LAND-USE TRANSPORT STRATEGIES TO COPE WITH SUBURBANISATION

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DECLARATION

I the undersigned, hereby declare that the work contained in this dissertation is my own original work and has not previously in its entirety or in part been submitted at any university for a degree.

Nicolaas Jacobus Walter van Zyl

SUMMARY

Suburbanisation is a world-wide phenomenon and is characterised by the decline of central business districts and accelerated growth of commercial activities in the suburbs. The impact of suburbanisation is wide-spread and multi-dimensional, affecting the whole urban system in terms of its structure, activity and transport patterns.

In South Africa, suburbanisation, together with the impact of the former group areas policy, has made suburban developments less accessible to the low-income groups living on the edges of the metropolitan area. Planners have proposed various urban densification strategies for the rather unique problems of the spatially inefficient South African cities, including corridor development along main public transport routes and the development of activity nodes. In order to implement these urban densification strategies successfully, it is important to understand the locational choice behaviour of business managers, and the factors that will attract them to locate in a certain area. This will enable metropolitan authorities to evaluate and implement the best policies to promote development of priority corridors and nodes

The research for this dissertation was motivated by the extensive problems of suburbanisation, the lack of knowledge on the relative impact of land-use transport factors on the locational choices of businesses, and the apparent limited application of stated preference (SP) survey techniques and discrete choice models to spatial choices of businesses for urban planning purposes. The main objectives of the research were to determine the locational choice behaviour of retail businesses in strategic spatial terms, and how this knowledge can best be used to manage suburbanisation.

The dissertation reviews international and South African studies on the planning and policies of the main role players in the urban system relating to retail suburbanisation, i.e. the planning authority, retail firms and consumers.

The dissertation discusses the results of the market research that was done among Cape Town retailers located in the CBD, and in low- and high-income suburbs. The survey collected quantitative information regarding the locational choice factors of retail managers, importance ratings of choice factors as well as stated preferences for CBD and suburban locations. The calibration results of various discrete locational choice models are discussed, including elasticities of choice factors obtained from model applications to the SP data. The development of a spreadsheet locational choice model based on typical characteristics of CBD and suburban locations is subsequently discussed. Elasticities of choice factors from the application of the spreadsheet model were determined and the model was also used to test a decentralisation trend scenario and a managed suburbanisation scenario.

The dissertation makes conclusions and recommendations regarding the most important locational choice factors of retail managers, and the most effective policies and strategies for metropolitan authorities to manage suburbanisation and promote urban densification. The performance of SP models applied to spatial choices are also evaluated and recommendations are made regarding their application and further research needs.

OPSOMMING

Stedelike desentralisasie is 'n wêreldwye verskynsel wat gekenmerk word deur die verval van sentrale sakegebiede (SSG) en die snelle groei van handelsbedrywighede in voorstede. Die impak van desentralisasie is verreikend en multi-dimensioneel en beïnvloed die hele stadstelsel in terme van sy struktuur, aktiwiteite and reispatrone.

In Suid Afrika het desentralisasie saam met die impak van die voormalige groepsgebiedebeleid voorstedelike ontwikkelings minder toeganklik gemaak vir die lae-inkomstegroepe wat op die rand van die metropolitaanse gebiede woon. Beplanners het verskeie stadsverdigtingstrategieë, insluitende korridorontwikkeling langs hoofvervoerroetes en die ontwikkeling van aktiwiteitsnodusse voorgestel om die unieke probleme van die ruimtelik ondoeltreffende Suid-Afrikaanse stede die hoof te bied. Om hierdie stadsverdigtingstrategieë suksesvol te implementeer, is dit egter belangrik om die liggingskeusegedrag van besigheidsbestuurders, sowel as die faktore wat hulle beweeg om hulle in 'n spesifieke gebied te vestig, te verstaan. Hierdie kennnis sal metropolitaanse owerhede in staat stel om beleid te evalueer en die beste beleidsopsies te implementeer om die ontwikkeling van voorkeurkorridors en nodusse te bevorder.

Die navorsing vir hierdie verhandeling is gemotiveer deur die omvattende probleme wat deur stedelike desentralisasie veroorsaak word, die gebrek aan kennis oor die relatiewe impak van grondgebruik-vervoerfaktore op die liggingskeuse van besighede, en die klaarblyklik beperkte toepassing van verklaarde-voorkeuropnametegnieke (V V) en diskrete-keusemodelle op die liggingskeuses van besighede vir stadsbeplanningsdoeleindes. Die hoofdoelstellings van die navorsing was om die liggingskeusegedrag van kleinhandelbesighede in strategiese ruimtelike terme te bepaal en vas te stel hoe hierdie kennis gebruik kan word om stedelike desentralisasie te bestuur.

In hierdie verhandeling word 'n oorsig gegee van die internasionale en Suid-Afrikaanse studies oor die beplanning en beleid van die belangrikste rolspelers in the stadstelsel wat desentralisasie van kleinhandel betref, naamlik die beplanningsowerheid, kleinhandelfirmas en verbruikers.

Die resultate van marknavorsing onder kleinhandelaars vanuit Kaapstad se SSG en lae- en hoë-inkomstevoorstede, word bespreek. Die opname het kwantitatiewe inligting oor die liggingskeusefaktore van kleinhandelaars, die belangrikheid wat hulle aan keusefaktore heg, en hulle verklaarde voorkeure ten opsigte van vestiging in die SSG of die voorstede, ingesamel. Die kalibrasieresultate van verskeie diskrete-keusemodelle word bespreek, insluitende die elastisiteite van keusefaktore wat deur die toepassing van die model op V V-data verkry is. Vervolgens word die ontwikkeling van 'n liggingskeusemodel in 'n spreitabel wat op tipiese kenmerke van SSG- en voorstedelike liggings gebaseer is, bespreek. Elastisteite van die liggingsfaktore is bepaal deur die toepassing van die spreitabelmodel, en die model is ook gebruik om 'n desentraliasietendensscenario en 'n bestuurdedesentralisasiescenario te toets.

Ten slotte word daar gevolgtrekkings en aanbevelings gemaak oor die belangrikste liggingskeusefaktore van kleinhandelaars, en die mees effektiewe beleidsopsies en strategieë wat metropolitaanse owerhede kan volg om stedelike desentralisasie te bestuur en stadsverdigting te bevorder. Die werkverrigting van V V-modelle wanneer dit op die liggingskeuse van besighede toegepas word, word ook geëvalueer en aanbevelings word gemaak oor die toepassing daarvan en verdere navorsing wat nodig is.

FOREWORD AND ACKNOWLEDGEMENTS

Foreword

The trend of urbanisation and suburbanisation can be said to be the story of my personal life. Our family became urbanised in 1965 when we moved from a small town in the Northern Cape to Pretoria to be close to a major university for further education purposes. We rented a flat in the Hatfield business suburban node next to a shopping centre and a train station. My parents commuted to the CBD by train that was well utilised and more convenient than car. When doing shopping for speciality goods such as clothing or furniture, we went to the CBD. We often travelled to town by bus. At that time the urban edge was a few kilometres further and it was formed by the Lynwood Ridge and Lynnwood Park suburbs.

During my student years, in 1974, we bought a house in Faerie Glen, some 5 kilometres further out. At that time, Faerie Glen formed the urban edge. My parents still tried to commute by bus to the CBD, but often reverted back to car as the travel time by bus was quite long. When I started to work in 1977, I moved out of my parents' house to rent a flat in Sunnyside because it was close to recreational opportunities and alive with other young people. I subsequently bought a flat in Sunnyside and met my future wife there.

My university education allowed me to earn a good income, and I could afford a car and a house in the suburbs. Therefore, after our marriage, we bought a house and moved back to the suburbs, close to the Menlyn shopping centre. At the time Menlyn shopping centre was just a large grocery store and a few shops. My wife and I commuted by car, and we did all our shopping in the suburbs. The continuous development of the Menlyn node, which crept closer and closer to our house, forced me to move a few kilometres further to a quieter suburb. The Menlyn node now consists of a mega shopping centre, office parks, a smaller retail centre and a motor city. We currently only visit the CBD if we are forced to. At such times the buildings look old and a bit rundown. The CBD is also not very clean. The hawkers have created a different kind of environment in the CBD, and one feels a bit unsafe because one often hears of theft and attacks in the CBD.

Our domestic worker lives in Mamelodi and commutes by bus. She never complains, but research on the impact of suburbanisation on travel patterns in 1991, that I was involved in, made me realise that the benefits of urbanisation that we enjoyed, were more of a negative experience for the captive public transport users living in the Mamelodi's of our cities. I am glad that I could contribute in a small way, hopefully, to bring the benefits of the suburbs closer to our Mamelodi people. In the mean time, I am just watching how the urban edge moves out further and further, jumping across Hans Strijdom Avenue that used to be a rural road when we arrived in Pretoria.

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GLOSSARY OF TERMS

The terms and abbreviations used in this dissertation, in alphabetical order, have the following meanings:

Accessibility

Accessibility is a function of both the mobility offered by the transport system and the degree of physical separation between the origin and destination of a trip.

Activity-based model (ABM)

A transportation model that considers travel demand as derived demand from activities of households and their members and that uses activity diaries as data input.

Aggregate model

Aggregate models are mathematical representations of data, such as trips, population and employment, grouped together for each sub-region, or zone, of the study area. Typically, the model will estimate the transport volumes between zones, the population and employment of each zone.

Categorical judgement analysis (CJA)

This is a statistical technique for analysing ratings on a semantic scale, such as an importance rating on a scale from 1 to 5. The technique fits a normal distribution through the ratings of a group of people and estimates importance weights on a scale from 0 to 1. The technique also indicates these weights relative to the semantic scale intervals.

Central business district (CBD)

This is the central core of the city consisting of high-rise buildings and offices accommodating a wide range of commercial and employment activities.

Corridor

An activity corridor, traditionally called ribbon development, is a strip of land containing a main road, or activity spine, that accommodates different travel modes, carrying high volumes of traffic, and providing accessibility between passing traffic and roadside establishments. The corridor also contains a parallel limited-access right-of-way for fast-moving traffic, such as a freeway or a railway line. The corridor further links a large number of major traffic generators along its length and major commercial and employment nodes at the ends of the corridor.

Decision table

A table representing the exhaustive set of mutually exclusive conditional expressions within a pre-defined problem area - a popular technique used in activity-based models.

Discrete choice model

Discrete choice models, or individual choice models, or disaggregated choice models, are mathematical representations simulating the travel choices, such as which travel mode to use, where to shop, live or work, of individuals based on data describing the characteristics of the alternatives, and the socio-economic characteristics of the individual. The model is often based on the multi-nomial logit function, and is derived from micro-economic theory of people's choices that states that a person will try to maximize the utility, or general benefit, that he/she can derive when he/she chooses between alternative travel modes, or any other type of product or service. Typically, the logit model estimates the probability that a person would, for example, use a car or a bus to make a trip.

Elimination-by-aspects

The elimination-by-aspects (EBA) model is a discrete choice model that considers the most important attribute of alternative options, and eliminates all the alternatives which do not satisfy the threshold level of acceptability of that attribute. The process is repeated for the second highest ranked attribute, and so on, until only one alternative is left. This model is therefore based on non-compensatory decision rules, as opposed to compensatory rules in which a good factor compensates for a bad factor.

Experimental design

This is a well-known statistical technique to design an experiment that will ensure that the independent variables of a measurement of interest are varied independently from each other, showing no correlation, so that the impact of the independent variables on the dependent variable of interest can be estimated. This is usually applied when the researcher deals with a large number of possible combinations of variables, and he needs to select only a few combinations to conduct his experiment. The technique is used in stated preference studies to design a questionnaire that offers the respondent various combinations of the characteristics of alternative travel options. The technique ensures that the correct selection of a limited number of combinations of characteristics, amongst a wide range of possible combinations, is used in the experiment. This ensures that the logit model that is calibrated on the data provides a statistically sound simulation of the data.

Gross leasable area (GLA)

This is the square metre (m^2) of floor space in a shopping centre or office block that can be rented for commercial use and it excludes staircases and corridors that cannot be leased.

High-income groups or people

These are typically people who have not been affected by the previous government's group areas policies, who generally have high incomes and own cars.

High-income suburbs

These are suburbs where predominantly high-income people reside. (See definition of high-income people.) These suburbs have been targeted by developers for the development of shopping centres and office blocks, and they also have very good transport infrastructure and engineering services.

High occupancy vehicle (HOV)

High occupancy vehicles refer to vehicles with a high number of occupants such as buses, mini-bus taxis and cars with 2 or more occupants. HOV lanes and other measures are typically used to promote the use of high occupancy vehicles.

Independence of irrelevant alternatives (IIA)

The multi-nomial logit model suffers from the so-called independence of irrelevant alternatives property (IIA), which indicates that the relative probabilities of any two alternatives are unaffected by the presence of any other alternatives. In the case of similar or correlated alternatives, the model yields incorrect results. The probit model (MNP) and nested logit models overcome this problem

Integrated development plan (IDP)

Integrated development plans, initially called land development objectives, are plans required by the Local Government Municipal Structures Act (Act No. 117 of 1998) that local authorities need to formulate in terms of a programme of projects and budgets over the short and long term to address all planning functions of the authority in an integrated manner with full participation of the public and other stakeholders. These typically address land-use, transport, engineering services, social development, economic development, institutional development and a financial plan.

Integrated land-use transport model

These models are also called interactive land-use transport models, and they are mathematical representations on computer that simulate the short-term and long-term interactions between land-use and transport. Typically the model will estimate both population and employment for each zone in the study area, as well as transport volumes on the transport network. The models often link conventional transport models with land-use models and the two models iterate until they converge. Well-known models in S.A. are the MEPLAN model and the HLFM2 model.

