- Total number of taxis on a particular route and taxi operating hours,
- Total number of trips per vehicle, and
- Vehicle and rank capacities.

The on-board taxi results obtained for the Devon Valley route is used as an example to illustrate some of the recorded information, as indicated above. Annexure E provides the summary findings for all 10 routes surveyed.

5.2.1 Devon Valley route analysis

Devon Valley forms part of the Stellenbosch wine route. It lies to the west and alongside the town of Stellenbosch. The valley has a number of popular wine estates which includes Middelvlei, Louisvale, Clos Malverne, Devon Hill, Hidden Valley and J.C. le Roux.

A total of 286 passengers were recorded on the 2 taxis currently servicing this route. During the peak periods, the average travel time is approximately 30 minutes roundtrip with 20 minutes towards Devon Valley and 10 minutes towards Stellenbosch town centre. Currently this route departs from the Merriman taxi rank in Merriman Street.

Table 5.2 summarises the information for the Devon Valley route.

Table 5.2: Summary information for Devon Valley

Route Number	Route 2	**OLB Code**	664
Route Name	Devon Valley	**Taxi Association**	STA
Location of taxi departure point	Merriman Taxi Rank	**Route Distance**	11km
No. of vehicles	2	**Estimated route capacity per hour**	56
Vehicle Registration Numbers	CL 18995 *(12 trips recorded)* CL 14561 *(14 trips recorded)*		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Devon Valley**
	30 min	**20 min**	**10 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	286	70	59

Figure 5.2 shows an aerial photo with the routes travelled by the taxis on the survey day, as well as highlighting the locations where 5 or more passengers were recorded boarding or alighting.

The graph in Figure 5.3 shows the available capacity on the Devon Valley route and was calculated by assuming a capacity of 15 passengers per vehicle. The capacity is shown for both vehicles on this route and based on the travel time provided by the on-board surveys, it was assumed that each vehicle could complete one roundtrip per hour. Significant differences between the available capacity between Stellenbosch and Devon Valley are observed from the graph. Throughout the day, more than 40 seats are available in the Stellenbosch direction, with 20 seats available in the Devon Valley direction. The observation that can be made from these results is that there is an oversupply of vehicles on this route based on the low passenger demand and the available capacity throughout the day.

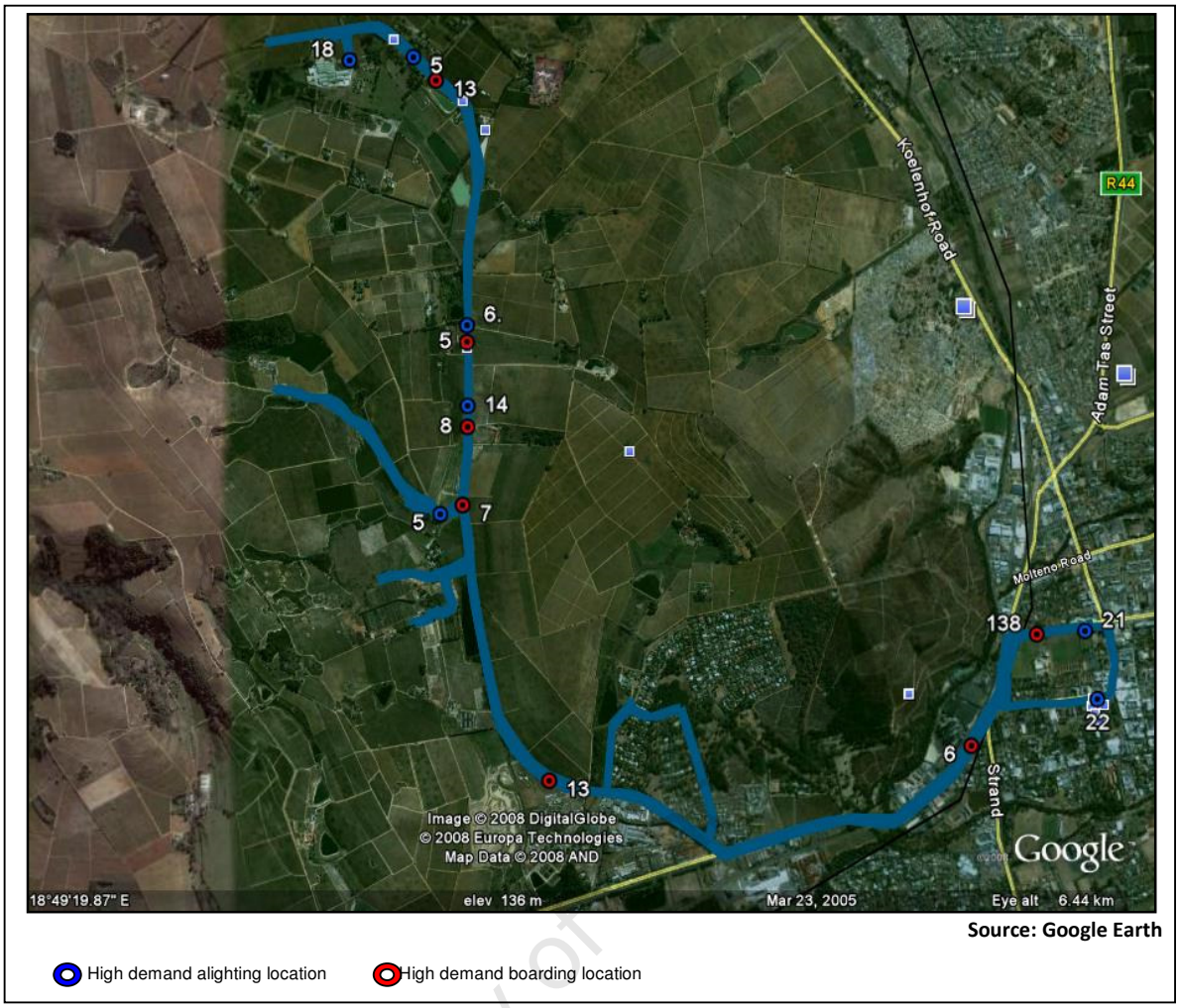


Figure 5.2: Aerial photo of Devon Valley with high boarding and alighting points

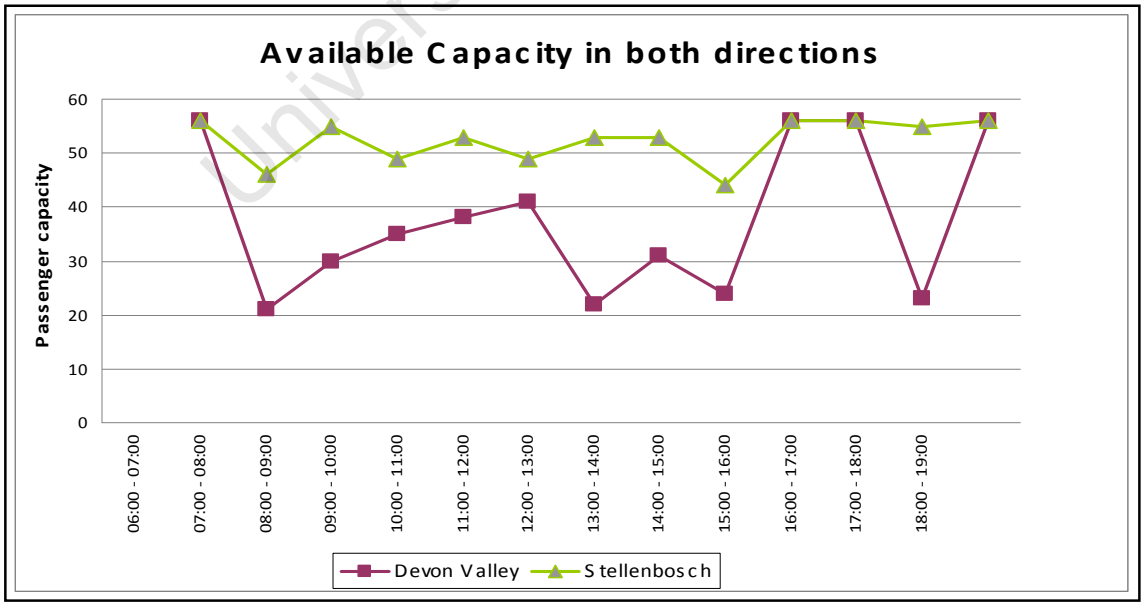


Figure 5.3: Available capacity on Devon Valley Route *(assumes 2 vehicles, 1 roundtrip/hr)*

5.3 Passenger Demand Analysis

Table 5.3 summarises the total passenger demand per route, as observed during the on-board taxi survey. The AM (6am-9am) and PM (3pm-6pm) peak period passenger demand is also provided in the table.

Table 5.3: Total passenger demand - 2008

Route	Rank observed	Period	2008 Pax
Cloetesville	Bergzight	AM	936
		PM	492
		Day	**2 043**
Devon Valley	Merriman	AM	70
		PM	85
		Day	**286**
Elsenberg	Stelmark	AM	40
		PM	47
		Day	**220**
Idas Valley	Bergzight	AM	579
		PM	222
		Day	**1 243**
Jamestown	Blom St	AM	480
		PM	162
		Day	**995**
Jonkershoek	Stelmark	AM	0
		PM	48
		Day	**99**
Kayamandi	Bergzight	AM	442
		PM	221
		Day	**857**
Koelenhof	Merriman	AM	14
		PM	0
		Day	**47**
Somerset West	Blom St	AM	127
		PM	109
		Day	**362**
Somerset West	Kayamandi	AM	258
		PM	136
		Day	**451**
Vlottenberg	Merriman	AM	43
		PM	23
		Day	**165**

The data indicates that the Bergzicht taxi rank has the highest passenger volumes, with Cloetesville currently being the busiest route in Stellenbosch. It is observed that there are no passengers travelling to Jonkershoek in the morning peak. Although Jonkershoek has two registered taxis providing this service, only one vehicle operates per day, with an agreement between the two owners that they would operate every alternate day.

During the survey process taxi operators indicated that certain vehicles provide private service, such as contracted worker transport and scholar travel. These operations mainly occur during off-peak periods or after-hours and was not picked up during this survey.

All services surveyed operate during the weekday, largely between 6:00am and 6:00pm. As expected, there is a distinct peak-type nature on some of the services. This was experienced mainly on the commuter services from local residential areas. Services to outlying farm areas were less likely to peak during morning and evenings, but showed a more even demand throughout the day.

COMPARISON OF RESULTS

This chapter summarises the results of the on-board taxi survey and presents the findings of the comparison between the survey results and the 2003 CPTR results for Stellenbosch, which was updated in 2004 as part of the OLS. The following survey results were used for the comparison:

- Total weekday passenger demand per route,
- Passengers at ranks,
- Route comparison, and
- Total trips per rank.

6.1 Passenger Demand

Using a growth rate of 2% per annum, as estimated by the analysis undertaken by Zietsman (2007), the 2004 CPTR/OLS passenger volumes was projected to 2008 and compared to the results of the 2008 on-board survey. The on-board survey observed a total of 6 768 passengers through all the ranks, with the projected 2004 data indicating a total of 5 746 passengers in 2008. The comparison between the passenger demand analysis per route is shown Figure 6.1.

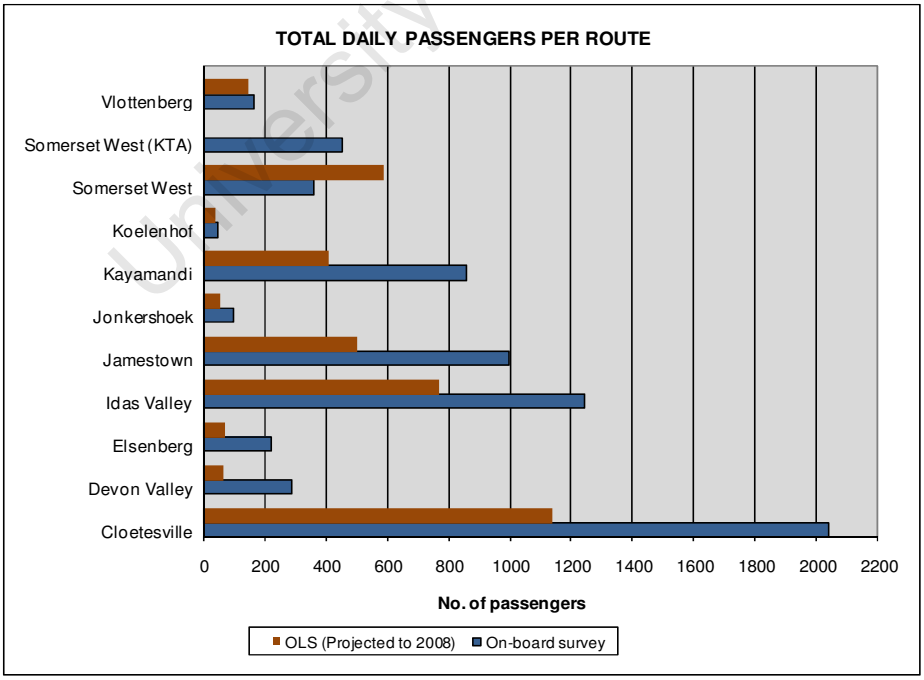


Figure 6.1: Comparison between CPTR and On-board survey results

The graph indicates that for all routes, except for Blom Street to Somerset West, the total *daily passenger boarding's have increased significantly* when compared to the projected 2008 OLS passenger information. Results from the 2008 on-board taxi surveys indicate a decrease in the passenger demand on the Blom Street to Somerset West route, however, subsequent to the CPTR surveys conducted in 2003 and 2004, a route from Kayamandi to Somerset West was introduced. The 2008 results recorded 362 passengers boarding from Blom Street and 451 boarding from Kayamandi. This can be interpreted as a total of 813 passengers travelling between Stellenbosch and Somerset West, whereas in the projected CPTR surveys only 591 passengers were observed on the Somerset West route.

6.2 Route Comparison

One of the main functions of the GPS unit is the ability to record the routes travelled by each vehicle for the duration of the survey. Once downloaded, the route was converted into a GIS format as explained in Section 4.5.1 and was compared to the route description as registered with the OLB. To illustrate this, the routes currently travelled by Devon Valley taxis (blue route) are compared to the registered OLB route (red route) in Figure 6.2.