Integrated transport plan (ITP)

Integrated transport plans are required by the National Land Transport Transition Act, 2000 (Act No. 22 of 2000), in terms of which transport authorities have to prepare a short-term and long-term plan addressing all aspects of transport services and infrastructure in an integrated way. The ITP should also be fully integrated with the IDP.

Locational choice

Locational choice refers to the choice that business managers make when they decide on a specific location in the urban area for their business. In the context of this dissertation the choice to locate in either the CBD or the suburbs, was investigated.

Low-income groups or people

This term refers to people who were disadvantaged by the previous government's group areas policy. Typically these people have low incomes, are captive to public transport, and live in dormitory townships on the outskirts of urban areas.

Low-income suburbs

These are suburbs where predominantly low-income people reside and are also referred to as townships. (See definition of low-income people.) These suburbs are generally characterised by poor infrastructure and are mainly dormitory areas. Recently some convenience shopping centres have been developed in these areas.

Mobility

Mobility is defined as the ease with which a person can move between the origin and destination of a trip.

Mode

A way or means of travel within the city such as a car, bus, mini-bus taxi or train.

Multi-nomial logit model (MNL)

This is a discrete choice model that assumes that the random, or error term, of the utility of an alternative follows the Gumbel distribution and that the error terms of the various alternatives are independent and identically distributed (IID). This allows the coefficients of the variables in the model to be estimated by means of a convenient mathematical algorithm based on the observed set of attributes of each alternative.

Multi-nomial probit model (MNP)

This is a discrete choice model that assumes that the random, or error term, of the utility of an alternative follows a normal distribution. This model overcomes the IIA limitation of the MNL model, but it is more difficult to calibrate.

National passenger panel (NPP)

A random stratified sample of public transport commuters selected from the main urban areas in South Africa, who were interviewed on a regular basis by the National Department of Transport to monitor travel patterns and attitudes towards transport policy.

Network transport models

This is another term for the conventional four-step transport model to distinguish it from discrete choice or individual choice models. The conventional transport model operates on a representation of the transport network consisting of links and nodes coded on computer. Discrete choice models, on the other hand, do not require such a coded network. Well-known transport models in S.A. are EMME/2 and SATURN.

Node

Activity nodes are localized areas where there is a concentration of commercial and office-based activities, and are often developed near one or two intersections of high-order transport routes.

Previously disadvantaged people (PDI)

See definition of low-income people.

Retail and retailer

Retail trade is the resale, without transformation, of new and used goods and products to the general public for household use. A retailer is an enterprise deriving more than 50 per cent of its turnover from retail trade.

Revealed preference (RP)

Revealed preference surveys and models refer to the survey method of collecting data from a sample of people on their historic travel choices. Observing people's actual choices reveals their current preferences. These data are used to calibrate discrete choice models.

Shopping centre definitions

The following categories of shopping centres have been used:

Regional:	centres larger than 30 000 m^2 gross leasable floor area.
Community:	centres of between 10 000 and 30 000 m^2 gross leasable floor area.
Convenience:	centres of between 5 000 and 10 000 m^2 gross leasable floor area.

Sketch planning model

Sketch planning models are simplified versions of the conventional transport models that use a more coarse zoning system, a more coarse transport network, and default parameters of trip generation rates and other calibration parameters. The models are cheap and easy to calibrate and to use for policy testing

Stated preference (SP)

In contrast to revealed preference, stated preference surveys and models refer to the survey method used to collect data from a sample of people on their stated preferences when offered hypothetical travel scenarios in terms of various combinations of the attributes of the alternative transport mode, route, product or service.

Suburbanisation

Suburbanisation, or urban decentralisation, is the process of the decentralisation of retail, office and other commercial functions from the central urban area to outlying areas within the boundaries of the city.

Urban activity model

Urban activity models, or land-use models, are mathematical representations on a computer of the urban activities such as residential, employment, commercial, office, etc, estimated for various zones of the study area.

Value of time

The value of time is the monetary amount, say Rand, that travellers will be willing to pay to save a unit of travel time, say an hour. Typically, it is expressed in Rand per hour. Planners use the value of time in economic evaluation studies, or in traffic and transport models to simulate the route choice of traffic. It is therefore a means of translating time into monetary terms in order to combine it with road user costs as a measure of the total "generalised" cost of vehicle operations.

LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations have been used:

ABM

Activity-based model

CMC

Cape Town Metropolitan Council.

CJA

Categorical judgement analysis

EMME/2

EMME/2 is the commercial name of a popular conventional four-step transport model.

EBA

Elimination-by-aspects

GLA

Gross leasable area

GPMA

Greater Pretoria Metropolitan Area.

HLFM2

Highway land-use forecasting model – an integrated land-use transport model used for sketch planning purposes.

HOV

High occupancy vehicle.

IATBR

International Association for Travel Behavior Research

IDP

Integrated development plan

IIA

Independence of irrelevant alternatives

ISGLUTI

International Study Group on Land-use Transport Interaction

ITP

Integrated transport plan

MEPLAN

Commercial name of an integrated land-use transport model supplied by Marcial Echenique & Partners, also called MEP.

MNL

Multi-nomial logit model

MNP

Mult-nomial probit mode

NDOT

National Department of Transport

NPP

National passenger panel

RP surveys, models and studies

Revealed preference surveys, etc.

SAICE

South African Institute for Civil Engineers

SANPAD

South African – Netherlands Research Programme on Alternatives in Development

SAPOA

South African Property Owners Association

SARB

South African Roads Board

SARCC

South African Rail Commuter Corporation

SIC

Standard Industrial Classification: classification system of economioc sectors used by Statistics SA

SP surveys, models and studies

Stated preference surveys, etc.

Statistics SA

Statistics South Africa: Government department responsible for national statistics.

VOT

Value of time: Normally indicated in terms of Rand per hour travel time.

1. INTRODUCTION

1.1 PROBLEM STATEMENT

Suburbanisation is a world-wide phenomenon and is characterised by the decline of central business districts and accelerated growth of commercial activities in the suburbs. Traffic congestion and limited parking in central business districts (CBD), increased car ownership and urban sprawl caused retailers to follow their markets to the suburbs. Businesses in the service sector followed retail development to be closer to their employees and to enjoy the quiet and attractive environment of the suburbs.

Suburbanisation has lead to several problems, i.e. the negative impact of traffic in residential areas and a decline in the accessibility of employment opportunities to people from the low-income groups living in inner-city areas. Surveys conducted in Pretoria in 1991 indicated that suburbanisation, together with the former group areas policy, has made suburban developments less accessible to the low-income groups living on the edges of the metropolitan area (Cameron, Van Zyl, Naude and Loubser, 1991). These groups are captive to public transport, which is geared to serve the CBD. Suburbanisation has also lead to an oversupply of office and retail space in the suburbs.

The study in Pretoria proposed the development of transit corridors as the most effective way of countering the negative impact of suburbanisation. This involves the development of high density mixed land-uses along major arterials running parallel to rail lines linking low-income areas to the CBD. In this way public transport will be made more viable and access from low-income areas to shopping and employment opportunities will be improved.

The surveys conducted in Pretoria among business managers, indicated that transport issues, such as traffic congestion, availability and price of parking and accessibility to employees and clients, played a role in their decisions to locate in either the CBD or the suburbs (Cameron, Van Zyl, Naude and Loubser, 1991). Other factors, such as the environment, proximity to shops, rates and rents and space requirements played a lesser role. However, the study did not quantify the relative impact of these factors on business managers' choice to locate either in the CBD or the suburbs.

Planners have proposed various urban densification strategies for the rather unique problems of the spatially inefficient South African cities (Naude and Green, 2000, University of Pretoria, 2001). These are:

- Corridor development, i.e. high densities along transport corridors.
- Promoting compact cities and defining the urban edge i.e. contain development within defined boundaries.
- Land infilling, i.e. developing vacant land between outlying townships and the central developed areas.

The expected benefits of these strategies are that the transport system will be more efficient and effective, land will be better utilized, while the lower land-use and transport costs will release funds for higher priority activities and services, and people will be more productive. This will facilitate the government's policy of promoting and improving public transport, as public transport is better geared towards serving higher land-use densities.

A crucial problem facing urban authorities in South Africa is to identify the most effective policies and strategies to achieve the desired urban densification objectives. Assuming that South Africa will remain a free market society where people and businesses can choose where to live and do business, authorities need to make use of the normal land-use and transport regulatory controls, as well as incentives and disincentives to achieve a desired urban land-use transport system. To achieve this, authorities need to understand the locational choice behaviour of the different role players in the urban system, and need to quantify the elasticities of the main factors driving locational choice.

Aggregate, interactive land-use transport models offer a useful method of testing strategic suburbanisation policies on the performance of the urban system and these have been applied extensively internationally, and to a very limited extent locally. However, for the purpose of the dissertation, the conventional land-use transport models did not offer the best analytical tool due to various limitations, the most important being their lack of detail and a sound behavioural basis. The latest trend in integrated land-use transport models, which do provide a sound and more detailed behavioural basis for simulating urban activities, follows an activity-based modelling (ABM) approach. Current operational models are limited to the short-term activity choices of households, while models simulating short- and long-term choices of households and businesses are still in the research and development phase. The high cost and huge resources required to develop such models prohibit planning authorities in developing countries to consider the ABM approach seriously.

Discrete choice models, which simulate decision-makers' choice behaviour more accurately, have been applied very successfully to various urban travel and spatial choices. These models are relatively cheap to develop, as they are based on relatively small sample sizes. They are flexible in that a large number of variables can be included, and the models are sensitive to changes in input variables. Stated preference (SP) survey techniques have become very popular internationally and locally as they overcome the problems of revealed preference (RP) survey data, which limit the performance of discrete choice models. SP techniques, specifically, offer many advantages in analysing the locational choices of businesses. One of the main advantages is that an experiment can be designed that would test the reaction of business managers to any choice situation of interest.

In summary, the following specific problems and issues motivated the author's research:

- The lack of knowledge on the important factors that influence business managers' decisions to locate in the CBD or the suburbs, and the extent to which land-use and transport factors impact on the locational choices of businesses.

- The severe problems associated with suburbanisation and urban sprawl, especially in the unique South African situation, which prompted planners at all spheres of government to promote urban densification and the use of public transport, and to integrate the post-apartheid cities.
- The apparent limited application of discrete choice models to spatial choices of businesses for urban planning purposes, and the need expressed internationally to apply SP models to longer-term spatial choices.
- The potential of SP models to provide a behaviourally sound and affordable analytical tool to test suburbanisation policies for metropolitan planning authorities in a developing country such as South Africa.

1.2 MAIN OBJECTIVES

In view of the above problems, the main objective of the dissertation is to understand the locational choice behaviour of businesses in strategic spatial terms, and how this knowledge can best be used to achieve the objectives of urban densification and managing suburbanisation. In more specific terms, by quantifying the relative impact of various factors on the choice of businesses to locate in the CBD or the suburb, the most effective policies to manage suburbanisation can be identified.

A secondary objective was to test the performance of SP models to simulate the locational choice behaviour of business managers. If successful, such models would provide a good behavioural modelling tool to be used by metropolitan authorities to test suburbanisation policies, as well as other spatial policies.

The more specific objectives of the research were therefore:

- *to conduct market research among business managers to quantify the factors that influence their choice of locating in the CBD versus the suburbs, and to determine their attitudes and preferences towards these locations;*
- *to develop a behavioural locational choice model of business managers using SP techniques;*

- *to determine the relative importance and impacts of locational choice factors as well as the elasticity of suburbanisation with respect to these factors;*
- *to apply the locational choice model to demonstrate its capability to test policies that will promote urban densification and assist authorities to cope with, and manage, suburbanisation; and*
- *to evaluate the performance of SP models applied to the spatial choices of businesses.*

To focus study resources, the retail sector, which plays an important role in the land-use transport system of the urban area, was selected for the purposes of the dissertation. The premise was that with a good understanding of retail businesses' locational choice behaviour, demand for retail space may be influenced by implementing the right mix of land-use/transport policies and strategies. In this way mismatches between supply and demand in retail space can be addressed and development can be attracted to dedicated public transport corridors and primary development nodes as part of an overall urban densification strategy.

1.3 Research Methodology and Scope

To develop the various components of the knowledge-base necessary to achieve the objectives of the dissertation, it was necessary to include certain secondary topics in the literature review. A brief explanation is provided here to explain the role of the various topics reviewed in supporting the research. The subsequent empirical research activities carried out to achieve the objectives of the dissertation, are also briefly summarised.

International literature review:

Four broad focus areas were covered in the international literature review: The first two focus areas relate to the planning and policies of the main role players in retail suburbanisation, i.e. the planning authority, retail firms and consumers. The first focus area relates to suburbanisation trends and the evaluation of various policies from the metropolitan planning authority's point of view. Policy impacts based on empirical evidence and on the application of land-use transport models are summarised. The results of the policy tests conducted by the models also help to understand the relative impacts of various factors, which are not always possible to determine from empirical trends.

The second focus area addresses the locational choice of retail firms and consumers, which are strong determinants of suburbanisation. To model retail managers' locational choice behaviour, it is useful to understand the planning processes and factors that retailers consider when selecting the best site for their retail outlets. Consumer preference is one of the key locational choice factors of retailers, and this is also included in the review. As the purpose of the dissertation is not to assist in the logistical planning of retail firms, only a selected number of references were reviewed to obtain a basic knowledge of retailers' planning to satisfy the objectives of the dissertation.

The last two focus areas relate to the planning and modelling techniques that planning authorities use in urban planning to address suburbanisation, and retail firms use in their own planning to select locations for their retail outlets. The purpose of the research was not to develop an improved land-use transport modelling system to simulate suburbanisation. The SP modelling technique was only selected to understand the locational choice behaviour of retail firms as a strategic planning tool for metropolitan authorities , and to test whether such a model would be valuable in evaluating policies to manage suburbanisation. However, the purpose of the review of the aggregate land-use transport models is to assist in the understanding of the underlying processes driving urban change and the behaviour of the various role players, as well as to put the role of the SP models into perspective in a broader modelling framework. The review of various aggregate land-use, retail, and interactive land-use models therefore only gives a strategic summary of selected literature for the purposes of the research and is by no means a comprehensive review of the wide range of literature that exists.

A review of discrete choice models using RP and SP survey techniques included the basic theory, various model formats, issues that need to be considered, advantages of SP techniques and the latest trends. The application of discrete choice models and SP techniques in urban spatial choices was important to consider. A brief review of residential location choices was included in order to identify the problems and issues of applying discrete choice models to long-term spatial choices. This was due to the fact that more information could be obtained from these applications compared to the rather limited applications to the locational choices of retail firms.

The basic theory and application of attitudinal scaling techniques in market research and in the application of discrete choice models were also reviewed as these techniques were applied to determine the attitudes of retail managers towards CBD and suburban locations.

The last focus area relates to the techniques used to model the choice of retail firms and this was covered in a review of selected literature to gain a better understanding of the locational choice behaviour of this sector. As indicated above, the purpose was not to develop a logistical model to assist retailers in selecting the best outlets.

<u>South African literature review</u>

The review of South African studies attempted to cover research and planning applications to understand the local experience of suburbanisation impacts and policies to address these. This included the results of the application of land-use transport models that were used to test urban densification policies.

A review of the main RP and SP public transport mode choice studies is included in order to understand the important mode choice factors of low-income public transport users, and the implications of these for transport policy to provide acceptable and affordable levels of access to and mobility in development corridors and nodes, especially at decentralised nodes. These studies and basic research conducted are also useful in understanding the performance of SP techniques among South African population groups and problems that need to be addressed when applying these techniques.

Finally the review concluded with the profile of the retail sector in South Africa and the significant problems experienced with retail decentralisation.

Empirical research activities

The author undertook the following empirical research activities to achieve the objectives of the dissertation:

- Conducted market research among Cape Town retail managers in order to quantify the factors that they would consider when making choices to locate in the CBD or the suburbs.
- Calibrated SP locational choice models of retail managers and applied the models to the SP data to quantify the relative elasticities of various factors on locational choice.
- Developed a spreadsheet model to apply the locational choice model to CBD and suburban characteristics based on the survey data
- Determined relative elasticities using the spreadsheet model and tested a few selected policies to demonstrate the performance of the model in evaluating suburbanisation policies.
- Formulated policies that metropolitan authorities can apply to achieve urban densification strategies and manage suburbanisation in view of the results of the literature review and the empirical research.
- Evaluated the performance of SP models applied to spatial choices of businesses and identified further research needs.

1.4 Flow Diagram of Components Addressed by Dissertation and Structure of Report

Figures 1.1a and b are flow diagrams that illustrate how the main components of the dissertation relate to each other. Figure 1.1a gives the topics that were reviewed in international and South African literature, and those aspects that are the main focus of the research conducted for the dissertation. The problems that motivated the research are suburbanisation and urban sprawl within the context of metropolitan areas. As part of metropolitan authorities' policy evaluation process, they apply different planning tools, or models, to evaluate various strategies and policies and to identify the most effective policies. In terms of the problem statement, the urban densification strategies of developing public transport corridors and activity nodes are relevant.

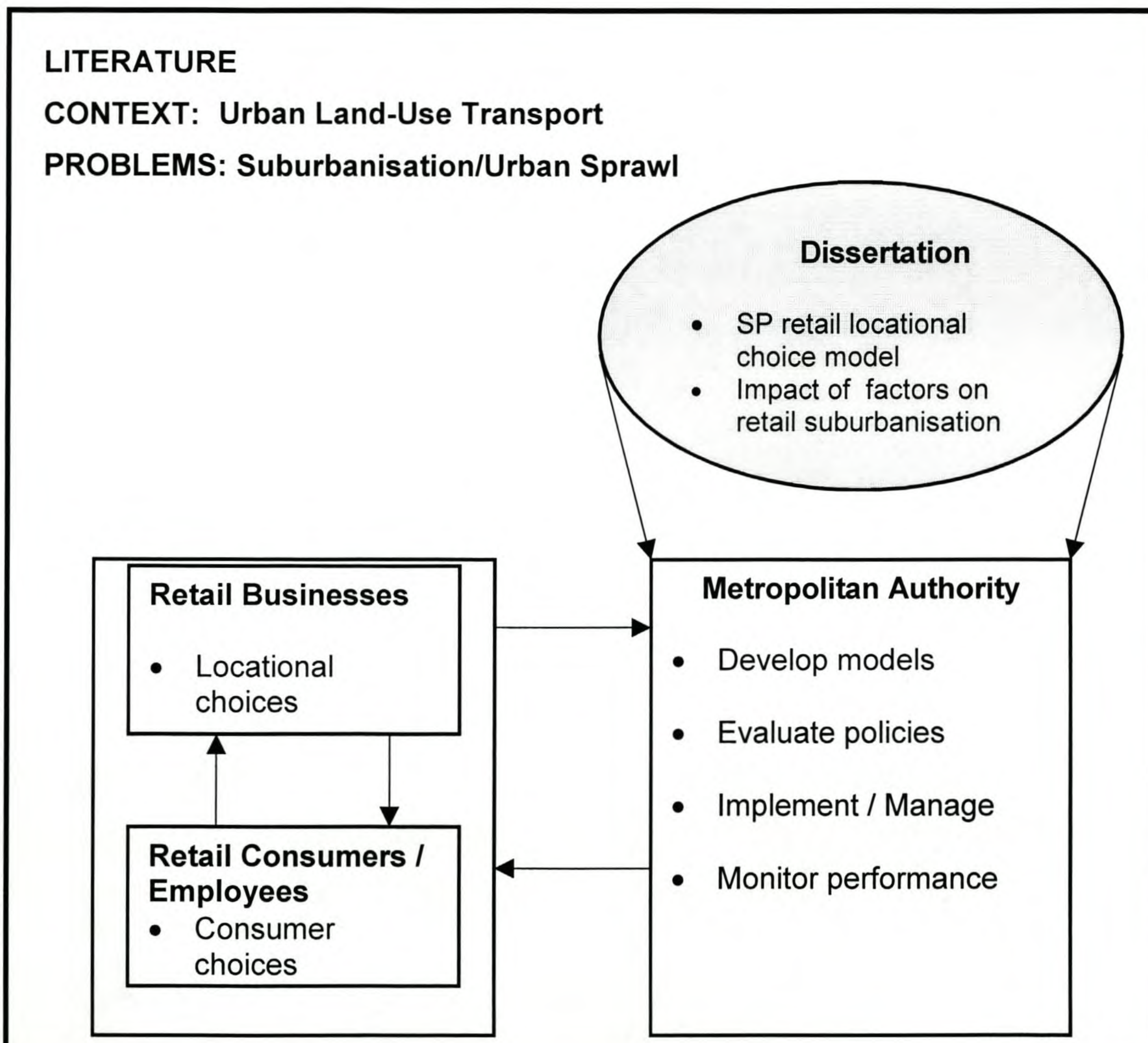


Figure 1.1a: Components of literature review and focus area of research

A critical input into the planning models is surveyed information on the preferences of urban role players, such as business managers and transport users. As part of their overall management function, metropolitan authorities implement the identified policies and monitor the impacts of these policies on the performance of the land-use transport system. The overall purpose of the research is therefore to assist metropolitan authorities in the policy evaluation process by identifying effective policies to pursue to manage suburbanisation and to evaluate appropriate spatial planning models that can be used by authorities in the evaluation process.

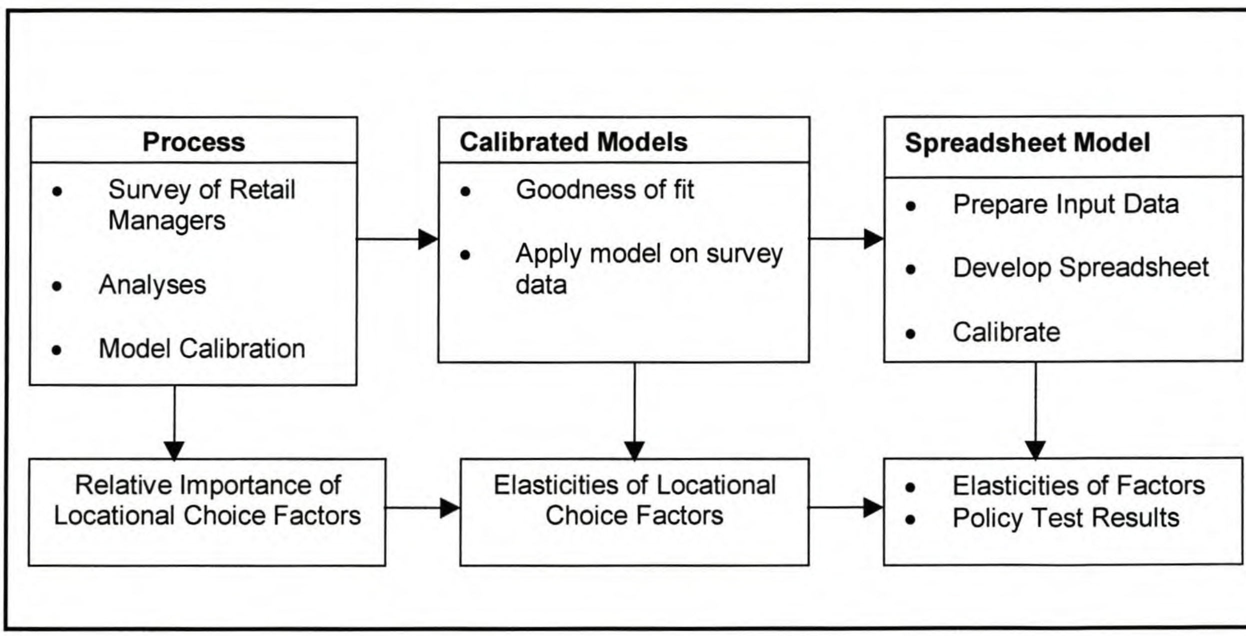


Figure 1.1b: Research process and main outputs

Figure 1.1b illustrates the main research activities conducted for the dissertation and the main outputs. The research focused more specifically on the policy evaluation process relating to a much neglected role player, or urban activity, i.e. the retail sector. The research involved the development of a planning tool to simulate the locational choices of retail managers and the application of this tool to identify the significant choice factors, to determine their elasticities with respect to suburbanisation, and to test typical suburbanisation policies. The analysis of the survey data provided the first output, which is the relative importance weights of locational choice factors of business managers. The second output is the application of the calibrated models to the SP survey data to estimate the elasticities for the choice factors with respect to the market share of the CBD compared to that of the suburb, or, in other words, the level of suburbanisation. The third output is the application of a retail location spread sheet model, which was developed from the calibrated model and the characteristics of the CBD and suburban locations reflected in the survey data, to obtain a refined set of elasticities of the choice factors. Another dimension of this output is the use of the spread sheet model to test the impact of typical policies on suburbanisation. The various outputs were compared to obtain increased confidence in the results.

The various components of the flow diagrams of Figure 1.1 are addressed as follows in the main body of the dissertation:

Chapter 2 sets the theoretical framework based on a review of international literature, covering the following aspects:

- Definition of terminology and concepts.
- Suburbanisation trends, as well as the main causes of the trends, their impacts and proposed policies to manage suburbanisation.
- Land-use and retail location theory and models, which form a good framework for understanding interactive land-use transport models.
- Theories, structure and the performance of interactive land-use transport models and relevant policy impacts identified by these models.
- Optimal site selection for retail outlets from the view-point of the retail business.
- The theory and application of RP and SP discrete choice models, advantages of SP techniques, and attitudinal scaling techniques.
- Application of discrete choice models to housing and retail location, including issues in the application of discrete choice models to spatial choices, residential location, retail business location, and retail consumer location choices.
- Conclusions on international literature review

Chapter 3 focuses on South African experience in terms of the evaluation of urban densification strategies with the use of land-use transport models. The author was intimately involved in many of these studies and a synthesis of the studies provides a valuable context for the main research conducted for this dissertation. The following studies are reviewed:

- Research conducted for the National Department of Transport (NDOT) on the impact of suburbanisation on mobility provided the basic framework;
- The application of interactive land-use transport network models to evaluate urban densification strategies in the East Rand, Pretoria and Cape Town;
- A review of the retail sector in South Africa and retail decentralisation trends, problems and solutions.

Chapter 4 reviews the main RP and SP public transport mode choice studies in South Africa to identify the important transport policy factors that impact on urban densification strategies, and also to evaluate the performance of SP models under local circumstances. The review includes:

- RP surveys and the transferability of RP models
- Review of SP surveys and quality of responses
- Significant factors impacting on mode choice and their monetary values
- Research into the performance of SP models among less-literate commuters

Chapter 5 describes the market research conducted by the author specifically for this dissertation among retail managers in Cape Town. The purpose of the survey was to determine the most important factors considered by retailers in making locational choices, and to provide SP data for the calibration of a discrete choice model. The following aspects are discussed:

- The survey design and the basic survey results in terms of the retail characteristics and the accessibility of the businesses.
- Importance ratings and weights of locational choice factors.
- Retail characteristics of Cape Town for use as input into the retail location spread sheet model.