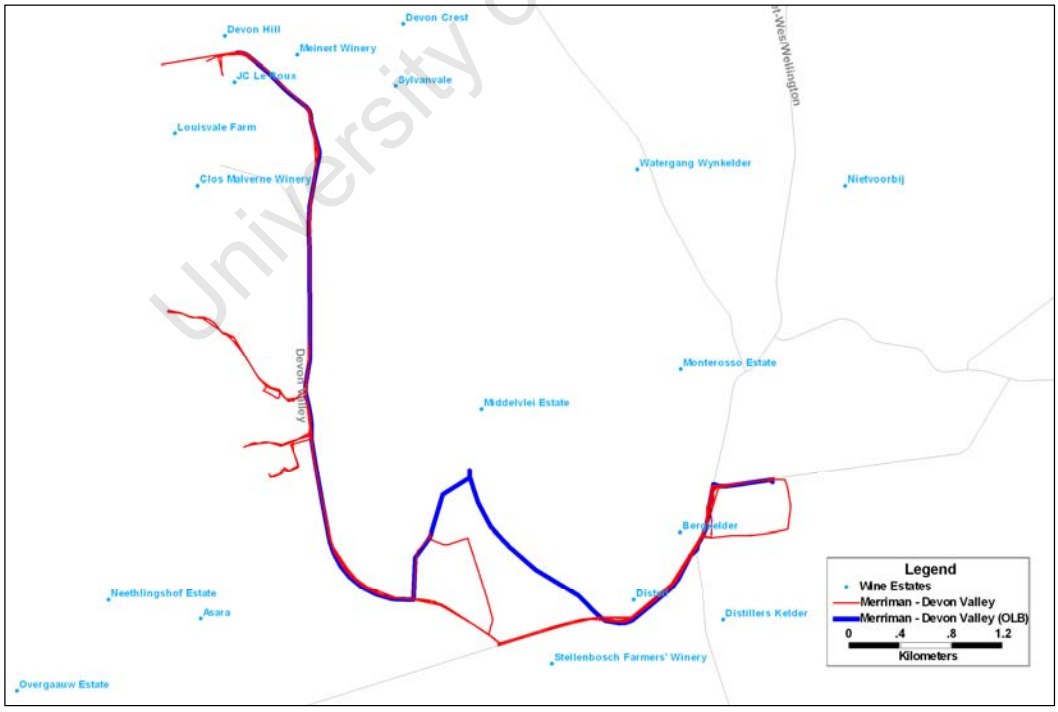


Figure 6.2: Comparison of current Devon Valley taxi service to registered OLB description

From the map it is observed that taxis are currently deviating from their registered routes. The on-board survey results for most of the routes indicated that the majority of taxis were not conforming to their permit requirements, which provides a detailed route description for each registered route.

6.3 Taxi Rank Analysis

A rank survey analysis, of the on-board survey results, was undertaken to identify the proportion of passengers that utilise the taxi rank, when compared to passengers boarding and alighting en-route. The results are provided in Table 6.1. The analysis was conducted by comparing the total daily passengers per route, with the passengers observed at the ranks. The percentage difference between the rank passenger boarding's and alighting's, and the total passengers on the route is shown in Table 6.1.

Table 6.1: On-board taxi survey rank analysis

2008 Rank analysis					
Route	**Rank**	**Total passengers**	**Rank passengers**		**% Difference between total passengers and rank counts**
			Boarding	**Alighting**	
Idas Valley	Bergzicht	1243	222	89	18%
Cloetesville	Bergzicht	2043	469	152	23%
Kayamandi	Bergzicht	857	352	90	41%
Koelenhof	Merriman	47	13	0	28%
Vlottenberg	Merriman	165	98	32	59%
Devon Valley	Merriman	286	150	44	52%
Somerset West (STA)	Blom Street	362	118	87	33%
Jamestown	Blom Street	995	409	261	41%
Elsenberg	Stelmark	220	111	8	50%
Jonkershoek	Stelmark	99	69	14	70%
Somerset West (KTA)	Kayamandi	451	127	20	28%
TOTAL		**6 768**	**2 138**	**797**	**43%**

The analysis indicate that for the shorter distance trips, such as Idas Valley, Cloetesville, and Koelenhof less than 30% of the total daily passengers were recorded at the ranks, which indicates that *more than 70% of the passengers are missed if boarding and alighting on-route is not recorded*. For the longer distance routes, except Somerset West, more than 50% of passengers were recorded boarding and alighting at the ranks. Unlike the rest of the routes, the Stellenbosch

to Somerset West route originates and ends at a taxi rank. However, Somerset West is not included in the study area, which meant that passengers boarding and alighting at the taxi rank in Somerset West were not included in the analysis. Since this route is regarded as a long distance route, this is a possible reason for the low percentage of rank passenger boarding's and alighting's as indicated in Table 6.1. The rank analysis show that for all 10 routes approximately 43% of passengers are recorded at the ranks, which means that 57% of the total passengers would not have been picked up using normal rank surveys as they are boarding and alighting on-route as indicated by the on-board surveys.

A total of 76 vehicles with 757 taxi trips were surveyed as part of the on-board taxi survey. Origin-destination patterns were recorded for a total of 6 768 passengers. Although taxi services operate on a demand basis and do not have fixed stops along the route, passengers have begun to informally assemble at specific points, which have become typical boarding locations. An example of this is shown in Figure 6.3, which was taken outside the J.J. Rhode Primary School, along the Elsenburg route in Stellenbosch.

Figure 6.3: Example of a typical on-route boarding location along the Elsenburg route

6.4 Comparison between On-board Survey and CPTR Methodology

The decision made regarding the survey method to be used, is based on the type of information required. It is, therefore, emphasised that the requirements of the CPTR and the importance of it's results to the transport planning industry should guide the data collection methodology. As stated by Behrens (2000) the use of more qualitative surveys (i.e. on-board surveys) are not necessarily inteded to replace quantitative surveys (rank surveys), nor need they be conducted using equivalent sample sizes. Smaller, qualitative surveys using automatic methods of data collection, do therfore not need to be expensive.

While both the CPTR data collection methodology and the on-board taxi survey provide information on taxi movements and passenger demand, they both have their strengths and weaknesses. This is presented in Table 6.2.

Table 6.2: Comparison of data collection methodologies

Methodology	Strength	Weaknesses
CPTR methodology (Rank survey)	• Lower costs • Easier methodology • Less labour and training required • Can be completed over shorter time periods	• Does not count on-route passenger demand • Unable to track routes travelled therefore cannot compare with OLB routes • Does not provide passenger origin and destination pairs • Have to estimate travel time
On-board taxi survey	• Includes both rank and on-route passenger demand • All passengers are included in the survey • Able to track taxi routes to check whether taxis are complying to permit rules • Provides an electronic spatial mapping of the actual routes • Able to track passenger origin and destination pairs • Specifies high boarding and alighting locations on-route • Can determine actual travel time and number of trips per vehicle	• Higher costs • More complex methodology • Requires extensive training and high number of surveyors • Extensive preplanning and expensive equipment required

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The main conclusion that can be drawn is that the results provided in the Current Public Transport Record (CPTR) for Stellenbosch, are incomplete and does not reflect the actual passenger demand on the majority of minibus taxi routes in the area.

The on-board taxi survey was regarded successful, since no major obstacles were experienced, and the results were considered to be reliable based on the final outcome. The study area chosen for the project i.e. Stellenbosch, was also deemed suitable for this survey. Since this was the first time that a taxi survey was undertaken in this manner, it was beneficial to have picked a study area where there is little, or no, taxi conflicts and the number of vehicles are relatively low so that all vehicles per route could be surveyed on the same day. With only 2 taxi associations operating on the specified routes, interaction and communication with the taxi industry was unproblematic. The conclusions listed below summarise the findings of the on-board survey as compared to the CPTR results.

7.1.1 General findings from on-board survey

The results of the on-board taxi survey indicate a significant increase in the total passenger volumes even when projecting the CPTR results by 2% per annum, an increase of more than 1 000 passengers is observed. Although an increase in passenger volumes can be expected over the 4 year period, the survey also recorded an average of 89 passengers per vehicle per day, which is more than twice as many as the CPTR data.

Travel times averaged on the shorter commuter routes between 10-15min in the peak outbound direction and 20-25 minutes to the outlying farm areas. Generally, this enabled a taxi vehicle to undertake approximately 3 round-trips in the peak hour for the local services and approximately 1 round-trip per hour for the farm areas.

7.1.2 Comparison with CPTR operational data

As indicated in Section 6.3, a total of 76 vehicles were surveyed, with 6 768 passengers recorded on the 10 routes. Comparing the 2004, projected to 2008, rank survey data for the same routes, which surveyed 130 vehicles, a total of 5 746 passengers were recorded. As expected, an increase in total passenger volumes for each of the routes can be observed, due to factors, such as population growth or growth in employment opportunities. In contrast, decreases in the number of vehicles on all routes (with the exception of Idas Valley, which increased by 2 vehicles) is also observed. This decrease in vehicles and simultaneous increase could be attributed to better utilisation of the current taxi vehicles, but could also be, due to more accurate recording of passenger data along the routes as part of this survey.

The 2004 rank survey information shows an average of 40 passengers per vehicle per day, while the on-board survey is showing roughly twice as many, with an average of 89 passengers per vehicle per day.

7.1.3 Lessons learned

Some key lessons should be noted:

- It is critical to have good relationships with the taxi associations. Interactions need to be continuous rather than only established when surveys need to be undertaken.
- A detailed and current database of contact details of owners/drivers and respective registration numbers per route is essential to be able to plan and carry out the survey successfully.
- Pre-planning of the survey with regular interactions with the taxi association leadership, taxi owners and drivers is critical. This is required to understand the nature of the taxi operations and where to link with the taxi driver in order to start the survey day.
- Surveyors do not only need to be trained on the equipment and the methodology, but it is also vital that each one undertakes a pilot survey to ensure that they understand the process and to identify possible problems, which could occur while conducting a survey.

As stated in Section 6.4, the decision made regarding the survey method to be used, is based on the type of information required. It is, therefore, emphasised that the requirements of the CPTR and the importance of it's results to the transport planning industry should guide the data collection methodology.

7.2 Recommendations

In South Africa, the ability to effectively monitor performance on transport systems, as well as creating intervention strategies, is hindered by the absence of reliable data on public transport demand and supply. Although it can be noted that the methodology for the on-board taxi survey is expensive and labour intensive, the results obtained from the survey proved to be more valuable as a planning tool for future public transport development, than data obtained via the CPTR surveys. This investigation confirms that the on-board taxi surveys can be successfully used to collect, not only passenger information, but all other operational information such as travel time, routes travelled, trip length and number of trips on public transport systems.

Data collection processes currently being adopted internationally, have made great strides in developing effective methodologies for accurately providing operational data on public transport systems in their countries. With the current interest in the applicability of ITS in South Africa, it is recommended that further studies be undertaken to promote the use of ITS in public transport data collection.

Collecting on-board data is time consuming and expensive, even on relatively low volume routes. Hence, it is unlikely that a complete fleet of taxis will be surveyed in other areas. Because of time and cost elements, the amount of data collected will be limited, and the number of taxis surveyed will be relatively small. It will, therefore, be necessary to investigate using a sample of the full service.

Sampling theory says that a correctly taken sample of an appropriate size will yield results that can be applied to the whole system (Richardson, 1995). The fundamental question, to ensure that the sample will represent all services, is: "*how big should the sample be?*". This is entirely dependant on the circumstances and the outcome required from the survey. It is recommended that for a particular taxi rank or taxi association, a 100% sample be surveyed on one route (usually the route with a low volume of taxis) using the on-board survey methodology. This survey is carried out in conjunction with a rank survey, on the same day, from which the route operates. The results of the on-board survey on the 100% sample will yield a factor based on passengers counted at the rank versus passengers observed on route. This factor can then be applied to the

remaining routes, which were surveyed by the rank survey, to get a better estimation of the passenger demand in a particular community. It is important to note that this is not the only sampling method, which could be used, further research is recommended to identify a suitable method based on various situations.

Due to limited time this investigation, only focuses on minibus taxi data collection. Further investigations are required to identify the success of such a methodology to collect information on other modes of public transport services in South Africa.

1.1.1 Final recommendations

In summary, the following recommendations are proposed:

- For large areas with big taxi fleets it is recommended that on-board surveys be conducted on a sample of the taxis on each route as a representation of the full fleet.
- Further investigations into the utilisation of ITS applications, such as fare collection systems and GPS technologies, be undertaken. It is important to highlight that fare collection systems would need to be installed on all vehicles to be effective, whereas a sample of vehicles could be used for GPS technology to track and record vehicle movements.
- GPS technology can be used on buses, as well to collect operational information, as part of the CPTR and ticket sales can be used as an indication of passenger movements.Further studies and pilot surveys are recommended.
- The current methodology for data collection on rail systems has not been included as part of this report, and further studies is recommended to investigate this mode as part of the CPTR information.

LIST OF REFERENCES

Cape Metropolitan Council (CMC), 1998, *Cape Metropolitan Transport Plan : Part 1 - Contextual Framework.* Cape Town.

Cape Metropolitan Council (CMC), 1999, *Cape Metropolitan Transport Plan: Part 2 - Public Transport Strategic Component.* Cape Town.

Cape Winelands District Municipality (CWDM), 2003, *Current Public Transport Record - 2003.* Cape Town: Africon Consulting Engineers.

Cape Winelands District Municipality (CWDM), 2004, *Operating Licences Strategy.* Cape Town: Africon Consulting Engineers.

Cameron, J. W., 2005, *Questions about the Quantitative Basis of Municipal Transport Plans*. Presented at South African Transport Conference. Pretoria.

CNdV Africa, 2005, *Western Cape Provincial Spatial Development Framework.* Cape Town.

CNdV Africa, 2005, *Stellenbosch Municipality IDP - Preliminary Spatial Development Framework (SDF)*, Cape Town.

Department of Transport (NDoT), 2005, *National Household Travel Survey 2003: Technical Report.* Pretoria.

Department of Transport (NDoT), 2000, *National Land Transport Transition Act (NLTTA).* Pretoria.

Department of Transport (NDoT), 1996, *White Paper on National Transport Policy.* Pretoria.

Federal Transit Administration, 2008, *National Transit Database*. Retrieved December 2008, from www.ntdprogram.gov.

Institute for Transportation and Development Policy, 2007, *Bus Rapid Transit Planning Guideline: 3rd Edition*. USA.

Kracht, M., 2004, *Tracking and Interviewing Individuals with GPS and GSM technology on Mobile Electronic Devices*. Presented at the *7th International Conference on Travel Survey Methods.* Costa Rica.

Krygsman, S. C., 2005, *The Use of Cellphone Technology in Activity and Travel Data Collection.* Presented at South African Transport Conference. Pretoria.

Letshwiti, V., 2004, *Appropriate technology for automatic passenger counting on public transport vehicles in South Africa.* Presented at South African Transport Conference. Pretoria.

Liebenberg and Stander, 1992, *Transport Survey: Public Attitudes Towards Certain Transport Attributes.* Cape Town.

Mokonyama, M., 2006, *Harnessing Innovation in Passenger Transport Research in Africa.* Pretoria: CSIR.

Moodley, G. Y., 2005, *Developing the Ethekweni OLS: How useful is the CPTR information.* Presented at South African Transport Conference. Pretoria.

National Centre for Transit Research (NCTR), 2003, *Handbook of Automated Data Collection Methods for the National Transit Database.* Florida.

Provincial Government of Western Cape, 2005, Prepared by J.W Cameron, *Public Transport Status Quo.* Cape Town.

Pendulum Consulting, 2008, *Integrated Rapid Transit (IRT) System: Data Collection Plan.* Cape Town.

Richardson, 1995, *Survey Methods for Transport Planning.* United States, 1995.

Roger Behrens, 2000, *Activity-Travel Analysis: A Review of Theoretical Origins, Recent Developments and Local Application.* Presented at South African Transport Conference. Pretoria.

Stellenbosch Municipality, 2007, *Integrated Development Plan.* Cape Town: CNdV Africa, 2007.