Chapter 6 describes the SP locational choice models that were calibrated by the author based on the Cape Town retail survey results in terms of the following:

- The calibration procedure and the performance of the models calibrated.
- Elasticities of locational choice factors obtained by the application of the models to the SP survey data.
- The implications of the elasticities for policies to manage suburbanisation.

Chapter 7 describes the spreadsheet model the author developed, based on the calibrated locational choice model and the retail characteristics obtained from the survey. The following aspects are discussed:

- Sensitivity tests of the impact of significant factors on locational choice are compared with the importance weights obtained from the importance ratings provided by the retail managers.
- A decentralisation trend scenario and a managed decentralisation scenario were tested with the model and guidelines are given on the best policies to pursue to manage suburbanisation.
- Proposed method of interfacing the business locational choice model with a typical four-step transport model.

Chapter 8 contains the conclusions and recommendations in terms of:

- An appropriate modelling approach for South Africa .
- A summary of locational choice factors and the role of transport.
- A summary of the impacts of suburbanisation and strategies to manage suburbanisation and promote urban densification.
- The contribution of the dissertation to knowledge.
- Further research needs and recommendations on how metropolitan authorities can apply, and build on, the results of the dissertation.

List of references

Appendix A gives a copy of the questionnaire used for the Cape Town retail survey.

2. REVIEW OF INTERNATIONAL LITERATURE

2.1 INTRODUCTION

This chapter starts by reviewing mostly international literature on suburbanisation trends, which is the core motivation for this dissertation. The phenomenon of suburbanisation is described as manifested in terms of urban spatial structures. The causes of suburbanisation are described in terms of the roles played by various stakeholders such as developers, users of land and metropolitan authorities. Particular attention is paid to the role of transport in the process. The relationship between suburbanisation, mobility and accessibility is put into perspective. The success of public transport investments to shape urban structure is evaluated. The positive and negative effects of suburbanisation are described as well as the reaction of metropolitan authorities in terms of policies to minimize the negative impacts of suburbanisation. Included in the metropolitan policy response is a management and decision-orientated approach to planning, which is an important requirement for the successful management of suburbanisation.

The above-mentioned review relied heavily on literature reviewed as part of a national research project conducted for the National Department of Transport on the impact of suburbanisation on mobility in which the author was also involved (Cameron, Van Zyl, Loubser and Naude, 1991).

Land-use and retail location models are subsequently reviewed in terms of their historic development, followed by short descriptions of various categories of land-use location models and their typical uses.

The review of the land-use location models forms a good background for the subsequent review of interactive land-use and transport models and their use in evaluating alternative policies to manage suburbanisation. The theories, structure and performance of aggregate land-use transport models are reviewed, as well as the policy results of suburbanisation and densification policies indicated by these models. The latest trends in the development of integrated land-use transport models are also identified. This background to land-use transport models also assists in providing the context for discrete choice models, reviewed in a subsequent section.

Following on the review of the planning of metropolitan authorities, the planning and modelling techniques from the viewpoint of retail businesses are reviewed. This includes the planning objectives, process and factors considered by retailers to select the best sites for their outlets.

The next section reviews the theoretical background of discrete choice models, different modelling formats, and issues that need to be addressed in the application of discrete choice models, such as the use of RP and SP survey techniques. The advantages of SP techniques, which became very popular in transport and urban planning during the last few decades, are summarised. The theory and use of attitudinal scaling techniques are also discussed to provide the necessary background for the measurement and analysis of the attitudes of retailers conducted for the dissertation.

The application of discrete choice models and SP techniques to spatial choices are subsequently discussed, including residential location, retail business location and consumer location choices. The review of residential location choices focuses on the modelling approach in order to understand the complicating issues relating to the modelling of spatial choices.

The main conclusions relevant to the research are summarised in terms of four focus areas:

- Suburbanisation trends and evaluation of policies to address suburbanisation from the planning authority's viewpoint;
- Locational choices of retail firms and consumers, including a summary of the important factors considered in locational choice;
- Planning and modeling techniques of metropolitan authorities; and
- Planning and modelling techniques of retail firms.

2.2 DESCRIPTION OF SUBURBANISATION IN TERMS OF URBAN SPATIAL STRUCTURE

Alternative urban spatial structures may be described in terms of the distribution of population, employment and infrastructure amongst different areas within the city boundaries. Suburbanisation, or urban decentralisation, is the change in the location of urban activities from the CBD to suburban locations over time as a result of the expanding city (White, 1986). The outcome of suburbanisation is a spatial structure where a significant percentage of retail, office and other commercial development occur in suburban areas.

Suburbanisation should not be confused with decentralisation and deconcentration policies applied by British authorities who developed "new towns" around London in the post-war era, or the development of dormitory townships in S.A. in support of the former apartheid policy (Cameron, Van Zyl, Naude and Loubser, 1991). Suburbanisation is an intra-city trend driven by private developers in reaction to opportunities presented by market forces and transport infrastructure in the suburbs.

Suburbanisation is recognized as a worldwide trend (UITP, 1983) and low-density development of residential areas and suburbanisation are mutually supportive forces. As residential areas expand, the market for retail, services and offices are created closer to the locations of demand (USA Department of Transport, 1974). Substantial research was undertaken in the USA and some metropolitan areas also developed guidelines to manage suburbanisation. Typically the process of suburbanisation starts with housing developments, a retail centre would then follow near the intersection of two or more highways. The retail centre then forms the nucleus for further development. Locally, this trend is well illustrated by the development of the Menlyn node in Pretoria and the Sandton node in Johannesburg. With further development the suburban nodes generate increased traffic that begin to approach the traffic conditions in the CBD.

A worldwide survey of 77 transport organizations indicated that the population growth of urban areas slowed down, while the physical area expanded. Urban population increased primarily in outlying belts, while the inner city showed a decrease or limited growth in population (UITP, 1983).

Alternative forms of urban change

Suburbanisation is not the only pattern in urban structural change, and two other trends have been observed (Cameron, Van Zyl, Naude and Loubser, 1991):

- De-urbanisation is the trend of shifts from urban areas to smaller towns and rural areas. This is seen as the last stage of suburbanisation and it is caused by restrictions on outward expansion.
- Re-urbanization is the trend back towards the central city, observed in some American cities and London in the late 1980's. This trend is caused by saturation of the suburban market, provision of housing in central areas, and efforts by authorities to revitalize central areas.

2.3 THE CAUSES OF SUBURBANISATION AND THE ROLE OF LOCATIONAL FACTORS

The basic causes of suburbanisation can be described in terms of the following:

- Town planning motivations reacting to saturation of building space in the city.
- Economic motivations based on changes in the economic base of the city.
- Social motivations relating to residents looking for larger, cheaper houses in a more attractive environment.

Hughes and James (1974) describe the cycle of urban location patterns and the range of forces that influence locational decisions of the various economic activities, i.e manufacturing, office, service, retail and residential activities. Space requirements, transport and communication, external economics, labor and land prices determine the spatial distribution of manufacturing. These locational factors also influence the spatial distribution of the other sectors to varying degrees, with household preferences and environmental quality playing an increasingly important role. The factors that promote central locations are dominated by the factors that drive the dispersal of economic units and residential activities.

The following factors act in favour of decentralized locations as opposed to central locations (Hughes and James, 1974):

- Higher space requirements of new production techniques.
- Private transport for goods and passengers is demanding of space, but also more flexible and this makes suburban locations more attractive for high-income workers and firms.
- New communication media that make some firms more footloose.
- The traditional benefits of the CBD such as support services for firms, have decreased as larger deconcentrated nodes have taken over this function.
- More sophisticated production technology that requires highly skilled and better paid workers, enables workers to afford suburban homes closer to work locations.
- Inner city decline forces inner city population to move to better suburban locations.
- The growth of tertiary and service sectors requiring a more sophisticated living and working environment that is better served by "green-field" office parks than by that provided by inner city areas.
- The downward trend of input costs of freight transport, and the upward trend of input costs of land intensive requirements, cause a shift of manufacturing concerns to cheaper total input cost areas.

The following trend in the decentralisation of economic and residential activities in the USA between 1950 and 1970 was observed (Fischer and Dornbusch, 1983):

- Population in suburbs compared to total : 42.2 to 56.9 per cent.
- Employment: 29.9 to 45.4 per cent.
- Manufacturing: 36.7 to 49.0 per cent.
- Retail: 25.6 to 47.8 per cent.
- Service: 19.2 to 35.8 per cent.
- Wholesale: 12.9 to 34.5 per cent

In 1980, only 7.5 per cent of total jobs remained in the CBD according to Gordon and Richardson (1989). The decentralisation in retail and wholesale was the strongest in view of the demand created by the suburban population.

The trend in Britain was similar: Growth in urban areas, decentralisation of population to suburban areas and physical expansion of urban areas, have coincided with, and were reinforced by the advent of the private motor vehicle. Most residents in the suburbs own a car and this selective redistribution in population patterns left the inner areas with less skilled workers (Dasgupta, 1983).

In the USA the form of suburbanisation and the increased dominance of the car, caused the railway infrastructure, that initially structured urban form, to be abandoned (Ullmann, 1977). Roads and freeways replaced the rail and this reinforced the dominance of the car.

The trend of suburbanisation changed the urban structure from low-density residential areas surrounding a strong central city, into a collection of regional multi-functional sub-centres. This caused diffused travel patterns with many trips taking place between low-density residential areas and suburban activity nodes (USA Department of Transport, 1974). This dispersed pattern of travel increases the utilisation of road space in both directions, but undermines public transport as no line-haul pattern can be established.

In terms of locational factors influencing household preferences, a survey by Varady (1990) in the USA indicated that life cycle positions and life styles are important factors. College-educated, dual-income households without children tended to favour central city locations, and so do households that emphasize urban residential attributes and access to employment in central locations. Other factors were income, race, quality of service and neighbourhood amenities.

In South Africa, the DOT research study indicated the following push and pull factors of suburbanisation (Cameron, Van Zyl, Naude and Loubser, 1991). The push factors are:

- CBD congestion;
- scarcity and cost of parking;
- escalating crime and violence in many CBD's;
- the decline in bus and rail serving the CBD; and
- crime on trains.

The pull factors are

- the well-developed suburban road network;
- accessibility to high-income population;
- relatively cheap land and services; and
- the emergence of the mini-bus taxi offering a more flexible and personalised service

2.4 THE RELATIONSHIP BETWEEN SUBURBANISATION, MOBILITY AND ACCESSIBILITY

In the urban context, mobility is the ease with which persons can move between origins and destinations. It is influenced by the ownership, availability and affordability of convenient private and public transport modes, and the availability of road space and parking (Naude, 1987).

Accessibility refers to the combined effect of transport connections, mobility and proximity between land uses (Naude, 1987). Accessibility is influenced by the maintenance and expansion of transport infrastructure, the acquisition, operation and finance of private and public transport vehicles, and the provision of housing and employment in close proximity to each other

The demand for mobility is a response to economic and social development and is determined by the distribution of land-use and the availability of public and private resources to meet the need to move around as efficiently as possible. The increasing demand for mobility is demonstrated by the growth in trip generation rates from 1.55 per day in 1960 to 2.06 in 1980 (UITP, 1983).

According to Naude (1987), the demand for mobility in S.A. is growing at an alarming rate due to the increasing lack of proximity between employment and residential areas, aggravated by rapid urbanisation on the edges of cities. Policies should not focus on mobility in isolation, but on affordable accessibility.

This sentiment is echoed by White (1986) who propagated changing the location and timing of activities rather than improving mobility through transport improvements. Suburbanisation is therefore a potential strategy to improve accessibility. However, in the South African context, suburbanisation is based largely on the improved mobility of private vehicles, reducing the mobility of those without cars.

2.5 Success of Public Transport Investments in Shaping Urban Structure

It is generally accepted that transport infrastructure and services are instrumental in shaping the distribution, intensity and mix of land uses. Through the feedback effect of transport on land-use, new developments are encouraged. However, analysts disagree on the effectiveness of transport investments to change established urban conditions (Cameron, Van Zyl, Naude and Loubser, 1991).

Newman and Kenworthy (1989) observed reinforcing effects between low-density sprawling developments, the building of freeways and congestion.

Stanger and Bates (1982) indicated the apparent success of the MARTA rail line, that increased corridor transit trips while car traffic was reduced. Newman and Kenworthy (1989) recorded the Portland light rail experience, and Gordon and Richardson (1989) recorded the success of the Toronto corridor. Both these examples were dependent for their success on comprehensive land-use stimulation and controls.

Other examples indicated the limitations of rail transit investments in the USA to impact positively on land development, and that other favourable factors are needed to induce changes. The BART rapid transit system in San Francisco was intended to promote public transport and induce densification of land-use. Webber (1981) and Gordon and Richardson (1989) indicated the failure of BART to achieve these objectives. Ullmann (1977) concluded that it is difficult to integrate efficient transit systems into the suburban economic network unless it already existed.

The DOT research report concluded that high costs and competing claims on scarce resources to address basic needs question the validity of large scale urban restructuring based on rail systems (Cameron, Van Zyl, Naude and Loubser, 1991). Urban structural changes also need to be initiated at an early stage in urban growth to be effective.

2.6 EFFECTS OF SUBURBANISATION

Suburbanisation has a major impact on social aspects, energy use, trip patterns and public transport.

Social effects

The Transport and Road Research Laboratory (Dasgupta, 1983) conducted surveys of employees in Manchester (U.K.) that indicated the dependence of inner city workers on public transport in terms of low levels of access to private transport, and experiencing shorter travel distances but longer travel times. Access to employment opportunities in external areas by public transport was also limited. Suburbanisation increased the mobility and access of high-income skilled workers, while the less-skilled worker in distant and central locations experienced declined mobility and access. Suburbanisation caused a mismatch between the labour force and the type of jobs available in the inner city.