Transit Department of New Zealand, 1999, *Travel Survey*. Retrieved March 2009, from Ministry of Transport: New Zeland: www.transport.govt.nz

Valbuena, J. L., *Public Transport Location Tracking in Madrid*. Retrieved November 2008 from www.datacollection.eu.

Vorster, J. C., 2002, *Data Capture and the Preparation of the First Gauteng OLS* . Presented at South African Transport Conference.. Pretoria.

Zietsman, H. L., 2007, *Recent changes in the Population Structure of Stellenbosch Municipality.* Stellenbosch.

ANNEXURE A:

PRO-FORMA OF TYPICAL CPTR DATA COLLECTION FORM

Information for all vehicles arriving and departing

Date:..... Location:..... Name:..... Town:.....

VEHICLES DEPARTING

Registration number	Total passengers Normal	Learner	Destination *Location and holding area - ask driver*	Route *info 1*	Route *info 2*	Route *info 3*	Route *info 4*	Route *info 5*	Route *info 6*	Vehicle Type *Combi,Ve nture,Quantum,Other*

V= venture, C= Combi/Minibus, SB = small bus, LB = large bus

ANNEXURE B:
TYPICAL OCCUPANCY SURVEY FORMS

Traffic Counts - Peak Period

Survey Station: Road Name:

Suvey Station Code: Day:

Direction: Weather:

Time	Taxis	Busses	Cars	Heavy Vehicles
06:00				
06:15				
06:30				
06:45				
07:00				
07:15				
07:30				
07:45				
08:00				
08:15				
08:30				
08:45				
09:00				
09:15				
09:30				
09:45				

Surveyor: Supervisor:

Traffic Counts - Daily (1)

Survey Station: Road Name:

Suvey Station Code: Day:

Direction: Weather:

Time	Taxis	Busses	Cars	Heavy Vehicles
05:00				
05:15				
05:30				
05:45				
06:00				
06:15				
06:30				
06:45				
07:00				
07:15				
07:30				
07:45				
08:00				
08:15				
08:30				
08:45				
09:00				
09:15				
09:30				
09:45				
10:00				
10:15				
10:30				
10:45				
11:00				
11:15				
11:30				
11:45				
12:00				
12:15				
12:30				
12:45				
13:00				
13:15				

Surveyor: Supervisor:

Traffic Counts - Daily (2)

Survey Station: Road Name:
Suvey Station Code: Day:
Direction: Weather:

Time	Taxis	Busses	Cars	Heavy Vehicles
13:30				
13:45				
14:00				
14:15				
14:30				
14:45				
15:00				
15:15				
15:30				
15:45				
16:00				
16:15				
16:30				
16:45				
17:00				
17:15				
17:30				
17:45				
18:00				
18:15				
18:30				
18:45				
19:00				
19:15				
19:30				
19:45				
20:00				
20:15				
20:30				
20:45				
21:00				
21:15				
21:30				
21:45				

Surveyor: Supervisor:

ANNEXURE C:
DESCRIPTION OF A TYPICAL SURVEY METHODOLOGY

The list below shows the components of a typical survey, as discussed by Richardson (1995), and also includes the issues to be addressed within each component.

1. Preliminary Planning:
    - Identifying survey objectives,
    - Reviewing existing information and data,
    - Determining survey resources, and
    - Formulating survey methodology.

2. Selection of Survey Methodology:
    - Survey time frame,
    - Survey technique, and
    - Consideration of possible survey errors.

3. Sample Design:
    - Define target sample size,
    - Sampling method,
    - Sampling size and composition, and
    - Conduct of sampling.

4. Survey Instrument Design:
    - Investigate types of survey instruments/equipment,
    - Data collection content and nature of forms,
    - Trip recording techniques,
    - Question types (where applicable), and
    - Survey form production.
5. Pilot Survey(s):
    - Adequacy of sampling frame,
    - Size of pilot survey,
    - Suitability of survey method and procedures,

- Efficiency of surveyor training, and
- Suitability of data capturing and data analysis procedures.

6. Execution of Surveys:

   - Procedures for survey administration,
   - Survey execution and monitoring, and
   - Quality control.

7. Data Capture:

   - Selection of capturing technique / method,
   - Administration of capturing process,
   - Quality control, and
   - Database management.

8. Data Analysis:

   - Determining outcomes required,
   - Decision on methods of presenting results, and
   - Interpretation of results.

9. Presentation of results:

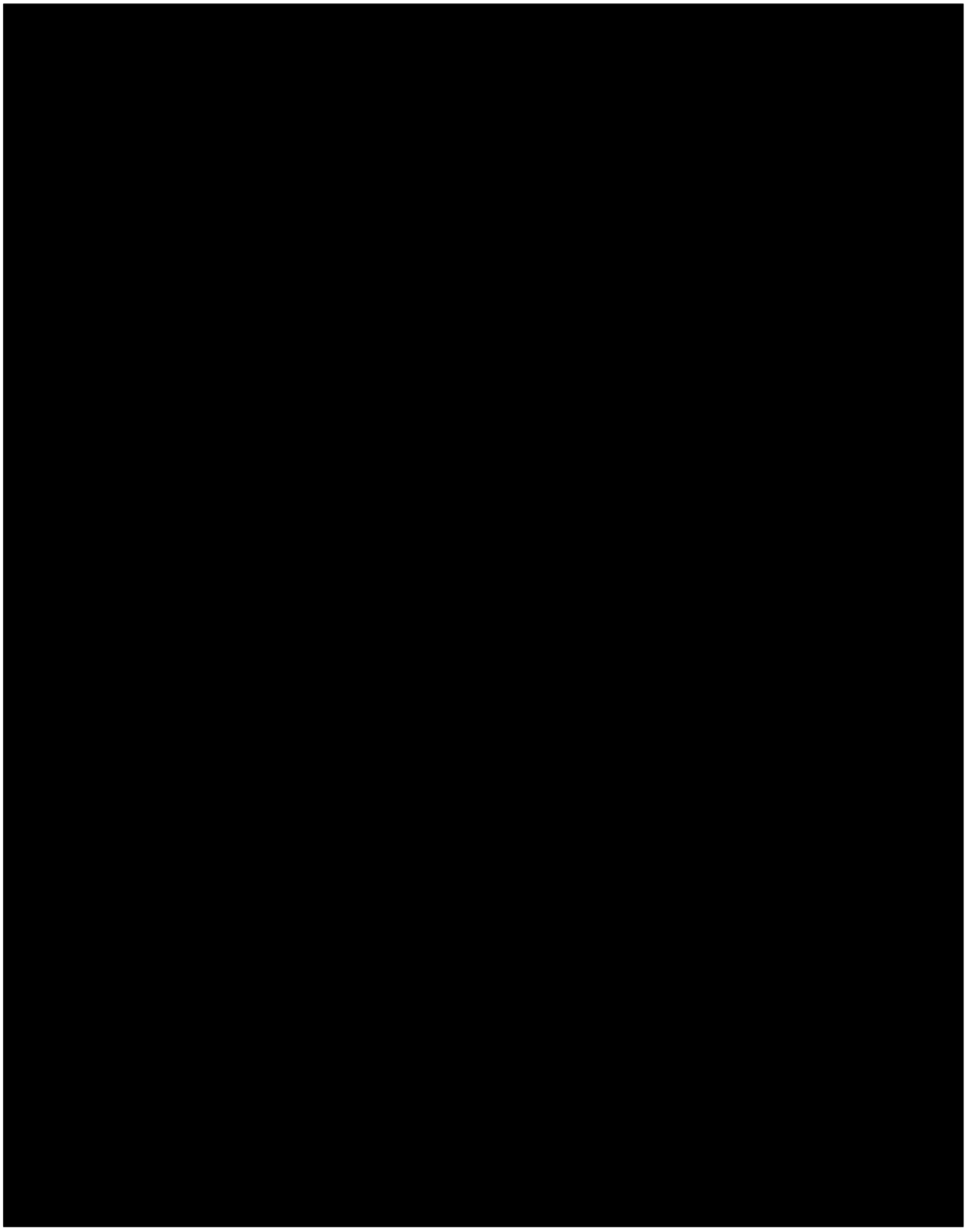
   - Verbal presentation,
   - Visual presentation, and
   - Preparation of reports.

10. Tidying up:

    - Documentation of survey method, and
    - Storage and data archiving.

ANNEXURE D:

EXAMPLE OF COMPLETED ON-BOARD SURVEY FORM



ANNEXURE E:
SUMMARY OF ALL ROUTES SURVEYED

1. ROUTE 1: CLOETESVILLE (OLB NO. 665,666)

Cloetesville is a traditionally "coloured" residential community in Stellenbosch which has several primary schools and one high school. It is located north of centre of town and is bordered by an industrial area to the west. Typically this is one of the higher volume commuter routes for Stellenbosch carrying over 2 000 passengers daily. The average travel time on this route is approximately 30 minutes roundtrip with 20 minutes in the Cloetesville direction and 10 minutes towards Stellenbosch town centre during the peak periods. Currently this route departs from Bergzicht Taxi Rank c/o Bird Street and Merriman Road. Table 1.1 summarises the information obtained for the Cloetesville route.

Table 1.1: Summary information for Cloetesville

Route Number	Route 1	**OLB Code**	665,666
Route Name	Cloetesville	**Taxi Association**	STA
Location of taxi departure point	Bergzicht taxi rank	**Route Distance**	5 km
No. of vehicles	18	**Estimated route capacity per hour**	504
Vehicle Registration Numbers	CL66858, CL62334, CL58339, CL52892, CL50176, CL47308, CL46366, CL44770, CL44603, CL43677, CL40253, CL40021, CL32016, CL26232, CL21075, CL12379, CL8500, CL7006		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Cloetesville**
	30min	**10 min**	**20 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	2 043	936	492

The figures below summarises the passenger information for the Cloetesville route. Figure 1.1 shows the total passengers per direction. The morning peak hour is between 07:00 and 08:00 with a total of 345 passengers boarding during this hour. There is no distinct PM peak hour as the passenger volumes in the Stellenbosch direction is spread over the afternoon period.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 1.2 shows the available capacity on the Cloetesville route with more than 150 seats available in total throughout the day on the 18 vehicles in both directions.

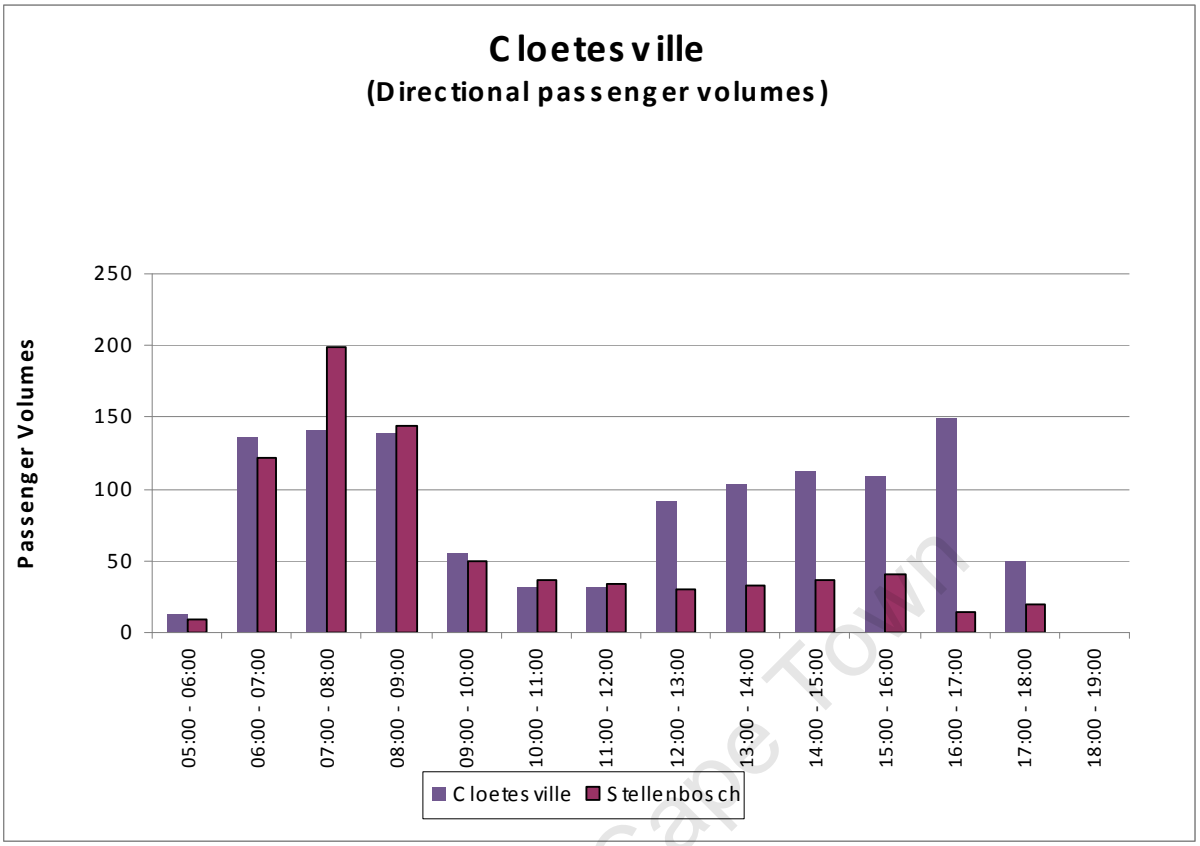


Figure 1.1: Cloetesville Passengers by Direction

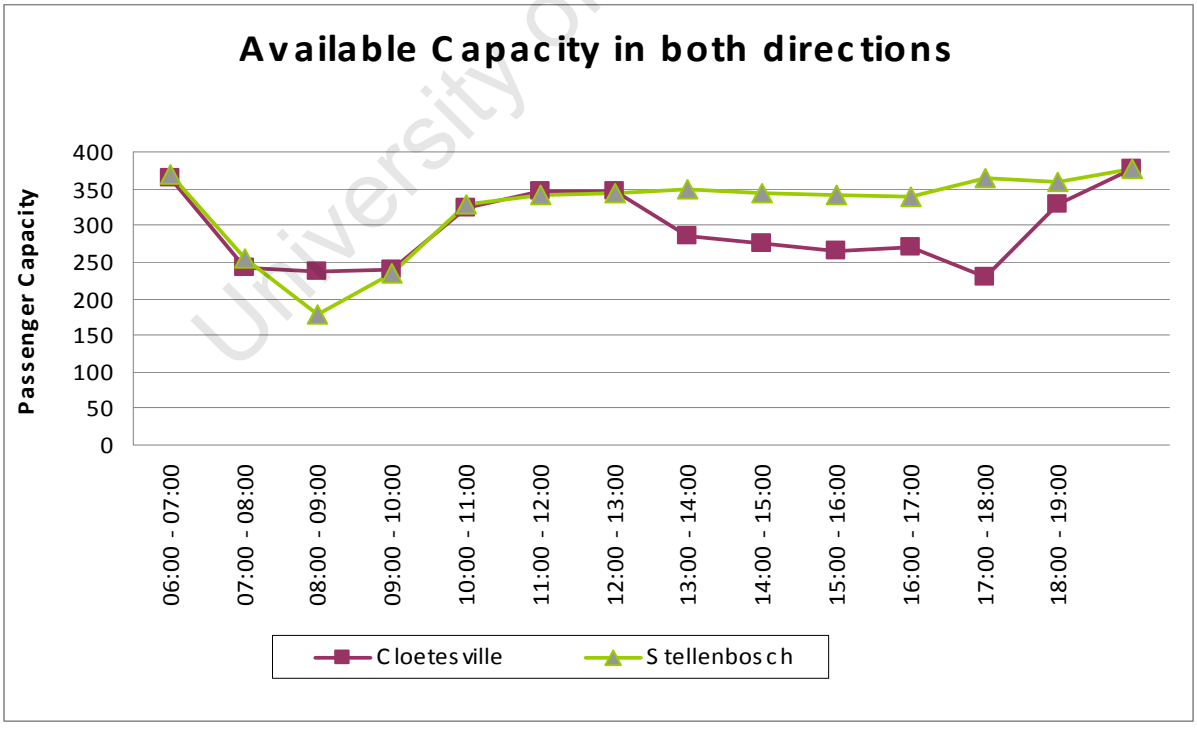


Figure 1.2: Available capacity on Cloetesville Route *(assumes 18 vehicles, 1.5 roundtrip/hr)*

2. ROUTE 2: DEVON VALLEY (OLB NO. 664)

Devon Valley forms part of the Stellenbosch wine route. It lies to the west and alongside the town of Stellenbosch. The valley has a number of popular wine estates which includes Middelvlei, Louisvale, Clos Malverne, Devon Hill, Hidden Valley and J.C. le Roux.