Energy and environmental effects

Suburbanisation has lead to increased private travel and substantially higher energy usage rates (Bowler, 1977). Hanson (1989) indicated the unaffordable levels of motorization in two cities, Mexico City and Jakarta, in developing countries in terms of high energy consumption and air pollution.

Effects on trip patterns and public transport

Suburbanisation and urban sprawl have made it impossible to serve these areas by public transport. Public transport threshold levels are reduced to below viable levels and service levels are reduced, resulting in shifts to private transport. This sets negative spiralling effects in motion (UITP, 1983).

There are substantial differences between inner city and suburban travel patterns. The low-density suburban areas result in low, dispersed demand and longer travel distances that favour car. The higher densities of the inner city favour public transport. The costly space demands of car in high-density areas cause problems to accommodate car (USA Department of Transport, 1974).

Attempts to design public transport systems to serve low and high densities require feeder line-haul systems and necessitate transfer. Failure to arrange quick and comfortable transfers, has been the demise of public transport and accelerated the process of suburbanisation (USA Department of Transport, 1974).

2.7 Policies In Response To Suburbanisation

The mainly negative impacts of suburbanisation and the deterioration of CBD's have lead planners and engineers to formulate policies to affect a return to the city (UITP, 1983). In the USA the objectives of such policies were:

- to strengthen the central-city at the expense of suburban areas; and
- to curtail further decentralisation by concentrating suburban development.

The specific policies are discussed below.

Support CBD office development

Policies in support of office development in the CBD were tax incentives, bonus zoning, public investment and co-ordinated public development agencies. These policies did not work in all the cities. In cases where central city housing projects were undertaken, a positive impact on office development was observed.

Discourage suburban office growth

There has not been a concerted effort to counteract dispersed office development, except to use rail transit projects as a catalyst to promote densification. This has largely been unsuccessful except where these projects were supported by comprehensive land-use controls.

Encourage suburban infilling

This policy aims to restrain further outward growth and to concentrate growth in existing suburban areas. This was seen to be potentially more attractive than discouraging suburban office growth due to concerns about the potential loss in the tax base.

Encourage suburban nodal development

This is a variation on infilling that concentrates growth around existing or potential nodes of employment development. Such policies, that respond to the reality of suburbanisation rather than halt or reverse the process, are regarded as more feasible. Transport measures in support of suburban nodal developments are improvements in transport in reverse and circumferential commuting to make suburban nodes more accessible to inner city residents, and mixed public transport systems using demand responsive large taxis and improved transfer systems.

Supporting mixed land-uses

The following policies to promote mixed land-uses need to be combined to be effective (Cervero, 1988):

- inclusive zoning to encourage joint office and retail developments;
- conditional zoning that allows office development only if it is close to retail complexes or high-density residential areas;
- incentive zoning that allows an increase in density if the development is mixed;
- zone swapping that allows development in one area where mixed use is promoted, in exchange for the right to develop in undesirable areas;
- tax incentives for diversified projects as they place less pressure on infrastructure; and
- performance standards that set limits to the trip attraction to the development and therefore encourage mixed uses with lower trip attraction rates.

Typical policies applied successfully in office parks to reduce transport problems are (Cervero, 1988):

- transport management associations that promote ride sharing, provide van fleets for employees and finance street improvements;
- trip reduction ordinances that require large employers to reduce peak hour trips by staggered working hours;
- traffic impact ordinances that require developers to participate in transport system management (TSM) programmes, and fees levied to be used to finance area-wide improvements; and
- parking reduction ordinances that require developers to contribute to TSM funds instead of providing the standard number of parking bays.

Policies to reduce the impact of traffic in residential areas

Increased traffic in residential areas is one of the main problems of suburbanisation. Traffic calming measures have become popular in S.A. to reduce these impacts.

Research indicated the typical problems such as reduced social interaction, increased urban blight that leads to reduced maintenance of properties, rapid turnover of sales and ultimate rezoning for commercial use (Cameron, Van Zyl, Naude and Loubser, 1991).

Typical traffic control policies can be divided into three categories:

- peripheral strategies that prohibit entry into residential areas from arterial roads;
- internal strategies that control traffic inside residential areas such as typical traffic calming measures; and
- external strategies that increase the capacity of the surrounding road network.

Experience in the USA and S.A. indicates that traffic impacts are seldom community-wide and that some residents lose while others gain due to the differential impact on property values (Cameron, Van Zyl, Naude and Loubser, 1991). These negative impacts of suburbanisation on residential areas make public participation an increasingly contentious issue and transport authorities will become increasingly involved.

<u>A management and decision-orientated approach to planning</u>

The complexity of the suburbanisation problem requires not only that a comprehensive set of the most effective policies are selected, but also that these are effectively implemented, that impacts are monitored and corrective actions are taken. Similar to many solutions to urban problems, the most effective solution for the suburbanisation problem relies on the very nature of the urban planning process. The policies described in the previous section can only be effective if they are implemented as part of an effective planning process. Meyer and Miller (1984) advocate a management and decision-orientated approach to urban transport planning based on an analysis of the evolving role of transportation planning in the development of the urban system, relating to American experience. A very brief account is given here of the main principles and framework proposed by the approach.

The urban transportation system is a basic component of an urban area's social, economic, and physical structure. The performance of the urban system not only provides mobility, but also in the longer term, patterns of growth and economic development. Many public officials have treated changes to the transport system as a means to achieve various national and community objectives.

The main purpose of transport planning is therefore not only improved transport efficiency, but also support of other community objectives. The final product of the planning is therefore not a comprehensive "Plan", but rather any form of communication with decision-makers providing useful information in identifying alternative actions and choosing between them. Planning is therefore an integral part of the decision-making process.

Several political, economic and social trends have influenced the form of transport planning, including pressure on resources, future uncertainty, the broadening role of transportation and the continuing suburbanisation of urban areas.

The focus of planning changed from large-scale infrastructure actions to managing the existing transport system. A decision-orientated planning approach should focus on the information needs of a wide range of decision-makers in the public and private sector. Planning should include a long-range perspective informing the short-term decision-making process.

During the 1950's and 1960's transport planning was based on rational choice addressing a single criterion of lowest transportation cost. This planning approach was characterised by a process centralised in few agencies, technical procedures and promoting personal mobility. In the late 1960's and 1970's this approach was replaced by an approach characterised by public participation, consensus, and amelioration of project impacts. Political factors, elected officials, funding and control over funding increasingly played a role in planning.

Uncertainty about the future compels planners to follow a cyclical process with continuous monitoring of the urban system and to learn how policies impact on the system. This also calls for flexibility in the transport system so that it can be adapted over time to meet changing demand patterns.

Understanding the dynamics of the urban system requires awareness of the key decision-makers and the factors that motivate them such as developers who develop land, firms who rent and utilise buildings and employ people, residents who buy and sell houses to live in, and governments who regulate, raise taxes and provide infrastructure.

The typical separation of the land-use planning and transportation planning functions, often in different departments, can result in wrong definitions of problems, solutions and model specifications as land-use and transportation are strongly linked.

2.8 LAND-USE AND RETAIL LOCATION MODELS

2.8.1 Introduction

In this section the theory and modelling of the location of economic activities in the urban area, and specifically models relating to the location of retail activity, are reviewed. The theory reviewed here forms a good background to the evolvement of interactive land-use transport models, which is discussed in section 2.9. The following topics are reviewed in this section:

- Historic development of location theory.
- Categories of activity location models and their typical uses.

2.8.2 Historical development of location theory

Price and Blair (1989) give a comprehensive review of the theory of the location of service activities. Throughout history geographers have been interested in the factors that influence location patterns, and much literature on this subject exists.

Only a brief review of the main theories and factors that influence locational choice of the service sector is given here.

Classification of activities, market areas and access

Locational choice is very dependent on the type of service activity and the market served. Various classifications of services have therefore been proposed. Consumer-orientated service activities would locate over a widespread area to serve the interest of consumers, while producer-orientated activities would be more concentrated in business centres. The market area theory classifies activities according to the market areas they serve. The size of the market area influences location patterns. Financial institutions will for instance seek different locations depending on whether they serve national markets or local consumer markets. The theory distinguishes distribution patterns in view of the position of the activity within the retail hierarchy. The criteria for the location of the headquarters of large corporations differ from the criteria for the location of commercial services.

The concept of access is also implicit in the theory of market areas. Access by the client is an important factor - if the cost of gaining access is too high, the client will go elsewhere.

Central place theory

Christaller devised the classical central place theory in 1933 to describe the laws governing the number, size and distribution of central places (Price and Blair, 1989). Central places are settlements with the prime purpose to provide goods and services to the surrounding area. The theory, which is often used in retail studies, states that the size of the market area served from a given place is determined by the distance people would be willing to travel to purchase the item. This distance was termed the range of the good. People's willingness to travel also depends on the type of good.

Thresholds, or the minimum number of customers needed to support the activity, also play a role. A market area with a range that is not sufficient to obtain the required threshold, will fail. Items with a long range were termed higher-order goods, while those with a short range were termed lower-order goods. High-order centres would be fewer as they cover larger areas. The central place theory therefore proposed a hierarchical structure of high- and low-order centres and a constant balance between these centres.

Empirical studies have supported many of the principles of the central place theory, but the theory's simplistic assumptions did not match the real world. Various criticisms of the theory were that it presented a closed system that ignored external forces, and that its many limitations offered no practical value to marketing studies. Ironically, the theory's popularity among planners resulted in it indirectly influencing shopping centre development.

<u>General interaction theory</u>

General interaction theory describes movement patterns subject to controls affecting the interaction between people and places. It makes use of Newton's gravity law in physics. Reilly introduced the first work in this field relating to the law of retail gravitation in 1929 (Price and Blair, 1989). The theory aimed to calculate the amount of interaction between two towns based on the area between them. Further sophistication of the theory introduced the calculation of break points between shopping centres, market potential, and overlapping trade areas. The retail location models proposed by Huff (1963) and by Lakshmanan and Hansen (1965) became very popular among retail planners and are discussed in more detail in the next section.

<u>Bid-rent theory</u>

Bid-rent theory introduced the concept of competition between activities for specific sites. It was assumed that activities with the greatest need for access to the market would pay the highest rent. Consequently, activities would be distributed in concentric zones around the centre determined by their rent-paying abilities. This theory is a simplistic view of the urban market due to constraints, such as length of lease, ownership of a site, profit maximisation for the developer, zoning regulations, and servicing of niche markets by some firms away from the central area. Modern developments such as traffic congestion in the CBD, also make the central area inaccessible resulting in decentralisation of activities.

2.8.3 Different categories of activity location models and their typical uses

Spatial interaction models (Batty, 1971)

Batty reviewed various types of land-use models, which are briefly described here (Batty, 1971). He distinguished partial models that simulate one land-use or activity, and general models that simulate more than one activity. The four-step transportation model originated in North America in the late 1950's and land-use models followed a decade later, building on the concepts of the transportation models.

Spatial interaction models describe the interaction between activities in terms of flows of people and commodities. The retail location models of Huff and of Lakshmanan and Hansen are the most popular and various publications on retail planning report on them (Batty, 1971, Terblanche, 1989, Landre, 1994). The models are based on gravity principles and are given below:

Lakshmanan and Hansen model:

$$S_{ij} = A_i\, C_i\, F_j\, (d_{ij}^{-a})$$

Where:
- S_{ij} = retail expenditure of zone i spent in zone j
- C_i = total retail expenditure of zone i
- F_j = size of retail activity in zone j
- d_{ij} = travel time between zones i and j
- a= parameter
- A_i = balancing factor to constrain productions
- S_j=sales in shopping centre j, is obtained by summing expenditures over all zones.

The Huff model defines the attraction factor, F_j, as the floor area of the sales activity in zone j. The dependent variable is also defined as the probability of the consumer travelling from zone i to shop in zone j.

The retail location models therefore use the gravity model to estimate the monetary flows from zone i to shopping zone j, instead of trips estimated by the gravity trip distribution model. The retail models assume that the monetary flows are proportional to the buying power in the origin zone and the sales potential, or floor area, of the shopping zone. In contrast, the trip distribution model uses trip generation and attraction based on population and employment in the origin and destination zones, respectively. Both models use travel time as the denominator, although generalised costs are also used in some trip distribution models.

The CSIR applied the Lakshmanan and Hansen model in the Milnerton municipal area (Cape Town metropolitan area) to formulate growth scenarios for the service sector (CSIR, 1991). They reported good calibration results to observed data with the exception of the over-estimation of floor space on the periphery of the metropolitan area.

The original gravity model was modified in various ways, the most notable in 1967 by Wilson who derived the new version of the gravity model from entropy theory. This model was based on the most probable distribution of person movements subject to any constraints. The theory provided a framework for the generation of a family of spatial-interaction models, that Wilson used to model residential location models.

The Lowry model, which originated in America in 1963, was stimulated by Wilson's concept of land-use activities as summation over interactions, or flows. The Lowry model generated a new generation of land-use models. The Lowry model partitions employment in basic (primary and manufacturing sectors) and non-basic employment (service sectors) and derives the non-basic employment and population from external allocation of basic employment activities. In 1966 Garin made further improvements to the Lowry model by explicitly incorporating spatial interaction models to allocate activities and to integrate these models with economic-base theory. Further modifications of the Garin-Lowry model were made by Wilson to build in locational constraints.

Many of the interactive land-use transport models discussed in the next section made use of the Wilson and Garin-Lowry type models.

Batty (1971) reported various applications of the Wilson and Garin-Lowry models in Britain and also identified various technical, calibration and data problems that needed to be resolved. The most significant problems were that the model treated the spatial system as if it was in equilibrium, and that it did not make provision for the dynamic nature of actual land-use activities.