A total of 286 passengers were recorded on the 2 taxis currently servicing this route. The average travel time is approximately 30 minutes roundtrip with 20 minutes towards Devon Valley and 10 minutes towards Stellenbosch town centre during the peak periods. Currently this route departs from the Merriman taxi rank in Merriman Street.

Table 5. summarises the information for the Devon Valley route.

Table 2.1: Summary information for Devon Valley

Route Number	Route 2	**OLB Code**	664
Route Name	Devon Valley	**Taxi Association**	STA
Location of taxi departure point	Merriman Taxi Rank	**Route Distance**	11km
No. of vehicles	2	**Estimated route capacity per hour**	56
Vehicle Registration Numbers	CL 18995 CL 14561		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Devon Valley**
	30 min	**20 min**	**10 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	286	70	59

The figures below summarises the passenger information for the Devon Valley route. Figure 2.1 shows the total passengers per direction. From the results it is observed that there is a high number of passenger trips towards Devon Valley between 7:00 and 15:00 with another peak between 17:00 and 18:00. The morning peak hour is between 7:00 and 8:00 with a total of 45 passengers boarding during this hour.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 2.2 shows the available capacity throughout the day with more than 30 seats available during the peak and off peak periods in the Stellenbosch direction. Capacity in the Devon Valley direction is less constant with variations ranging from morning, midday and afternoon peaks where the capacity is less than 10 while the inter-peaks range from 20 to 40 seats.

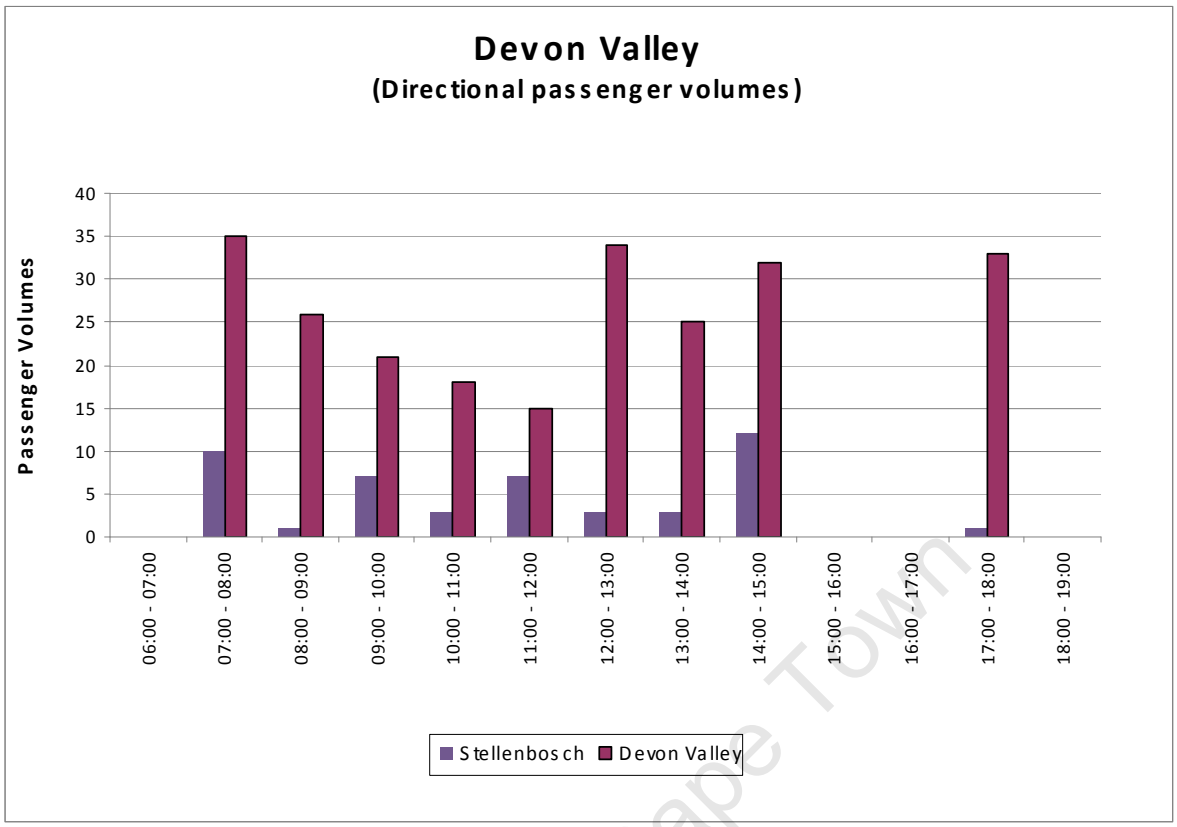


Figure 2.1: Devon Valley Passengers by Direction

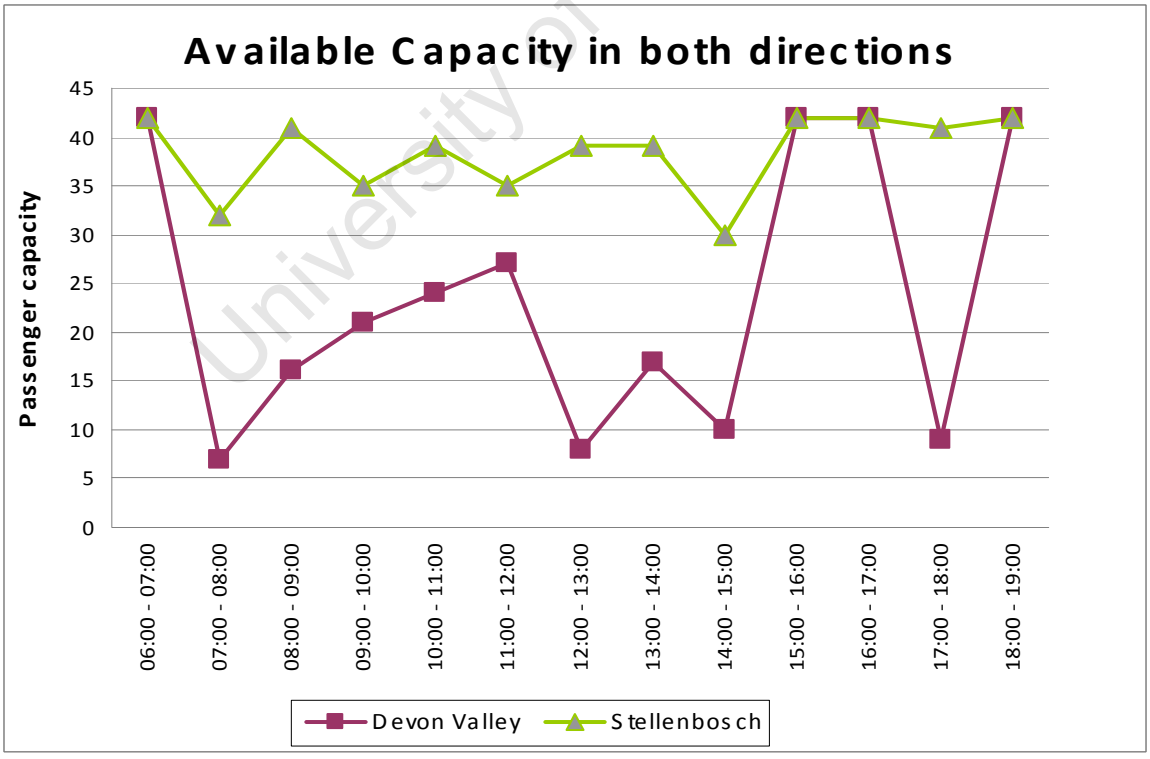


Figure 2.2: Available capacity on Devon Valley Route *(assumes 2 vehicles, 1.5 roundtrips/hr)*

3. ROUTE 3: ELSENBURG (OLB NO. 673)

The farm Elsenburg is located approximately 20km north of the town of Stellenbosch. Currently Elsenburg farm houses the administrative headquarters of the Western Cape Department of Agriculture and the main campus for the Cape Institute for Agricultural Training which provides a wide range of development, research and support services to the agricultural community in the Western Cape. This route also serves Simonsig via Kromme Rhee Street, Muratie wine estate and sometimes extends as far as Klapmuts.

A total of 220 passengers were observed along this route with 2 taxis currently servicing the route. The average travel time is approximately 50 minutes roundtrip with 25 minutes in either direction. Currently this route departs from the Stelmark taxi rank located in the parking area of the Stelmark Shopping Centre. Table 3.1 summarises the information obtained for the Elsenburg route.

Table 3.1: Summary information for Elsenburg

Route Number	Route 3	**OLB Code**	673
Route Name	Elsenburg	**Taxi Association**	STA
Location of taxi departure point	Stelmark taxi rank (Pick 'n Pay)	**Route Distance**	19 km
No. of vehicles	2	**Estimated route capacity per hour**	56
Vehicle Registration Numbers	CL25343 CL43600		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Elsenburg**
	50 min	**25 min**	**25 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	220	40	47

The figures below summarises the passenger information for the Elsenburg route. Figure 3.1 shows the total passengers per direction. From the results it is observed that this route is more active during the off-peak periods with a greater demand in the Elsenburg direction. The highest number of passengers boarding (40 passengers in both directions) is recorded between 13:00 – 14:00.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 3.2 shows the available capacity on the Elsenburg route which indicates a higher capacity in the Stellenbosch direction throughout the day. Utilisation of the 2 vehicles on this route is good and there is limited available capacity in the Elsenburg direction throughout the day.

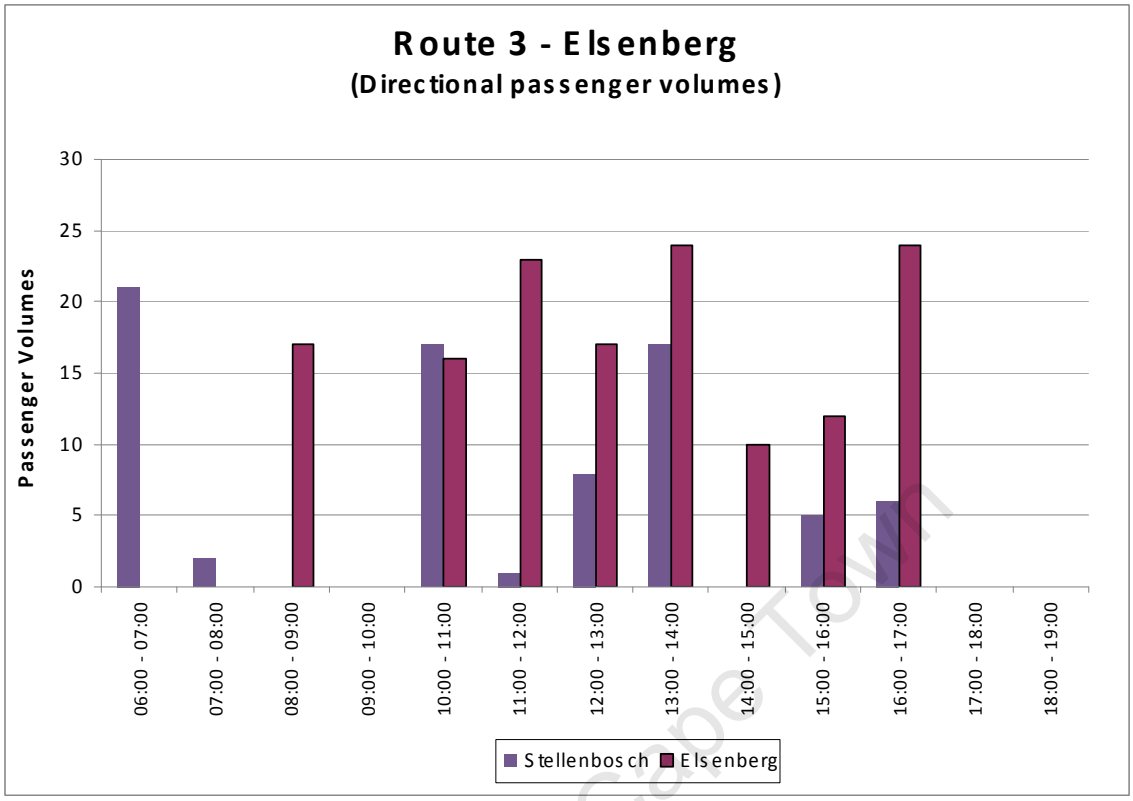


Figure 3.1: Elsenburg Passengers by Direction

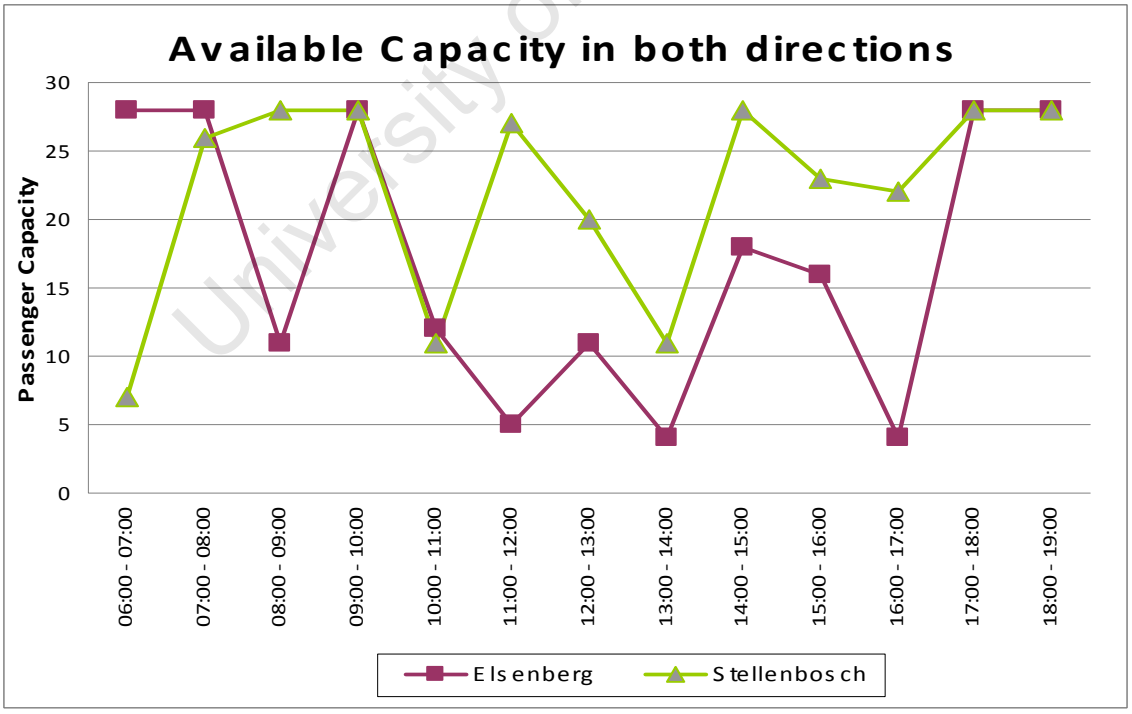


Figure 3.2: Available capacity on Elsenburg Route *(assumes 2 vehicles, 1 roundtrip/hr)*

4. ROUTE 4: IDAS VALLEY (OLB CODE: 656/657)

Idas Valley is an old traditionally "coloured" residential community in Stellenbosch. It is located north west of centre of town. Typically this is one of the higher volume commuter routes for Stellenbosch carrying approximately 1 200 passengers daily. The route is a short 4.5km trip and takes approximately 15 minutes roundtrip, with 10 minutes towards Idas Valley and 5 minutes towards Stellenbosch town centre during peak periods. Currently this route departs from Bergzicht Taxi Rank c/o Bird Street and Merriman Road. Table 4.1 summarises the information obtained for Idas Valley route.