Other land-use models that were reported by Batty (1971), were linear regression models and optimisation models. The linear models do not consider spatial interaction, which is non-linear. Optimisation models determine the optimal location of activities according to specified criteria. These models do not simulate human behaviour, but were used in some planning situations, such as the housing market, to assist in planning.

2.9 Modelling Of Urban Land-Use Transport Interaction And The Results Of Urban Densification Policies

2.9.1 Introduction

This section gives a brief overview of aggregate network-based models simulating land-use transport interaction. The main focus of the review is to determine the impact of land-use and transport polices on suburbanisation and urban development from the application of these models. The impact of any specific policy is often hidden in empirical observations of urban change and interactive land-use transport models offer the capability to study the relative impacts of different policies.

A secondary purpose of this review is to put the application of SP discrete choice models, which was chosen as an appropriate analytical technique for the purpose of this dissertation, into the context of the wider framework of land-use transport models.

It is appreciated that there exists a wide body of literature on the subject of modelling the interaction of land-use and transport. However, it is outside the scope of the dissertation to give a comprehensive review of the theory, model development, calibration and application of these models. This review therefore only gives a brief summary of typical models by making use of literature that gives an overview of interactive land-use transport models. The following two studies were used, as they give a very comprehensive overview of these models:

- TRANSLAND is a comprehensive European Union research project on integrated land-use transport planning. It reviewed state of the art in the theory, empirical studies and modelling of land-use transport interaction (Wegener, 1999). The project focused on European studies, but relevant studies from North America were also reviewed.
- ISGLUTI is a major international research study that was undertaken to evaluate the performance of interactive land-use transport models (Webster, Bly and Paulley, 1988). The research was co-ordinated by the UK Transport and Road Research Laboratory (TRRL) between 1981 and 1991. The TRRL set up the International Study Group on Land-use Transport Interaction (ISGLUTI) to apply the models developed by various research teams to evaluate a common set of land-use transport policies.

The review of the above two studies were further supplemented by a few selected publications.

This section reviews the theory of land-use transport interactions, describes and evaluates existing interactive land-use transport models, identifies recent trends in model development, and summarises the results of various policies on suburbanisation and urban development.

2.9.2 Theory of land-use transport interaction

Theories on the two-way interaction between urban land-use and transport address the locational and mobility responses of private role players, such as households, firms and travellers, to changes in the land-use transport system. The principle that the spatial separation of human activities creates the need for travel is well understood and forms the basis of transport analysis and forecasting. However, the impact of transport on land-use is less well understood, but is clearly evident from observed changes in historic urban development following the development of firstly the railway and then the private car.

The two-way land-use transport interaction can briefly be described as follows (Wegener, 1999):

- The distribution of land-uses, such as residential, industrial and commercial, over the urban area determines the locations of human activities, such as living, working, shopping, etc.
- The distribution in space of activities requires trips, or spatial interaction, to overcome the spatial separation.
- The distribution of infrastructure in the transport system provides opportunities for spatial interaction and can be measured in terms of accessibility.
- The distribution of accessibility in space co-determines location decisions and results in land-use changes.

The main theories trying to explain the land-use transport interactions can be categorised into technical theories, or urban mobility systems, economic theories describing cities as markets, and social theories relating to urban space (Wegener, 1999).

<u>Technical theories</u>

The original explanations for the location, growth and decline of cities were based on technological development. The industrial revolution first brought the railways and then the car and related highway development, which had a major impact on urban development. Today, the integration between transport and telecommunications is creating the global city, which makes even remote locations accessible.

Advances in transport development reduced the cost and effort to overcome the spatial separation of human activities and allowed activities to be located further apart. The recognition that transport and location decisions are inter-related formed the basis of urban land-use transport planning during the 1950's in North America, and generated a wide range of spatial interaction models, based on the gravity model of Lowry and later developments by Wilson discussed in Section 2.8 (Batty, 1971). These models were made increasingly more complex by combining equilibrium models of location choices of various activities, and transport choices, such as mode and route choice. Typical models developed by Echenique, Putman and Macket, are discussed in more detail in the next Section (Echenique, Flowerdew, *et al*, 1990; Wegener, Macket and Simmonds, 1991).

The main criticisms of the spatial interaction models were:

- The models are based on the assumption that there is equilibrium between transport and location. In reality, the different urban processes have different response times and demand and supply are always in disequilibrium.
- The models lack economic content. The only cost variable is transport cost, but there is no interaction with other household expenditure.

Economic theories

Urban development has also been explained in terms of economic paradigms. Historically, city growth in Europe has been closely linked with the economic structural change resulting from the industrial revolution that caused rural to urban migration, reduction in agricultural employment and growth in industrial employment.

The well-known economic base theory of Jacobs (1969) is based on the assumption that regional income, and hence the number of people that can be supported, depends on the region's exports. The central place theory of Christaller (Batty, 1971) takes transport costs into account, from which a hierarchical pattern of activities around central places is derived. The bid-rent model of the urban land market of Alonso (Batty, 1971) introduces land prices into the equation. The model assumes that firms and households choose the location at which their bid rent equals the asking rent of the landlord. A fundamental assumption of all spatial economic theories is that locations with good accessibility are more attractive and have a higher market value than peripheral locations.

Social theories

According to social theories, the spatial development is the result of individual or collective appropriation of space, which takes place as an invasion of a neighbourhood by different economic and ethnic groups depending on their ecological status. Despite the questionable analogy to biological systems and assumptions of stable equilibrium, the social theories is useful to explain social change in cities beyond economic processes.

Action-space analyses identify the frequency of activities as a function of space-time protocols and distances between activities. Hagerstrand (1970) introduced the concept of time budgets in which individuals command action spaces of different size and duration according to their social role, income and level of technology, subject to various constraints. On the basis of Hagerstrand's action-space theory, Zahavi developed his hypothesis that individuals do not minimise travel time or cost according to conventional transport theory, but rather maximises activities or opportunities that can be reached within their travel time and money budgets. (Zahavi, Beckman and Golob, 1981.) This theory explains why reduced relative transport costs and higher speeds of transport permit people to locate on the periphery of urban areas without increasing their time and money budgets. Likewise, this explains why shopping centres in these locations are able to attract customers from increasingly larger catchment areas.

The interest in activity-based surveys and remodelling approaches from the transport planning profession was motivated by the need to evaluate travel demand management policies as opposed to the conventional road-building policies to find solutions for the ever-increasing growth in car-ownership and travel (Axhausen and Garling,1992; Hensher and Stopher, 1979). Social trends such as the trend towards the 24-hour society, and the increasing role of women in the work force, also motivated the need for more sophisticated models (Arentze and Timmermans, 2000). The conventional four-step transportation model, which was geared towards one-stop one-purpose travel, was unable to represent traffic patterns that are the result of the complex interaction between the urban physical environment, the institutional context, the transportation system and peoples' needs to pursue activities to realise their goals (Arentze and Timmermans, 2000).

However, activity-based approaches are not unique to transport planning. Its origins can be traced back to geography and urban planning, such as the work by Hagerstrand, amongst others (Arentze and Timmermans, 2000). The main aim of activity-based approaches is to analyse decisions of households, or individuals, regarding their activities that affect their demand for travel. Such decisions are inter-related and include decisions regarding whether an activity should be undertaken and where, when, how long and with whom to participate. These approaches have therefore required surveys of households' daily and weekly activity diaries. Great advances in activity-based surveys and models have been made, and these are starting to become very popular (Harvey, 2001; Arentze and Timmermans, 2000).

Conclusions

A qualitative summary of expected impacts of the above theories in terms of land-use policies on transport, transport policies on land-use and transport policies on transport, correlate well with empirical evidence (Wegener, 1999).

The impacts of transport policy on transport patterns are stronger and better defined compared to the two-way interactions between land-use and transport. Accessibility was found to be of varying importance to different land-uses. It was an essential location factor for retail, office and residential uses.

2.9.3 Models of land-use transport interaction

Existing models

The TRANSLAND report (Wegener, 1999) provides a framework for the classification and evaluation of interactive land-use transport models. Eight types of urban sub-systems are identified, ordered by their speed of change:

- Transport networks and land-use change very slowly as they consist of large infrastructure development, which requires long planning and construction periods.
- The buildings accommodating work places and houses change slowly and change slower than the firms and households occupying them.
- Employment and residential activities change faster - they grow and decline according to their life-cycle processes.
- Goods transport and personal travel change quickly according to changing circumstances.

Seventeen models were subsequently evaluated in terns of nine criteria by the TRANSLAND report. The following evaluation is summarised from the TRANSLAND and ISGLUTI studies, and from selected publications. Only a few of the models are referenced here that represent the main differences in the various types of models:

- Comprehensiveness: Only four of the models address all eight sub-systems, eg DELTA (Simmonds, 1999) and MEPLAN (Echenique, Flowerdew, *et al*, 1990). Half of the models distinguish between activities and building stock. Only four models simulate demographic change and household information, eg DELTA and LILT (Wegener, Macket and Simmonds, 1991).
- Model structure: Two groups of model structures are distinguished. The "unified" models link all sub-systems by means of one modelling principle. The second group, "composite" models, regards the sub-systems as interconnected in hierarchy, but structurally autonomous.
- Theory: Due to great advances made in theories to explain spatial choice behaviour, there is broad consensus about the state-of-the-art land-use model. All but one of the models rely on random utility theory to explain the behaviour of

role players such as investors, firms, households and travellers. However, within this theory, there are significant differences between models. Some models assume equilibrium between demand and supply of land through endogenous prices within one analysis period (MEPLAN), while others assume delayed price adjustment (DELTA). Some models are hybrid models of bid-rent theory and random utility theory.

MEPLAN applies economic base theory to link population and non-basic employment to exogenous forecasts of exports. The basic employment is externally allocated by the user in some models, while other models allocate basic employment according to some index of attractiveness. Non-basic employment is typically located based on the Lowry-type gravity model, in terms of the attraction to the household locations, and some measure of accessibility. Residential activity is in turn attracted to employment locations subject to accessibility. All models recognise that land is a resource ultimately constraining the rate and direction of development. New dwellings and workplaces are likely to compete for the same available land on the land market, and this is also represented by some of the models. The transport system is mostly represented by inter-zonal travel times and costs that are combined into an aggregate measure of generalised cost or disutility of travel.

The DELTA model is based on sub-models representing processes derived from theories in the fields of economics and geography (Simmonds, 1999). Simmonds criticised the so-called Martin Centre models, such as MEPLAN, which integrate several cross-sectional sub-models in elaborate equilibrium calculations, based on spatial input-output systems. These models are inefficient in the development of theory and exploitation of empirical results which would be recognised by different disciplines relating to urban processes.

DELTA and LILT apply standard concepts of cohort-survival in their demographic and household sub-models.

- Modelling techniques: In all the models the urban region is represented as a set of discrete sub-areas or zones. Time is typically divided into one to five year periods, over a 20 to 30 year analysis period. In some models transport and location are simultaneously determined, while in others transport influences location through accessibility indicators. With the exception of two models, all models are aggregate using between 30 and 70 medium sized zones. Two models are disaggregate and apply micro-simulation techniques. For example, the CUFM model (Landis and Zhang, 1998) uses detailed land-use information generated by a geographical information system.
- Dynamics: All but one model are recursive simulation models. Typically, changes in land-use patterns cause short-term changes in the transport patterns, while the transport changes, in turn, have a more long-term impact on land-use. The unified models, such as MEPLAN, assume all sub-systems change at the same pace and give a snap-shot picture of the urban system within each time period. The composite models, such as DELTA, allow the different sub-systems to change at different paces, but this feature is not sufficiently used due to the long simulation periods.
- Resource and data requirements: Model development required huge resources in terms of costs and personnel. The models evaluated by the ISGLUTI study took between 4 and 64 years of development work (Webster, Bly and Paulley, 1988). Data requirements are also huge, but advances in computing and modelling techniques reduced the data requirements to some extent.
- Calibration and validation: All models use well-established calibration techniques on cross-sectional data. The ISGLUTI Phase 1 report concluded that models simulated their existing situations fairly well during calibration on cross-sectional data (Webster, Bly and Paulley, 1988). However, validation of the models to changing patterns over time was limited to time periods that were too short to validate longer-term impacts. Lack of data over long time periods also prevented the validation of models from some past point in time. The same conclusion was reached by the TRANSLAND report, having reviewed a larger number of models and more recent developments (Wegener, 1999). The report emphasized the importance of calibrating the models on time-series data over periods as long as

the forecasting period. It was felt that there had been very little progress in the methodology to calibrate dynamic models.

An additional limitation is the dependency of the models on external forecasts of many variables - the models can only perform well if these forecasts are reliable (Webster, Bly and Paulley, 1988). Sensitivity tests under different assumptions, and selecting policies that are robust, are therefore important considerations.

In general the ISGLUTI study group felt positive about the research results. Models gave mostly plausible results and provided consistent results between tests and between models (Webster, Bly and Paulley, 1988). However, certain problems and limitations were identified and there is room for improvements. Different models often gave different levels of impacts and occasionally in different directions as well.

- Operationality: All the models are operational in that they have been applied to real cities. However, only a few of the models have been developed to become standard software for the wider market.
- Applicability: In view of the wide range of planning problems facing metropolitan areas today, the spectrum of problems addressed by the seventeen models is very narrow, especially in terms of land-use policies. The majority of the policies relate to strategic land-use planning and investment programmes, transport network improvements and changes to travel costs. Detailed planning policies, such as detailed land-use plans, building standards and regulations, development charges and impact fees, and marketing, are not addressed.

Recent trends in model development

The main planning problems that the existing land-use transport models cannot address are environmental impacts at a detailed level and problems of spatial equity (Wegener, 1999). Environmental impacts need to be determined at a micro zone level to be useful. Existing models are too coarse in terms of their zoning system to achieve this. The existing models also favour solutions that have the greatest aggregate social benefit. Urban societies are increasingly becoming spatially and socially polarised. Existing models lack the sensitivity to address these problems.

The general disappointment in large-scale urban planning models gave rise to two trends in modelling approaches. Meyer and Miller (1984) described the trend towards small-scale problem-specific models, such as discrete choice models, in favour of large-scale long-term models. This trend was motivated by the high cost and complexity of the large-scale models, uncertainty about the accuracy of their predictions, and the changing focus of transport planning from large-scale infrastructure policies to managing the existing transportation system. The second trend was based on the search for more behaviourally accurate large-scale land-use transport planning models capable of addressing a wider range of policy options. To address these needs, models became more disaggregated in terms of their spatial and decision-making units (Wegener, 1999). This trend was made possible by the ever increasing power of computers and advances in GIS techniques. GIS platforms are becoming the main organisers of data for modelling. Multi-presentation of data in raster and vector format combine the advantages of spatial disaggregation and efficient network algorithms.

The latest model developments are using micro-simulation techniques. The greatest advances in micro-simulation were made in the field of trip assignment models. The driving behaviour of individual vehicles is simulated and graphically presented on the road network (Wegener, 1999).

The main trend relating to the structure of integrated land-use transport models, which is also based on micro-simulation approaches, is the move towards activity-based approaches. Activity-based models overcome the superficial modelling of the interaction between separate land-use and transport sub-models. The models allow land-use and transport to be truly integrated as both are treated in the same generic way as different types of activities.

Initially, activity-based models concentrated on short-term activities such as travelling, shopping, and other daily activities. Arentze and Timmermans (2000) described a comprehensive state-of-the-art activity-based model, ALBATROSS, which was developed by the European Institute for Retailing and Services Studies for the Dutch Ministry of Transport. Long-term choices, such as choice of home and work location are fixed, while short-term choices, such as travel, shopping and other daily activities are modelled. Households' decisions regarding activities are represented in terms of heuristic rules in the form of logical expressions, rather than algebraic equations. The rules are represented in the form of decision tables, which contain a set of exhaustive mutually exclusive logical expressions. The model assumes that households have imperfect information and make sub-optimal decisions to organise their activities in view of the spatial and temporal constraints of the urban system. For example, particular locations are not open during certain time periods, while the speeds of the transportation system only allow people to undertake a particular set of activities at a specific set of locations within certain time windows. Interesting scenarios could be tested with the model relevant to modern trends, such as a decrease in two-adult households, changes in work start-times, and an increase in part-time workers.

More recent model designs are also addressing medium and long term activities.
Two major integrated land-use and transport activity based models are currently being developed that simulate both short and long term activities: The Puget Sound Regional Council (USA) recently completed a design process for the development of a new integrated land-use transport model (Waddel, Outwater, Bhat and Blain, 2002). The model was designed in view of a comprehensive analysis of the policy needs of stakeholders and a review of the state-of-the-art in land-use transport models.

The land-use and transport components will be modelled as an integrated activity-based model. The main features of the model is described in terms of disaggregate, behavioural, discrete choice and micro-simulation. With travel cost becoming a less important determinant of locational choice, the model will be structured not to be dependent on travel cost as the main influence on location. The first three steps of the conventional four-step model, trip generation, distribution and modal split, will be replaced by an activity-based model. The last step, trip assignment, will make use of a micro-simulation model.

A major research programme, called AMADEUS, is funded by the Dutch Organisation for Scientific Research and is conducted by a consortium of Universities in the Netherlands. The programme is bringing together the components of the previous modelling efforts of the teams, one of which is the ALBATROSS model. (Timmermans, Arentze, *et al,* 2002). The model will follow an activity-based approach and simulate the short, medium and long-term activities of households, i.e. daily, weekly, monthly and yearly. Utility maximisation principles will be applied to household behaviour, subject to constraints imposed by the physical and institutional environment, and the transportation system.

Another modern approach is one based on the theory of cellular dynamics. Cellular automa (CA) are objects associated with areal units or cells (Wegener, 1999; Batty, 1997). The cells follow simple stimulus-response rules that change their state based on the state of adjacent cells. In its complex form, multi-reactive agents models are able to control their interaction pattern by changing their environment as well as their own behaviour. (Ferrand, 1999). The distinction between CA models and micro-simulation models is therefore becoming smaller.

2.9.4 Results of policies tested with land-use transport models

A summary is given here of a number of selected modelling studies and the results of policies relating to suburbanisation.

<u>ISGLUTI Phase 1</u>

The methodology agreed on by the ISGLUTI involved two phases (Webster, Bly and Paulley, 1988):

- Phase1: Each modelling group used their own model to simulate a set of relevant policy tests for the city for which the model was calibrated. In this phase 9 models were tested in 7 different countries (Webster, Bly and Paulley, 1988).

- Phase 2: A selected number of models were used to test different models on the same data set to eliminate the impact of the city type by applying the same model to different cities. The results of the second phase were published in a series of articles (Wegener, Macket and Simmonds, 1991; Echenique, Flowerdew, *et al*, 1990)

Phase 1 of the study indicated the following policy test results:
Typical decentralised growth of population and employment of modern cities has been tested. In reality higher growth rates lead to higher decentralisation. A low-density dispersed pattern of development benefits the car user, while this impacts negatively on the captive public transport user. The study suggests that restrictions on outlying developments will reduce the rate of decentralisation and increase residential densities in inner areas, but that such restrictions will have to be severe to stop decentralisation. This is true, even for a static population and declining incomes.

The distribution of employment is not greatly affected by even large population changes, although some retailing follows the population. Under high population growth the city centre attracts more trips, but this constitutes a smaller share of total trips. When land restrictions are applied on the outskirts, employment switches from the outer to the inner suburbs, rather than to the CBD, although the centre retains more of its activity.

The study examined various ways in which non-service employment might decentralise, allowing service employment to respond freely to changes in basic employment. The study suggests that it will not be sufficient to impose an initial relocation of employment, but that controls need to be maintained to avoid employment distribution reverting back over time to the initial distribution. This is a result of cities constantly being in a state of dis-equilibrium and forces that continue to change activity locations. It seems that planners' attempts to shape future employment patterns may have only partial success due to the strength of underlying forces.

In some cases there is an indication that relocation of employment into a concentrated industrial estate produces a more stable land-use pattern than when employment is more dispersed. The movement of non-service employment seems to have very little impact on the location of service employment, as service employment is mainly influenced by the population distribution.

Simulating typical retail decentralisation trends indicated that a shift in retail employment attracts population towards it, as people need to be near shops that both serve and employ them. This trend was generally stronger than a similar shift in non-service employment. When the shift in retail was more dispersed throughout the non-central area, the population shift was limited, but generally in the opposite direction as retail outlets outbid private house builders. In contrast, when the retail activity is concentrated in one decentralised location, it provides a stronger magnet to attract population towards it and this accelerated decentralisation. This trend favours car users and affords less accessibility to public transport users. Fewer trips are also made to the central city.

Two tests were conducted to attract shoppers to the city centre, i.e. free off-peak parking and free off-peak public transport. Free public transport was found to be more successful in slowing down the decentralisation trend than free parking. This is explained by the fact that bus use dominated car to the city centre in this policy test. Another modal split would have given a different result. Although the particular city shows a strong link between public transport and the amount of activity locating in the city, that is probably not typical. Improvements in public transport will in general have a positive impact on the city centre.

Increases in car costs have little effect on population location, but have a greater impact on employment location. In general, the rate of decentralisation of retail and service employment will slow down when car costs are increased, but will speed up when central city parking fees are increased. This result is of considerable importance to authorities that might contemplate schemes to raise parking fees or restrain car to the city centre in order to make the CBD more attractive to customers.

The study also suggests that longer-term effects of public transport subsidies on land-use are modest. This finding supported empirical evidence from other studies.

The policy tests defined a number of policies that will maintain the strength of the city centre, although their effects are modest. Measures to increase population density and reduce urban sprawl indicated that population location seems less respondent to policy levers than employment location, except for stringent zoning policies.

Policies to promote public transport only achieve significant shifts from car to public transport when the relative costs and speeds of travel by competing modes are changed directly. Measures that affect population and employment location are likely to have only minor effects on modal shifts, though they may be beneficial in other ways.

The Phase 1 study concluded as follows:
In each of the policy categories measures were found that achieved their objectives in the short term, but the effects of these measures may diminish over the longer term. Land-use patterns resulting from forced changes tend to revert back to the original trend, unless measures are taken to reinforce them. However, longer-term benefits may be in a different form such as wider destination choices rather than savings in travel costs.

The results indicated the importance of looking beyond the shorter-term impacts. Non-interactive types of models and the conventional transport models only consider the first round of direct effects. Even with their limitations, the interactive models provide a better understanding of the mechanisms involved and lend more certainty to predictions.

ISGLUTI Phase 2: Three models in one city

In one of the Phase 2 studies three models were applied to the Dortmund region in Germany (Wegener, Macket and Simmonds, 1991). The models were MEPLAN, LILT and DORTMUND. The purpose of this study was to determine how the different models would respond to a common set of policies applied to the same data set. Any differences in results could subsequently be related directly to differences in the model structures.

The models were all recalibrated on status quo data of Dortmund. The models were subsequently applied to estimate historic trends, and to test 18 land-use transport policies.

Dortmund is one of the main cities of the Ruhr industrial region in Germany. The wider metropolitan area has a population of 2.3 million. It is characterised by rapid decentralisation, high growth in car ownership and increasing trip distances.

All three models predicted the historic trend of population decentralisation. The DORTMUND model was most accurate in predicting the trend, while MEPLAN was the least accurate. The DORTMUND model predicted that high income population would be the first to decentralise. LILT and MEPLAN predicted that the low-income and medium-income population, respectively, would decentralise first. In reality, the high-income population was first to decentralise, followed by the medium-income and then by the low-income population.

DORTMUND and LILT overestimated the decline of the central city area, while MEPLAN underestimated the decline. MEPLAN also predicted the centralisation of retail, which was inaccurate.

The status quo transport trends were predicted fairly accurately by all three models.

In terms of the policy tests the following results were obtained:

- In most cases the models agreed with respect to the direction of land-use effects. There was consensus that the effect of transport policies on population distribution was small, and that restrictions on car use would not be able to reverse decentralisation. Population growth had the strongest impact on decentralisation.
- The results of the models were more diverse with respect to employment decentralisation resulting from population growth. MEPLAN predicted that higher petrol cost and free public transport would centralise employment, which was unrealistic. LILT predicted that employment would decentralise under these circumstances. The Dortmund model predicted only small impacts.
- The transport impacts of policies predicted by the three models were again fairly similar. Elasticities of car and public transport costs were similar between the models. However, differences were found with respect to car ownership predictions.

The study concluded that the differences in the policy test results could be traced back to the differences in model structures and theories used by the models. The average results of all three models were always plausible. The calibration was found to be a very long and painstaking process. The authors warned that the hope of accurately simulating the features of a city by means of a quick and efficient calibration process, was very premature. The study was regarded as the most rigorous testing of model performance in the history of urban modelling.

<u>ISGLUTI Phase 2: One model in three cities</u>

In this study the MEPLAN model was applied to three medium sized European cities i.e. Bilbao, Leeds and Dortmund (Echenique, Flowerdew, et.al., 1990). The cities have common characteristics in that they all suffered economic decline of their heavy industrial base. Otherwise the cities were different in terms of geography, urban culture and historical development.

The model was calibrated for each city. The same set of policies was tested relating to land-use regulations, transport pricing and investment options. The policy tests indicated the following results:

- An increase in car cost indicated similar results in modal shift. However, different land-use changes were observed. In Leeds the retail shifted to the central area, while it shifted away from the central area in the other two cities. An increase in parking fees in the CBD indicated slight decentralisation of service employment in each city. The effects on population distribution indicated differences due to differences in planning controls and parking fees.
- A policy of free public transport indicated the same direction of change, but at different levels. In Dortmund with its better public transport system, the land-use impacts were the greatest. Decentralisation occurred, but some concentration of employment, such as retail, also occurred due to improved accessibility.
- A controversial finding was that high-income car owners increased in the central area as a result of the free public transport, along with decreases in the middle and lower income groups. This was explained by the higher spending power of the high-income group, which allowed them to take better advantage of any benefits of a policy.
- A doubling of public transport fares yielded a centralisation of population in Leeds. Little change was indicated for Bilbao. The socio-economic distribution of population in central Dortmund indicated an increase in the lower status groups, and service employment decentralised.
- A policy of free car parking in the CBD for shoppers indicated no impact on land-use. Free public transport in the entire city indicated more significant decentralisation in Leeds compared to the other cities. This was explained by the apparent higher importance of access to non-work activities in Leeds compared to the other cities.
- Increased public transport speeds and decreased car speeds indicated a centralisation of higher income households and decentralisation of lower income groups. Decentralisation of the service sector was also indicated.

- The construction of an outer ring road showed an increase in the share of car and decentralisation of population and service employment for al three cities.

The study concluded that the differences in modelled results between the cities were plausible in view of the differences in their urban form and the characteristics of their private and public transport systems. Beyond these differences there were strong similarities between the policy impacts, indicating that the impacts seem to be transferable between cities.