Table 4.1: Summary information for Idas Valley

Route Number	Route 4	**OLB Code**	656/ 657
Route Name	Idas Valley	**Taxi Association**	STA
Location of taxi departure point	Bergzight Taxi Rank	**Route Distance**	4.5 km
No. of vehicles	13	**Estimated route capacity per hour**	364
Vehicle Registration Numbers	CL66300, CL56947, CL55614, CL20402, CL40714, CL18264, CL40554, CL5997, CL34010, CL651WP, CL28876, CL20421, CL56120		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Idas Valley**
	15 min	**5 min**	**10 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	1 243	579	222

The figures below summarises the passenger information for the Idas Valley Route. Figure 4.1 shows the total passengers per direction. Generally the morning peak direction is for commuters into Stellenbosch in the morning and returning to the neighbourhood in the evening peak. But there are surprisingly a high number of passenger trips towards Idas Valley throughout the day. The morning peak hour is between 7:00 and 8:00 with more than a 260 passengers boarding during this hour. The afternoon peak is between 16:00 and 17:00, but is smaller with about 120 passengers boarding during this afternoon peak hour.

Some rough estimations as to capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 4.2 shows the available capacity throughout the day with more than 300 seats available on the 13 vehicles on route.

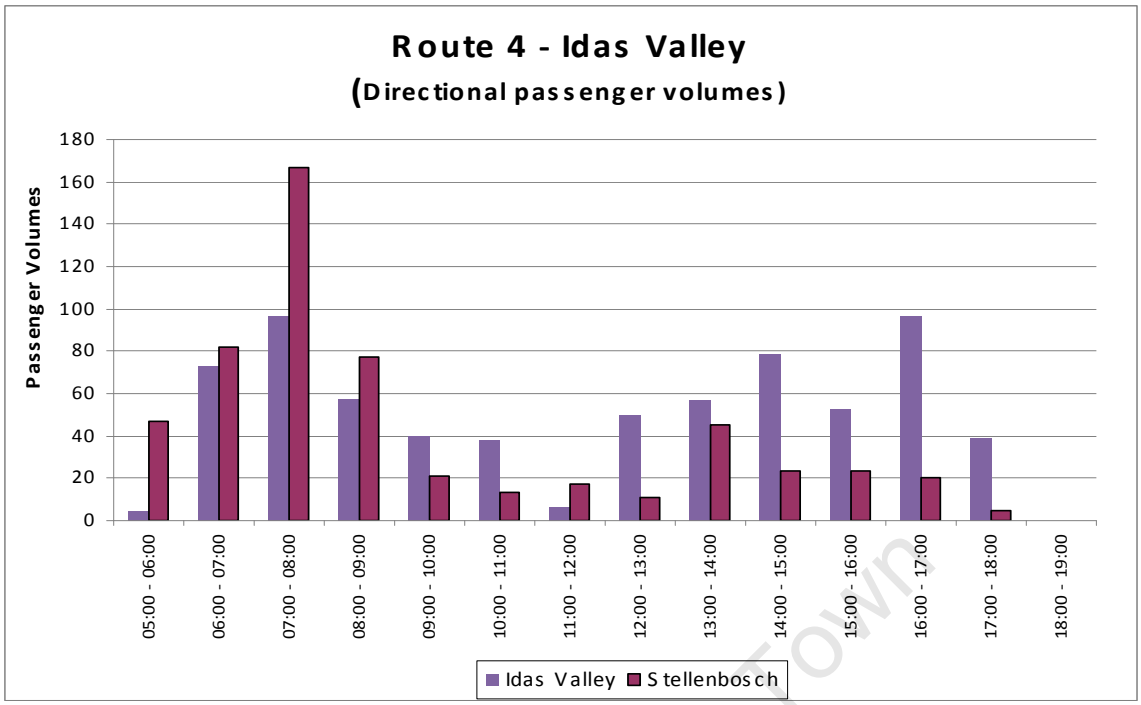


Figure 4.1: Idas Valley Passengers by Direction

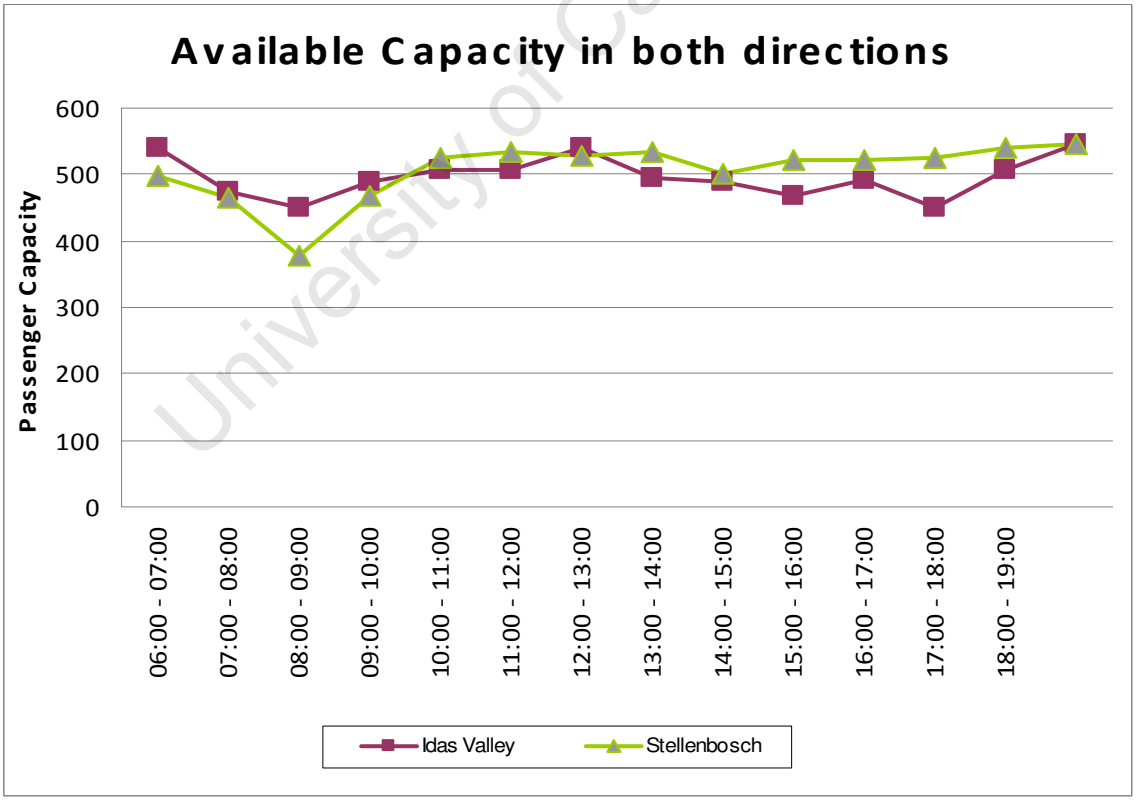


Figure 4.2: Available Capacity on Idas Valley Route *(assumes 13 vehicles, 3 roundtrips/hr)*

5. ROUTE 5: JAMESTOWN (OLB NO. 670)

Jamestown is a predominately residential area and is situated on the R44, south of Stellenbosch town. This route is regarded as a high volume commuter route carrying close to 1 000 passengers daily. The route also contains some wine farms, which includes Blaauwklippen Estate and Kleine Zalze, as well as the Stellenbosch Golf Club. Jamestown is located approximately 8.5 km from centre of town and the average travel time is approximately 25 minutes roundtrip with 15 minutes towards Jamestown and 10 minutes towards Stellenbosch town centre during the peak periods. Currently this route departs from the taxi rank in Blom Street also known as "*Die Braak".* Table 5.1 summarises the information obtained for the Jamestown route.

Table 5.1: Summary information for Jamestown

Route Number	Route 5	**OLB Code**	670
Route Name	Jamestown	**Taxi Association**	STA
Location of taxi departure point	Blom street taxi rank	**Route Distance**	8.5km
No. of vehicles	6	**Estimated route capacity per hour**	168
Vehicle Registration Numbers	CL915, CL5114, CL11277 CL58856, CL22340, CL36677		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Jamestown**
	25 min	**15 min**	**10 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	995	480	162

The figures below summarises the passenger information for the Jamestown route. Figure 5.1 shows the total passengers per direction. Generally the peak direction is for commuters going to Jamestown in the morning with much less passengers returning to Stellenbosch in the PM peak. The morning peak hour is between 7:00 and 8:00 with more than 240 passengers boarding during this hour. There is no distinct PM peak hour as the passenger volumes during the afternoon are much lower.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 5.2 shows the total available capacity on the 6 vehicles throughout the day with a large amount of seats available in both directions for most of the day except during the morning peak in the outbound direction towards Jamestown.

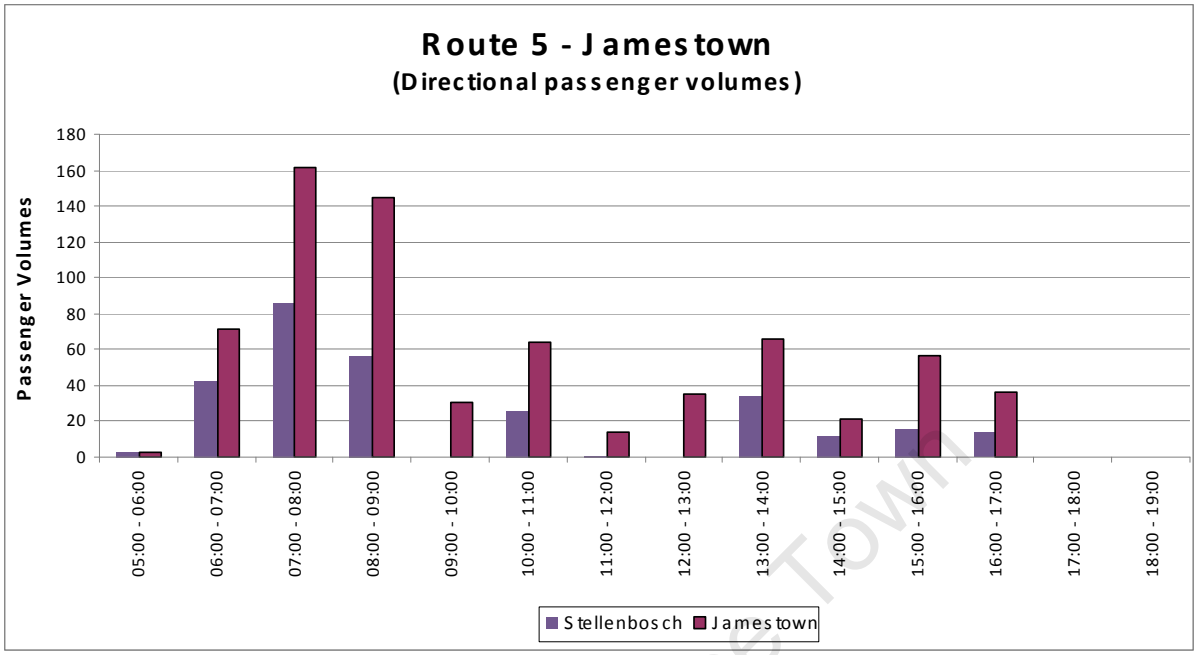


Figure 5.1: Jamestown Passengers by Direction

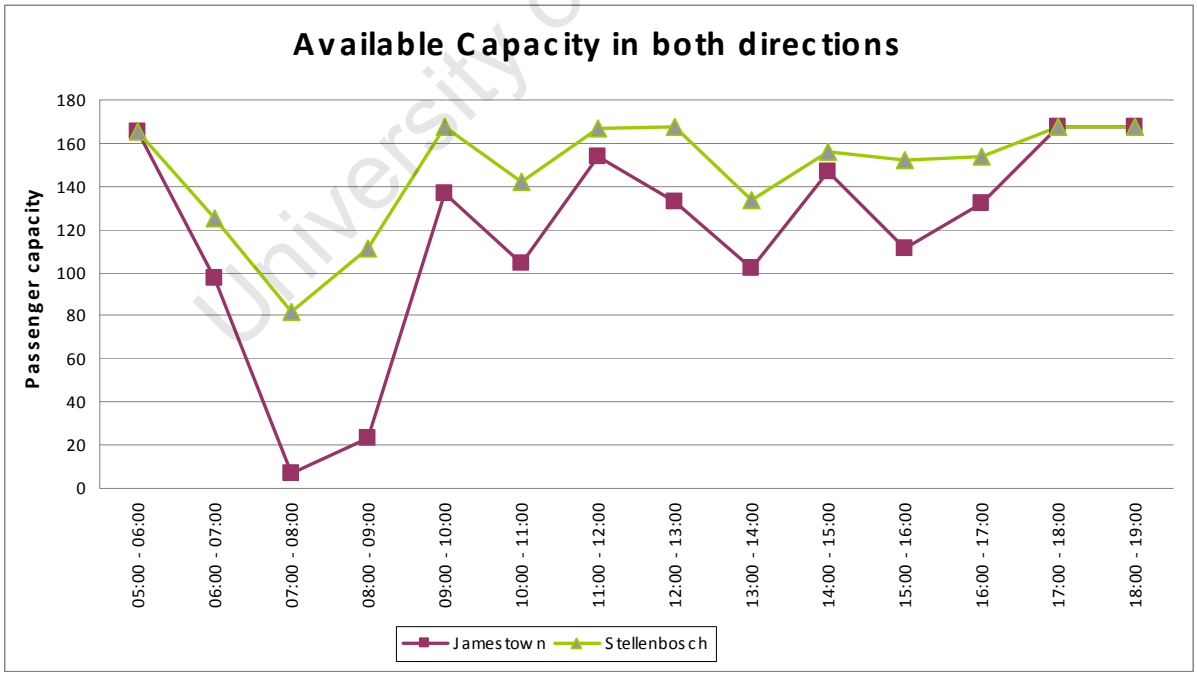


Figure 5.2: Available capacity on Jamestown Route *(assumes 6 vehicles, 2 roundtrips/hr)*

6. ROUTE 6: JONKERSHOEK (OLB NO. 675)

The route to Jonkershoek contains a number of wine estates, including the famous five-star Lanzerac Hotel, and ends at the Jonkershoek Nature Reserve. There are 2 vehicles servicing this route but due to low demands only 1 vehicle operates on this route per day. The owners of the 2 Jonkershoek vehicles have agreed to operate on alternate days to manage demand. A total of 99 passengers were recorded along this route on the 1 vehicle on the survey day. The average travel time is approximately 50 minutes with 25 minutes in either direction. Currently this route departs from the Stelmark taxi rank located in the parking area of the Stelmark Shopping Centre. Table 6.1 summarises the information obtained for the Jonkershoek route.

Table 6.1: Summary information for Jonkershoek

Route Number	Route 6	**OLB Code**	675
Route Name	Jonkershoek	**Taxi Association**	STA
Location of taxi departure point	Stelmark taxi rank (Pick 'n Pay)	**Route Distance**	12 km
No. of vehicles	1	**Estimated route capacity per hour**	28
Vehicle Registration Numbers	CL 38337		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Jonkershoek**
	50 min	**25 min**	**25 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	99	0	48

The figures below summarises the passenger information for the Jonkershoek route. Figure 6.1 shows the total passengers per direction. There is no distinct peak hour and the results indicate that there is no activity on this route during the morning peak period. There is a greater demand in the Jonkershoek direction with the highest number of passengers observed between 15:00 and 16:00.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 6.2 shows the available capacity on the Jonkershoek route which indicates a higher capacity in the Stellenbosch direction throughout the day. Utilisation of the vehicle on this route is good and there is limited available capacity in the Jonkershoek direction throughout the day.

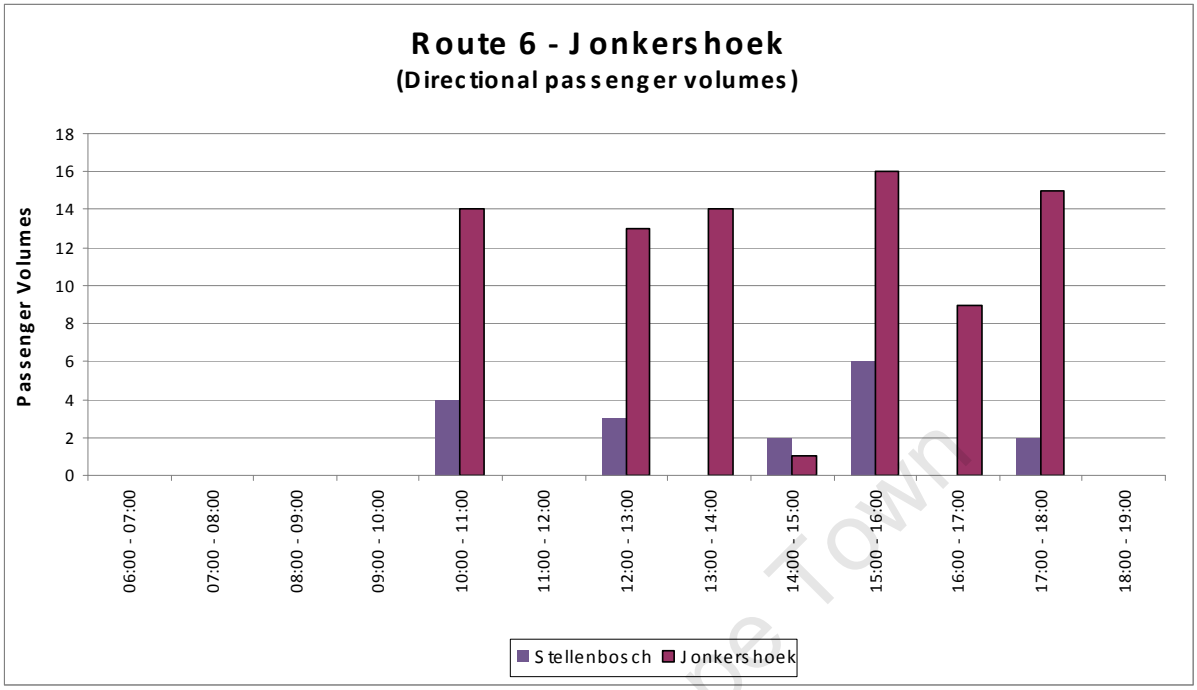


Figure 6.1: Jonkershoek Passengers by Direction

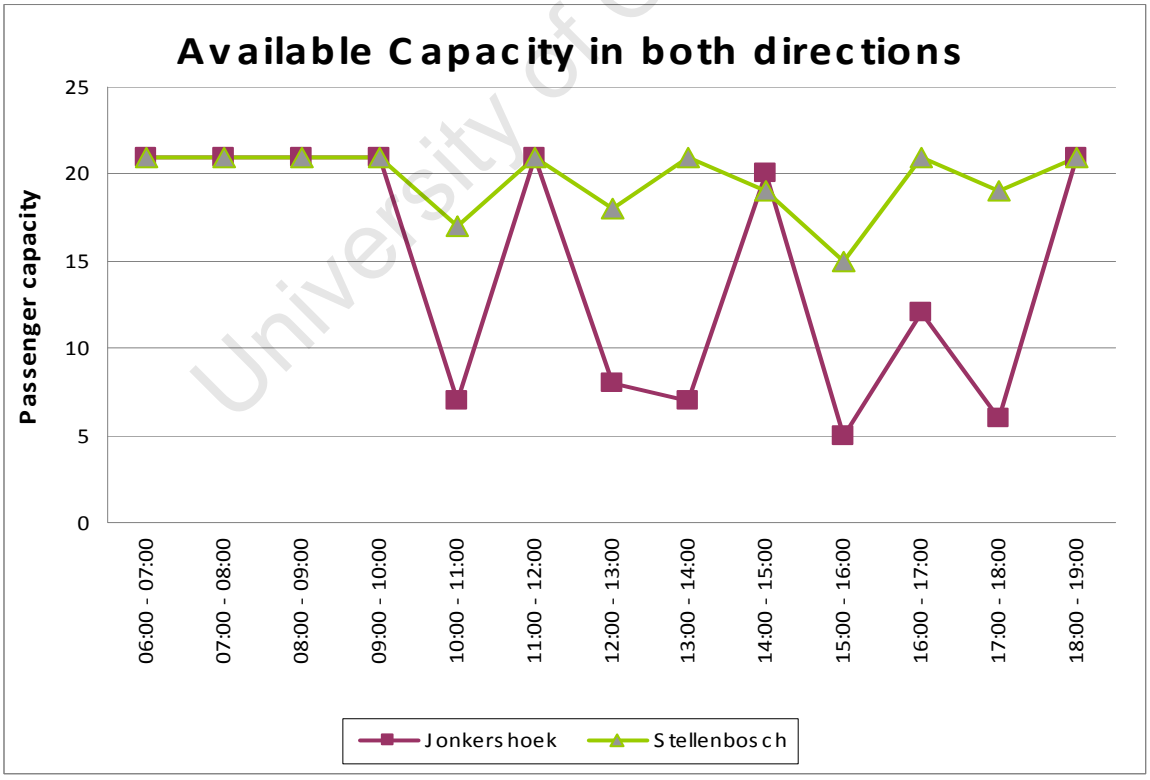


Figure 6.2: Available capacity on Jonkershoek Route *(assumes 1 vehicle, 1.5 roundtrips/hr)*

7. ROUTE 7: KAYAMANDI (OLB NO. 676,677)

Kayamandi is located in the town of Stellenbosch and is a residential area which was originally built to house black migrant male labourers which were employed on the farms in the Stellenbosch area. The route is a short 3 km from the centre of town and the average travel time is approximately 20 minutes roundtrip with 10 minutes in either direction during the peak periods. Currently the route departs from the Bergzicht taxi rank in Stellenbosch. Table 7.1 summarises the information obtained for the Kayamandi route.

Table 7.1: Summary information for Kayamandi

Route Number	Route 7	**OLB Code**	676,677
Route Name	Kayamandi	**Taxi Association**	KTA
Location of taxi departure point	Bergzicht taxi rank	**Route Distance**	3km
No. of vehicles	17	**Estimated route capacity per hour**	476
Vehicle Registration Numbers	CL59372, CL48303, CL45682, CL45019, CL43794, CL43321, CL41949, CL39532, CL39437, CL37037, CL29031, CL24234, CL15879, CL11943, CL11304, CL10943, CL5403		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Kayamandi**
	10 min	**10 min**	**10 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	857	442	221

The figures below summarises the passenger information for the Kayamandi route. Figure 7.1 shows the total passengers per direction. Generally the peak direction is for commuters going to Stellenbosch in the morning with more or less the same volume of passengers returning to Kayamandi in the PM peak. The morning peak hour is between 7:00 and 8:00 with more than 265 passengers boarding during this hour. There is no distinct PM peak hour as the peak passenger boarding volumes to Kayamandi spread from 14:00 to 17:00 with a total of 225 passengers travelling towards Kayamandi during this time period.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 7.2 shows the total available capacity on the 17 vehicles throughout the day with more than 500 seats available throughout the day in both directions. The results indicate that the vehicles on this route are considered to be underutilised.

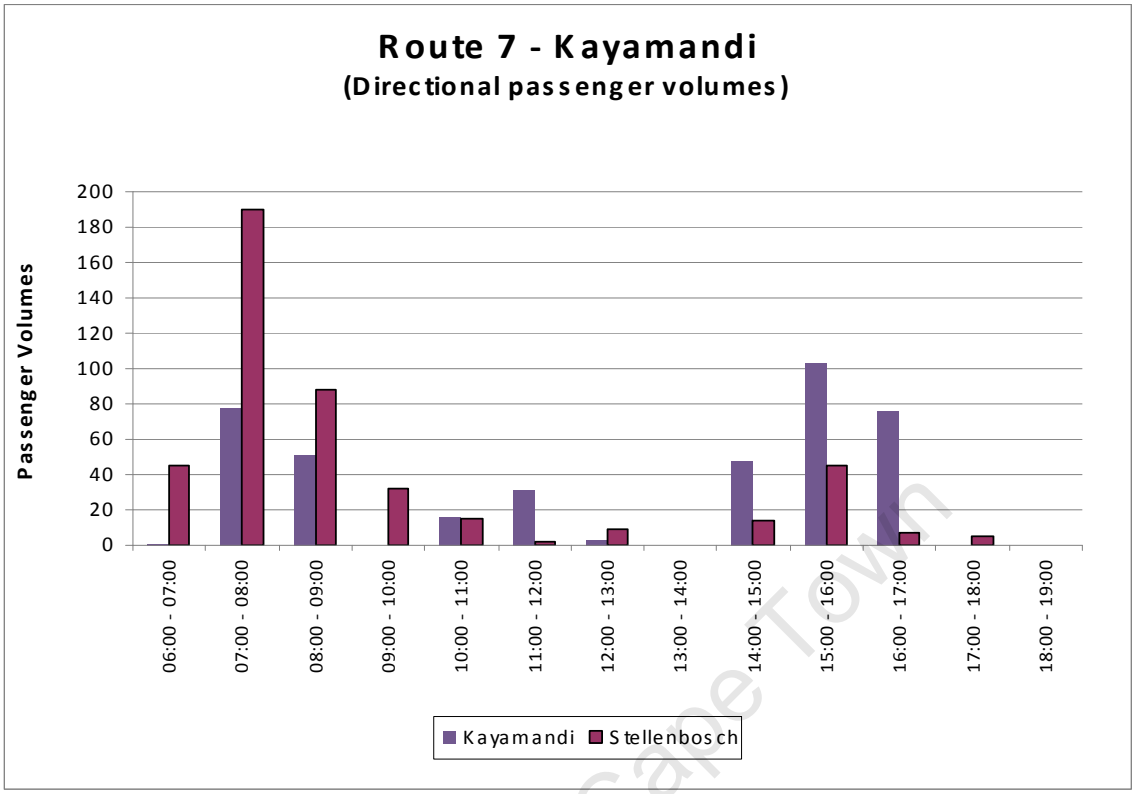


Figure 7.1: Kayamandi Passengers by Direction

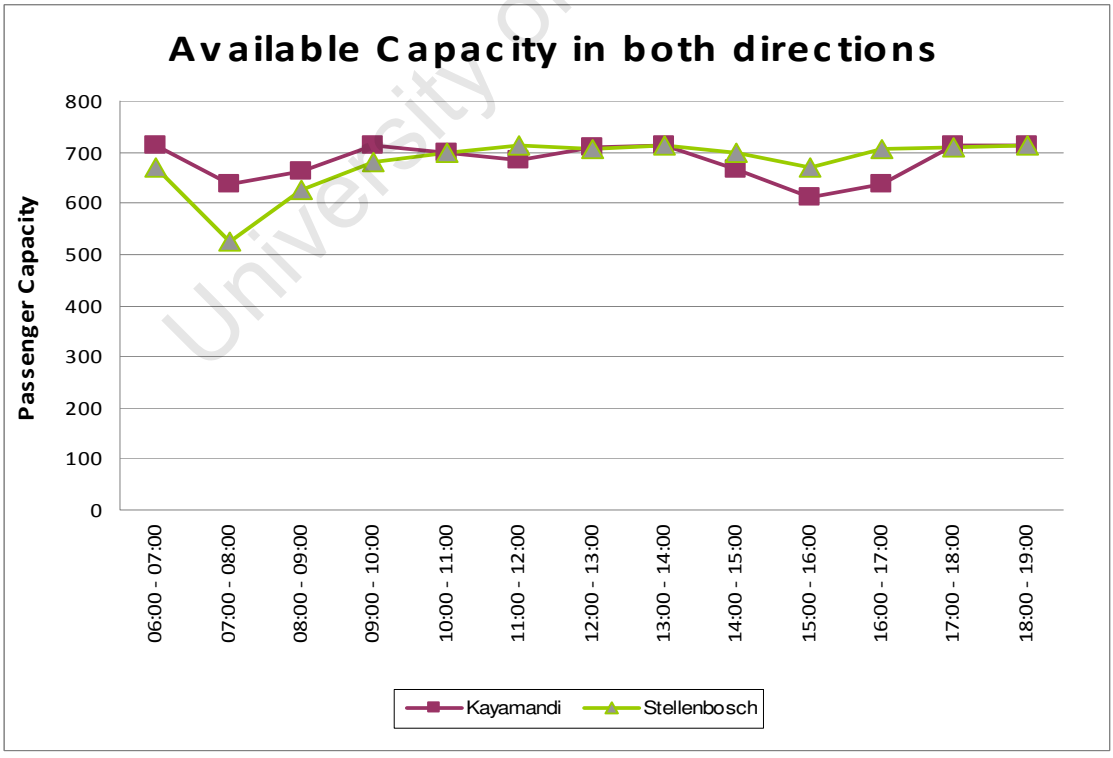


Figure 7.2: Available capacity on Kayamandi Route *(assumes 17 vehicles, 3 roundtrips/hr)*

8. ROUTE 8: KOELENHOF (OLB CODE: 662)

Koelenhof is situated north of Stellenbosch approximately 20 km from the centre of town. The route to Koelenhof contains a number of attractions located along the R44 and Bottelary Road (Beyerskloof, Muldersbosch, Bottelary and Devon Valley golf estate) and can be regarded as a main tourist route. A total of 47 passengers were recorded along this route with only 1 taxi currently servicing the route. The average travel time is approximately 45 minutes roundtrip with 20 minutes towards Koelenhof and 15 minutes on the return trip to Stellenbosch during the peak periods. Currently this route departs from the Merriman taxi rank in Merriman Street. Table 8.1 summarises the information obtained for the Koelenhof route.

Table 8.1: Summary information for Koelenhof

Route Number	Route 8	**OLB Code**	662
Route Name	Koelenhof	**Taxi Association**	STA
Location of taxi departure point	Merriman Taxi Rank	**Route Distance**	20 km
No. of vehicles	1	**Estimated route capacity per hour**	28
Vehicle Registration Numbers	CL 43619		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Koelenhof**
	45 min	**15 min**	**20 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	47	14	0

The figures below summarises the passenger information for the Koelenhof route. Figure 8.1 shows the total passengers per direction. This route has a very low passenger demand with only one vehicle operating along it. There is no distinct AM or PM peak hour and it is observed that the route is generally income driven and is operated on a demand basis. The highest passenger volume was recorded between 14:00 and 15:00 with a nearly 20 passengers boarding the vehicle during this hour.

Some rough estimations as to capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 8.2 indicates that there is available capacity of more than 15 seats throughout the day on the Koelenhof route with the exception of between 07:00 to 08:00 and 14:00 to 15:00.

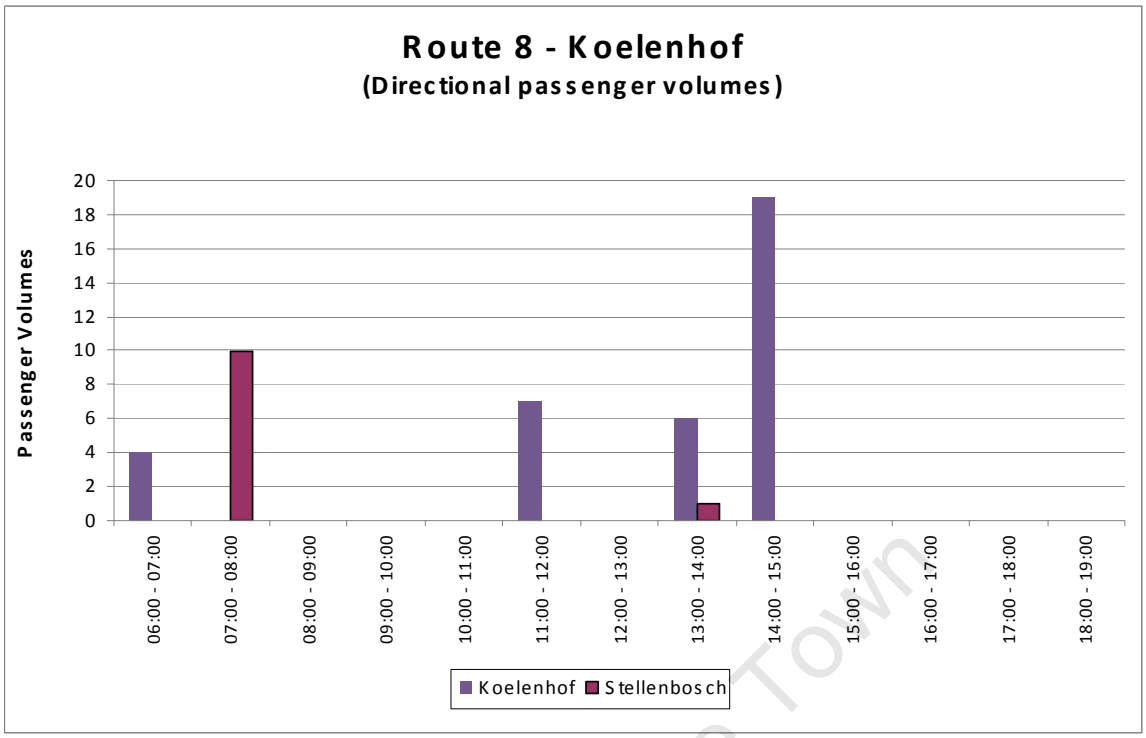


Figure 8.1: Koelenhof Passengers by Direction

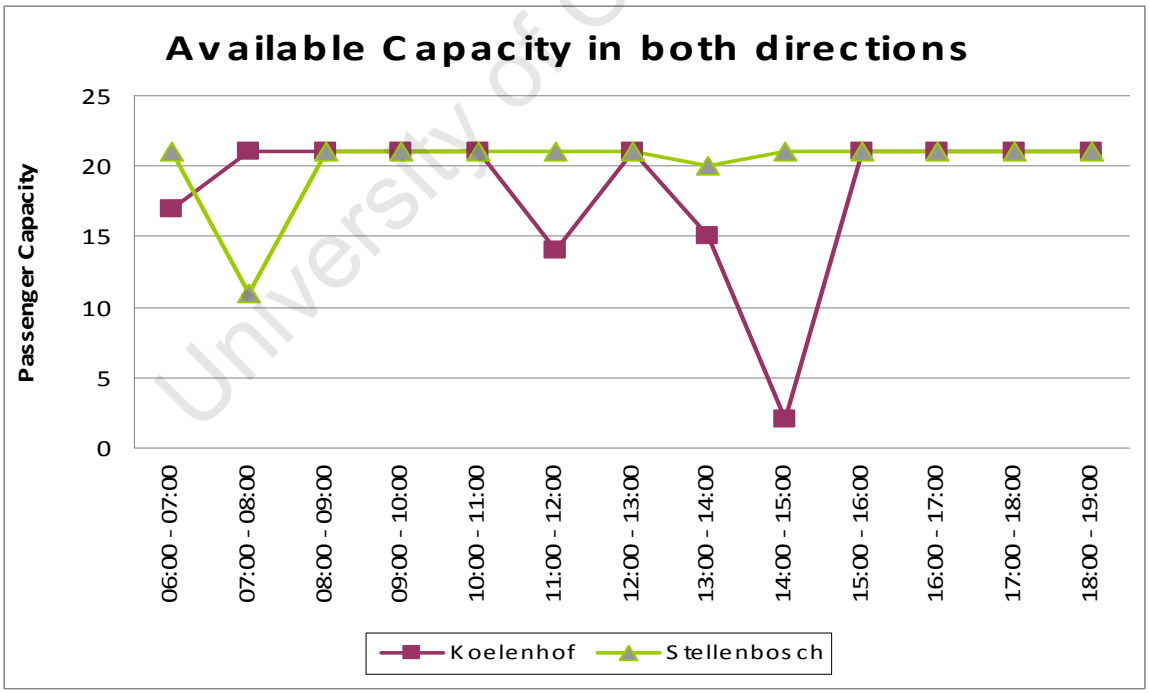


Figure 8.2: Available Capacity on Koelenhof Route ***(assumes 1 vehicle, 1.5 roundtrips/hr)***

9. ROUTE 9: SOMERSET WEST (OLB NO. 669,503)

Somerset West is currently being served by both Stellenbosch (STA) and Kayamandi Taxi Association (KTA) and is predominately a high volume commuter route. Somerset West is situated approximately 20km south from Stellenbosch CBD. The route between Somerset West and Stellenbosch forms part of the wine route as it encompasses a number of wine farms. Somerset West is renowned for its scenic beauty, flora and fauna and sporting facilities.

Stellenbosch Taxi Association

The Somerset West route currently being served by the Stellenbosch Taxi Association is summarised in Table 9.1 below. Currently this route departs from the taxi rank in Blom Street also known as "*Die Braak".*

Table 9.1: Summary information for Somerset West (STA)

Route Number	Route 9a	**OLB Code**	669,503
Route Name	Somerset West	**Taxi Association**	STA
Location of taxi departure point	Blom street taxi rank	**Route Distance**	20km
No. of vehicles	4	**Estimated route capacity per hour**	56
Vehicle Registration Numbers	CL24024, CL48901 CL61369, ZANE WP		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Somerset West**
	60 min	**30 min**	**30 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	362	127	109

The figures below summarises the passenger information for the Somerset West route. Figure 9.1 shows the total passengers per direction. From the results it is observed that the morning peak hour is between 7:00 and 8:00 with a higher demand towards Stellenbosch. In the afternoon the passenger boarding volumes to Somerset West spread from 14:00 to 16:00. There is surprisingly a higher demand of passenger trips towards Stellenbosch during the day. The results show that both Stellenbosch and Somerset West can be regarded as commuter destinations.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 9.2 shows the available capacity on the 4 vehicles throughout the day with more than 20 seats available in the Somerset West direction throughout the day and more than 50 between 11:00 and 15:00. During the off-peak periods there are more than 30 seats available in the Stellenbosch direction.

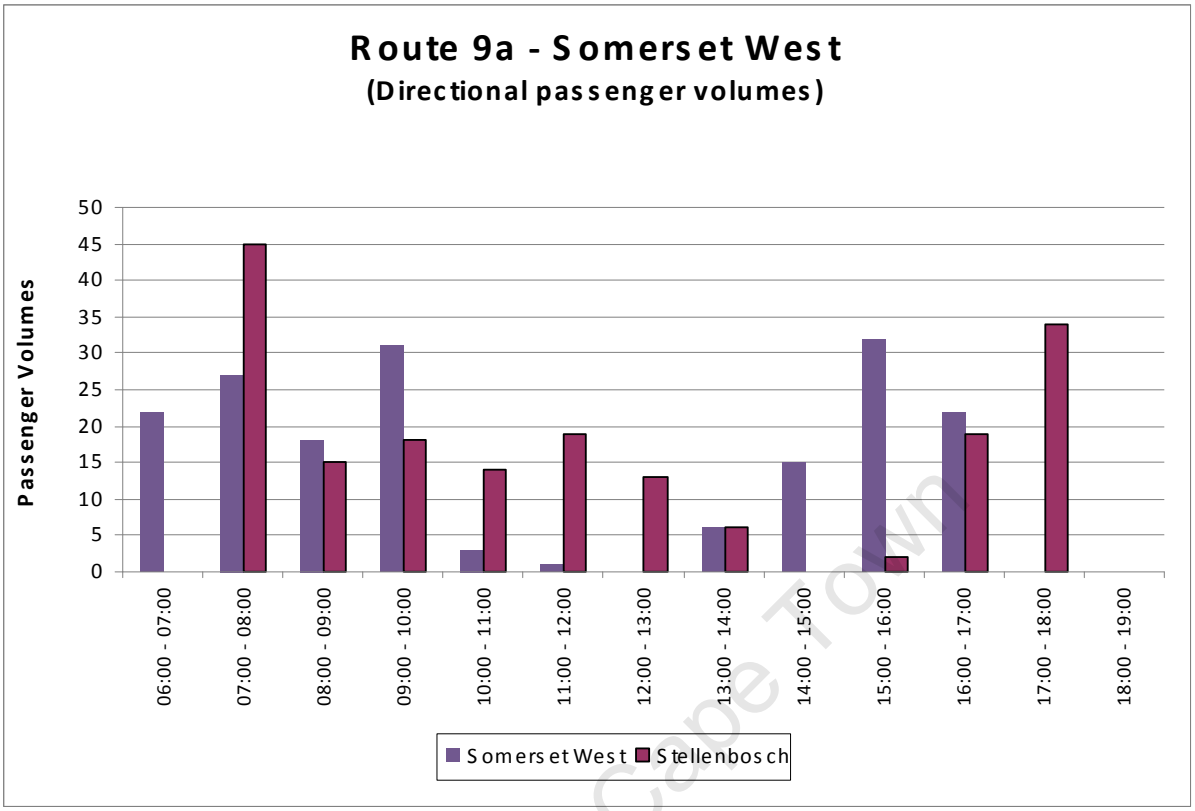


Figure 9.1: Somerset West (STA) Passengers by Direction

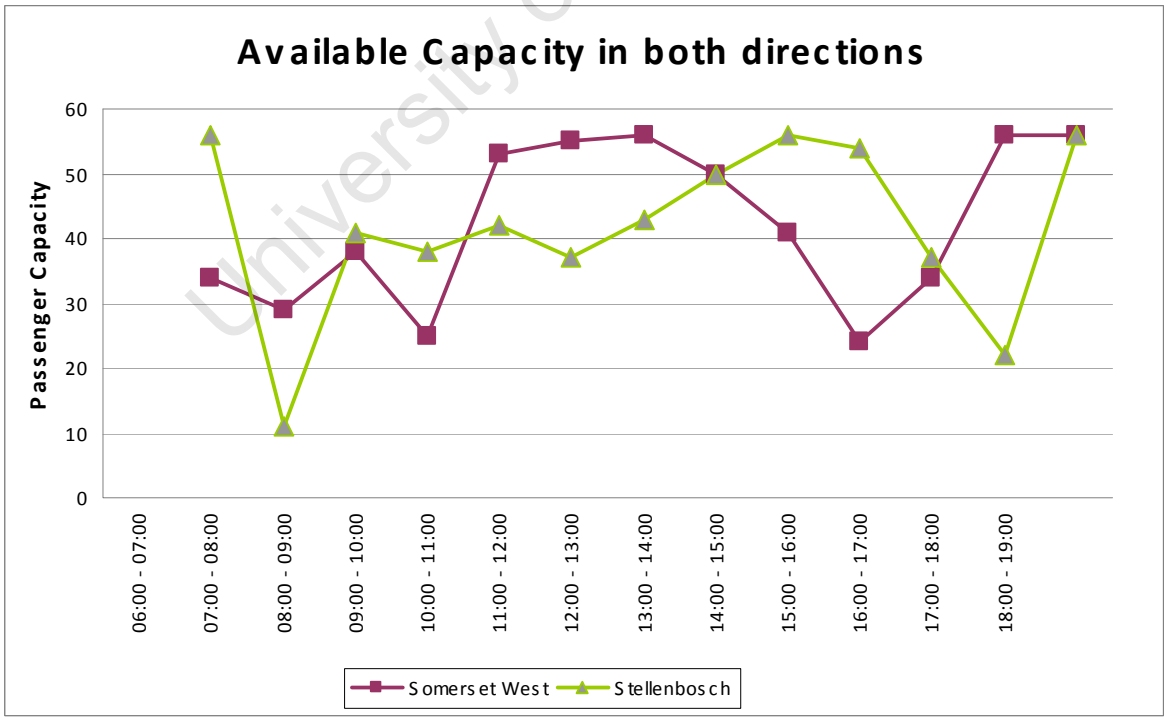


Figure 9.2: Available capacity on Somerset West (STA) Route *(assumes 4 vehicles, 1 roundtrip/hr)*

Kayamandi Taxi Association

The Somerset West route currently being served by the Kayamandi Taxi Association is summarised in Table 9.2 below. Currently this route departs from the Kayamandi taxi rank in Masithandane Street. This route operates mainly on a demand basis and is not registered with the OLB as yet, although an application has been made which is still pending.

Table 9.2: Summary information for Somerset West (KTA)

Route Number	Route 9b	**OLB Code**	Not registered
Route Name	Somerset West	**Taxi Association**	KTA
Location of taxi departure point	Kayamandi taxi rank	**Route Distance**	22km
No. of vehicles	10	**Estimated route capacity per hour**	140
Vehicle Registration Numbers	CL59928, CL54850, CL54333, CL42327, CL41035 CL39031, CL36247, CL26150, CL11304, CL19431		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Somerset West**
	60 min	**30 min**	**30 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	451	258	136

Figure 9.3 shows the total passengers per direction for the Somerset West (KTA) route. The results clearly show that this is not a frequent route with passenger demands only in the morning and afternoon peak periods. There is a high passenger demand (approximately140) towards Somerset West between 6:00 and 8:00 and towards Stellenbosch (approximately 100) between 7:00 and 9:00 with fewer passengers boarding in the PM peak.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 9.4 show that this route has a large amount of spare capacity during the off-peak period. There are more than 140 seats available between 10:00 and 14:00 on the 10 vehicles in both directions.

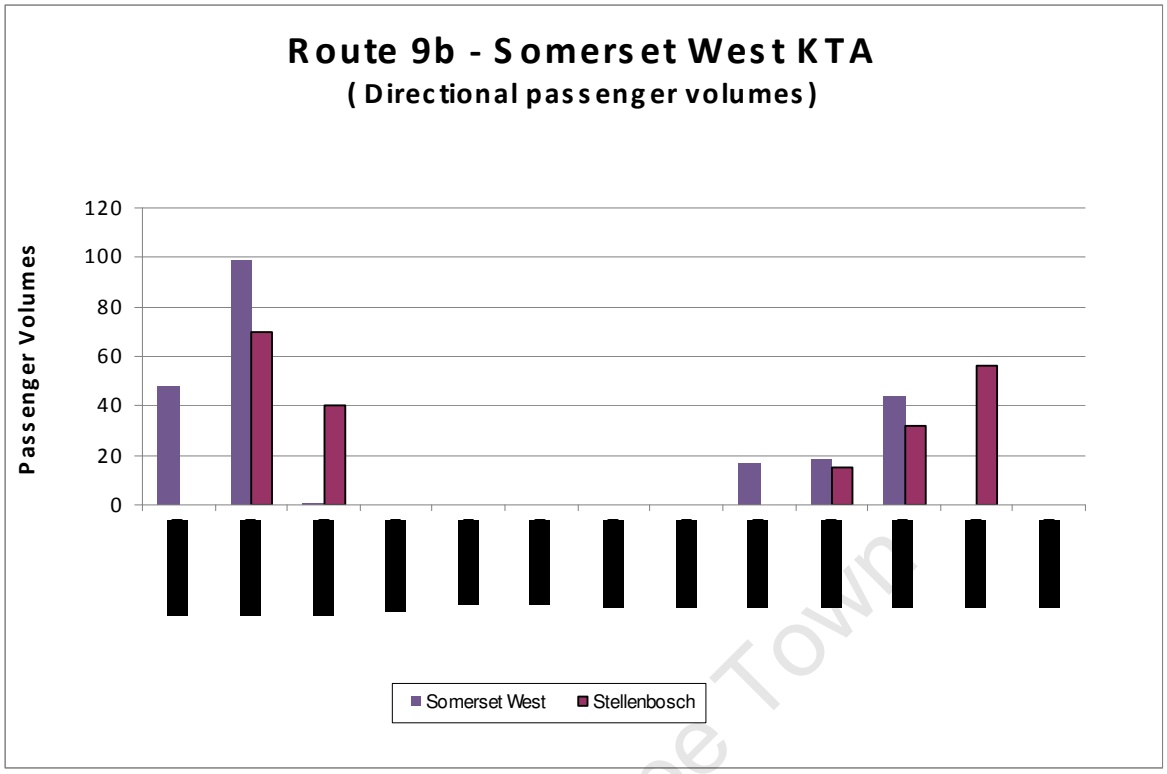


Figure 9.3: Somerset West (KTA) Passengers by Direction

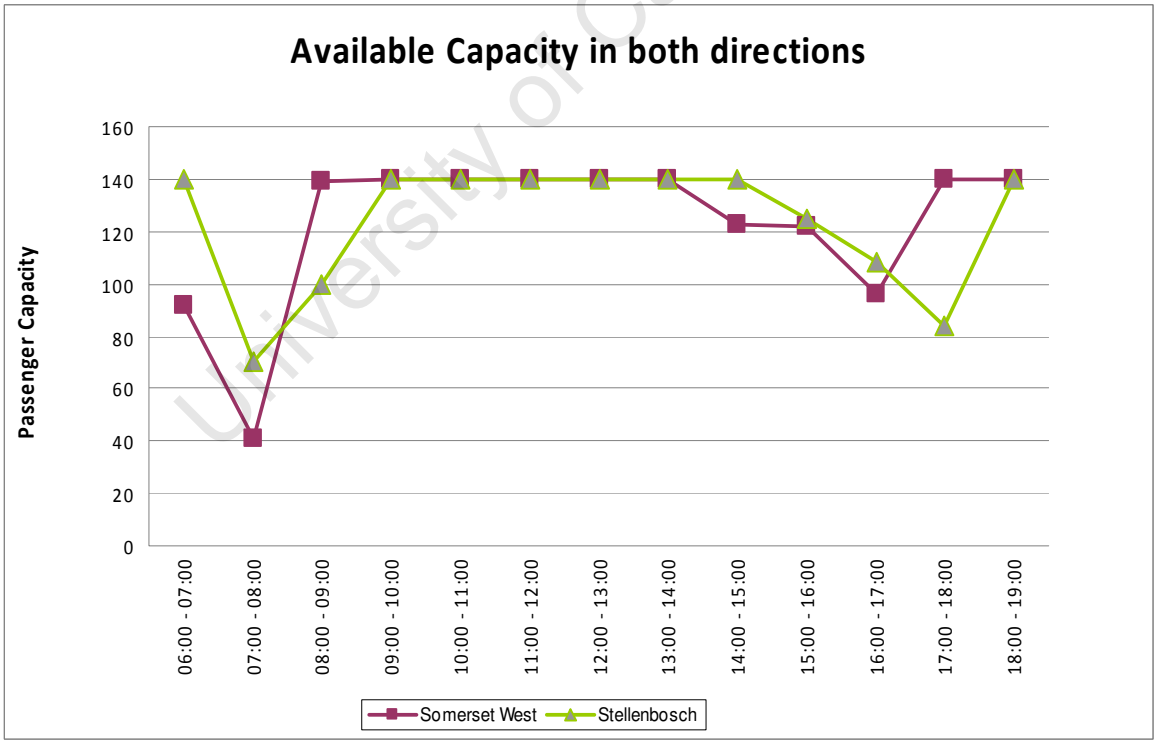


Figure 9.4: Available capacity on Somerset West (KTA) *(assumes 10 vehicles, 1 roundtrip/hr)*

10. ROUTE 10: VLOTTENBURG (OLB NO. 663)

Vlottenburg is situated approximately 9 km south of Stellenbosch town centre. The route to Vlottenburg contains a number of wine estates and is regarded as one of the main tourist routes. A total of 165 passengers were recorded along this route, with 2 taxis currently servicing the route. The average travel time is approximately 30 minutes roundtrip with 20 minutes towards Vlottenburg and 10 minutes towards Stellenbosch town centre during the peak periods. Currently this route departs from the Merriman taxi rank in Merriman Street. Table 10.1 summarises the information obtained for the Vlottenburg route.

Table 10.1: Summary information for Vlottenburg

Route Number	Route 10	**OLB Code**	663
Route Name	Vlottenburg	**Taxi Association**	STA
Location of taxi departure point	Merriman Taxi Rank	**Route Distance**	12 km
No. of vehicles	2	**Estimated route capacity per hour**	56
Vehicle Registration Numbers	CL 55497 CL 14561		
Average Route Travel Time	**Roundtrip**	**Inbound to Stellenbosch**	**Outbound to Vlottenburg**
	30 min	**20 min**	**10 min**
Passengers	**All Day (5:00-19:00)**	**AM Pk Period (6:00 – 9:00)**	**PM Pk Period (15:00 – 18:00)**
Boarding	165	43	23

The figures below summarises the passenger information for the Vlottenburg route. Figure 10.1 shows the total passengers per direction. From the results it is observed that this route is more active during the off-peak periods with a greater demand in the Vlottenburg direction. The highest number of passengers boarding (25 passengers) is recorded between 13:00 – 14:00.

Some rough estimations for capacity was carried out based on the number of vehicles and the approximate roundtrip travel time. Figure 10.2 shows the available capacity throughout the day with more than 20 seats available on the 2 vehicles on route in both directions.

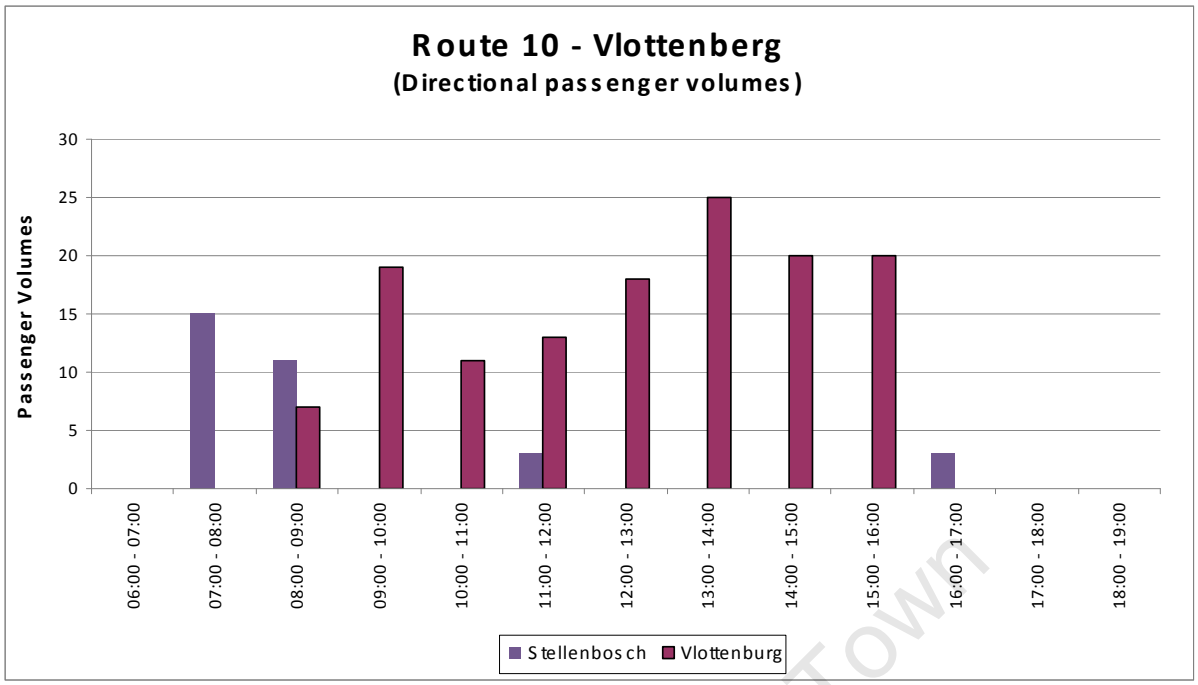


Figure 10.1: Vlottenburg Passengers by Direction

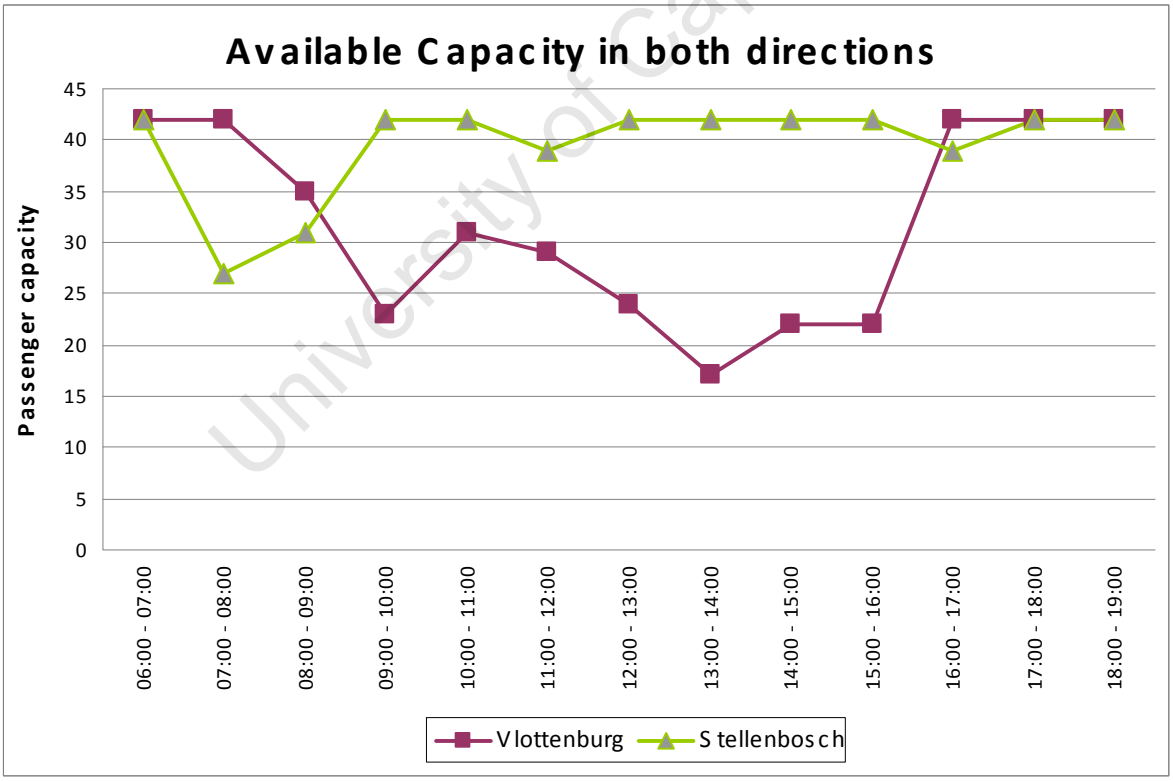


Figure 10.2: Available capacity on Vlottenburg Route *(assumes 2 vehicles, 1.5 roundtrips/hr)*