<u>European Union Research</u>
A wide range of research studies on the interaction of land-use and transport in more than 20 European regions have been supported by the European Commision's 4th Framework Programme of Research and Technological Development (Wegener, 1999). The following policy test results were obtained:

- The share of private transport was found to decrease with increasing city size for cities larger than 750 000 people. A slight positive correlation between city size and private transport share was found for smaller cities.
- Urban density and the share of non-motorised travel and public transport were positively correlated, confirming results of other studies.
- Inter-modal transport, such as park-and-ride, supported migration of households to the urban periphery.
- The construction of a new commuter rail line parallel to a motorway had little impact on land-use patterns, but reduced congestion on the motorway.
- Infrastructure investment enhanced economic growth only in areas where this alleviated isolation and bottlenecks. This trend occurred only where an economic basis and growth existed prior to the investment.
- A better spatial integration of jobs and homes, congestion pricing and increased use of telecommunication were expected to lead to a substantial reduction in traffic levels and emissions.
- Mixing employment and residential uses contributed significantly to reduce trip lengths and the share of car, and increased the share of walking and cycling.

- Peak travel on motorways was less with clustering of urban functions compared to dispersed functions. Clustering increased accessibility and benefitted public transport.
- Urban structure policies performed differently in different cities. However, mixed functions which are clustered in larger spatial units generally performed best, while a compact city form, which focuses on monocentric locations and separation of functions was generally not the best option, especially in large urban areas.
- High density and mixed land-uses are only prerequisites for reducing travel, but need to be supported by transport policies to be effective.
- The most promising land-use and transport policy from an urban sustainability point of view is pricing policies, followed by regulatory policies, such as lowering car speeds. Investment programmes may have positive local effects, but their overall effects on sustainability is negligible. Land-use policies need to address both employment and population to be effective.

Successful land-use transport policies

The TRANSLAND report (1999) discussed the difficulties in defining what successful land-use transport policies were. Many objectives of these polices are in conflict, such as sustainable and efficient transport. The report proposed that unsustainable travel should be reduced, measured in per capita distance travelled by car, while travel by sustainable modes should be increased.

The reviewed models mostly evaluated policies in terms of transport effects, which is not adequate to evaluate the complex impacts of policies. The SPARTUCUS project (Wegener, 1999) was the exception as it developed a methodology for evaluating policies in terms of environmental, economic and social indicators of urban sustainability.

From a comprehensive review of the empirical and modelling studies the following conclusions were made regarding successful policies:

- Land-use and transport policies are only successful in terms of sustainability if they make car travel less attractive. Increasing urban densities and mixed uses without making car less attractive have only little effect as people will continue to maximise opportunities within their time and money constraints. However, these land-use policies are still important preconditions for reduced long term car-dependence.
- Transport policies making car travel less attractive are very efficient to reduce travel distance and private transport share, provided that land-use is not too dispersed.
- Dispersed retail and leisure facilities increase travel distances and private transport share. Preventing such dispersed developments will be more effective than integrated developments.
- There is no evidence that car constraining policies in the CBD are detrimental to the economic viability of the CBD, except where massive retail developments at peripheral greenfield locations have been approved at the same time.
- Transport policies that improve the attractiveness of public transport, have in general not lead to a major reduction in car travel. They attracted only little development at public transport stations, but contributed to further suburbanisation.

2.10 Optimal Site Selection Of Retail Outlets From The View-Point Of The Retail Business

2.10.1 Introduction

The aggregate land-use transport models discussed in Section 2.8 and 2.9 are typically used by urban planners to simulate the activities of all the urban role players, such as firms and households, in order to plan infrastructure or determine the best regulatory policies to achieve an efficient urban structure. The objectives of individual firms are very different as each firm only focuses on its own market and infrastructure and tries to maximise its own profit and market share. The optimal location for the firm is therefore defined mainly in terms of commercial objectives.

A review of the wide range of literature on retail management and market research is not appropriate for the purpose of the dissertation. The purpose of this section is to summarise the retail location process, the main location factors and analytical techniques. This will assist in the interpretation and understanding of the research conducted for the purpose of the dissertation, which relates to the locational choice factors of retail firms and their locational choice behaviour.

2.10.2 Role of location choice in the management of the retail firm

Location choice is one of the key decisions forming part of the overall marketing strategy of the retail firm (Mason and Mayer, 1990; Terblanche, 1998; Van der Walt, Strydom, *et al*, 1998). The main aim of the marketing strategy is to meet customer needs, and the most important factor for the customer is the convenient location of the retail outlet. Location has a major impact on profitability and market share, while growth of the retail firm depends to a large extent on the location of new retail outlets.

Other objectives of location choice is to achieve a spatial monopoly, or to be next to competitors where customers do comparative shopping (Van der Walt, Strydom, *et al*, 1998). Location choice may also be used to build the image of the firm by having the "right address".

However, of all the marketing decisions, the location choice is the least flexible (Van der Walt, Strydom, *et al*, 1998). This is due to the constraints of long-term rental agreements, the costly and time consuming furbishing and lay-out of the shop, and high cost of advertising a new location.

The best location depends on the type of retail business and type of product sold. Location and size of trading area have therefore been used as some of the criteria for classifying retail firms (Mason and Mayer, 1990; van der Walt, Strydom, et al, 1998). The size of the market area depends on the size of the product range, their price and frequency of purchasing. Convenience stores which sell low-priced goods that are purchased frequently, are conveniently located within walking distance or less than 5 minutes drive time from the customer. Speciality and anchor stores in shopping centres, such as large department stores, sell higher priced goods that are purchased less frequently. The trade area of these stores is much larger, and they typically draw 75 per cent of their customers from within 15 minutes driving time, with some customers travelling up to one hour. Fast food shops are dependent on passing pedestrians, while factory shops are not dependent on a convenient location. Non-store shopping, such a catalogue and electronic retailers, are not dependent on location and are becoming increasingly popular,.

2.10.3 Location strategies and analytical techniques

Mason and Mayer give a detailed description of the retail location decision process (1990). The steps in the location process are briefly discussed here with emphasis on the intra-urban spatial analysis.

<u>Corporate strategy and location policy</u>

The choice of location basically involves deciding how goods and services are to be made available to the customer. The process starts with an assessment of the firm's corporate strategy and location policy, which sets the strategic framework of how to serve the firm's particular market segment(s).

<u>Spatial analysis of markets</u>

Market selection is the first step in the spatial analysis of markets, which is aimed at the strategic level. This is the process of evaluating different regions and metropolitan areas in terms of their economic base, socio-demographic characteristics of the population and the potential of different regions to meet the marketing objectives of the firm. Various indices are used to determine the relative buying power, retail saturation and market expansion potential of different regions. Statistics on population, income, retail sales, expenditure and number of retail facilities are used to determine the indices. Expected sales are also estimated from regression models.

Area analysis is aimed at the intra-urban level to evaluate the different sub-areas within the urban area for potential locations. This involves the assessment of the physical environment, analysis of the competition and economic potential.

The physical environment is ever changing as different areas grow and decline. Traditional retail areas such as the CBD and street-front shops along ribbon development in older suburbs are declining, while shopping centres in suburbs are following customers in outward growing concentric circles. The CBD has lost its external market and is now primarily a market for the poor, the elderly, ethnic groups, CBD employees and business people doing business in the CBD.

Various trends in the physical environment are redevelopment of the CBD motivated by young professionals returning to the CBD, downsizing of the space requirements of retail firms, more efficient use of space to obtain better returns and multi-level shopping centres motivated by increasing land values.

Analysis of the competition involves assessing the physical characteristics of competing outlets, the levels of service provided, size and overall condition, merchandising policies and target markets.

Finally, a portfolio of market sub-area options is presented in matrix format to indicate the economic potential versus the competitive strength of various locations. Locations with higher economic potential and higher competitive strengths are selected for further evaluation.

Site evaluation is aimed at the micro-level geographical location of the retail outlet. Multi-criteria methods are used to evaluate alternative sites in terms of a checklist of key factors. For example, each factor is ranked in terms of its importance to management, and each site is ranked in terms of its attractiveness on each factor. A score is calculated for each site by multiplying the importance ranking with the attractiveness ranking and summing these. Typical factors are the following:

- Accessibility: This is measured in terms of physical barriers, ease of ingress and egress from site, traffic congestion and composition, and road conditions.
- Traffic volume: This is generally seen as a rough indication of potential sales volumes.
- Rent and other investment costs: Rent is a function of the competition between firms for a site. The ability to pay a certain level of rent therefore affects the locations available. The highest rent would be paid at the point of greatest pedestrian traffic – called the 100 per cent location. The structure of rents paid is roughly explained by the concept of bid-rent theory (see Section 2.8). Medium-quality stores with a wide range of merchandise will typically occupy the 100 per cent locations because they attract the largest volumes of customers. Speciality shops may be situated at less accessible locations as customers are willing to walk, or travel, further to reach them.
- The retail structure: This varies between the CBD, different sizes and types of shopping centres, ribbon and urban arterial developments, specialised functional areas such as entertainment areas, mixed or multi-use centres in office blocks and nodal developments around major intersections which have the drawing power of regional shopping centres.
- Future growth potential.
- Strength of the competition.
- Ability to meet the needs of the market segment served.
- Profit potential.

<u>Sales forecasting and store assessment</u>

One of the key factors to consider when evaluating alternative locations is the sales forecast of the potential store. The trade area, i.e. the primary geographic area from where customers are drawn, is one of the important considerations to make an accurate sales forecast. Christaller's central place theory provides a widely accepted explanation of the size, location and spacing of markets (see Section 2.8). The basic principle is that the more specialised the product or service, the larger the trading area must be before the service can be supported. The retail industry developed general rules regarding the size and type of businesses that communities of various sizes can support. This is often used as a first screening device.

The following techniques are typically used to forecast sales:

- Simple space-sales ratios are applied on the assumption that a store's sales are proportional to its share of the selling space.
- Reilly's law of retail gravitation is used to calculate a breaking point between two communities. It is mainly applicable to rural communities.
- The analogue technique relies on customer surveys, census information and mapping the location of customers and existing stores. Primary, secondary and tertiary trade areas are determined and market shares are estimated for different zones. The information developed for existing stores becomes an analogue to estimate the sales of a new store.
- Multiple regression is a more sophisticated version of the analogue technique, which allows sales or market share to be estimated from various independent variables such as planned sales area of new store, sales area of competing stores, population age distribution, household income, etc.
- Spatial-interaction models, such as the those developed by Huff, Lakshaman and Hansen (see Section 2.8) are not only used to estimate the potential sales of a new store, but also its impact on existing stores.
- The multiplicative competitive interaction model technique is an extention of the spatial-interaction model, which allows any number of additional variables to be included in the utility of a retail outlet, apart from distance and size of the outlet. These may include the availability of credit card services, number of checkout counters, and the image of the retail outlet.

<u>Location of a network of retail outlets</u>

Retail management can achieve many benefits by developing a network of retail outlets, such as achieving a larger customer base, economies of scale in terms of advertising and distribution, and spreading risk across the metropolitan area.

To determine the optimum number and location of retail outlets, the net present value of future income and cost flows is determined for various market share targets. The best location of each outlet is determined using the techniques described in the previous section, and then customers are allocated to each outlet. This location allocation model establishes a travel time, or distance matrix between demand centroids and the retail outlets. Various rules are used to allocate customers to the outlets, taking into account customer choice processes. Some simplified mathematical models allocate customers to the nearest outlet, or to the nearest outlet belonging to the retail chain.

Empirical studies showed that there exists a S-shaped relationship between market share and outlet share. This implies that it is best to maximise incremental market share in existing markets before proceeding to the next market.

Optimum site selection using decision tables

Recent developments in methods to select the best site for industrial development made use of decision tables (Witlox and Timmermans, 1999). In principle, this method can also be applied to the retail sector. The method integrates behavioural approaches that incorporate the preferences of the decision-makers, and structural approaches that take practical social and political constraints into account. The methodology typically capture the decision-making processes of a small group of experts through an in-depth interview, and is applied to determine the best site for a single industry or development from the viewpoint of a single business or developer.

A decision table is a tabular representation used to describe and analyse procedural and decision-making situations. It displays the possible actions that a decision-maker can take according to the outcome of a number of relevant conditions. In-depth interviews with a small sample of experts are typically used to construct decision rules. The decision rules can be compensatory or non-compensatory. Complex decision-making procedures can be accommodated by constructing hierarchical tables.

10.2.4 Summary of location factors

The review of retail literature indicated the importance of the best location of retail outlets to the commercial performance of retail firms. As the commercial objectives of retail firms relate to the very existence of the retail firm, factors such as profitability, market share, market potential, competition, and net present value are the most important factors to consider in location choice. However, the commercial factors are very much dependent on customer preferences, one of which is a convenient position relative to the customers' locations.

With regard to the direct commercial factors, the following factors are important considerations in optimum location choice:

- Accessibility is important at a sub-regional level in the metropolitan area as well as at a micro level relating to a specific site. At sub-regional level, travel time and distance from the retail outlet to the target market are considered, while the road network, physical barriers, traffic and pedestrian volumes, traffic composition and congestion are important determinants of accessibility at a micro level.
- Consumer preferences relate mainly to the goods or services offered and the site specific attributes, such as the shopping environment, the store lay-out, and service levels.
- The spatial profile of customers in terms of density, distribution, income and expenditure also determines the trade area and size, or threshold, that can be supported. The type of goods or service categorised in terms of their degree of speciality, price and frequency of purchase, determines the trade area of a retail outlet.
- The physical environment distinguishing at sub-regional level between the CBD, sub-urban retail areas and ribbon developments, and at micro-level between street-front, stand-alone, shopping centres of various sizes, and the characteristics of the buildings.
- The retail structure determined by the type, size and mix of various retail outlets at sub-regional and micro-level.

- Rent of retail space, which is related to the accessibility to the customers at a sub-regional and micro level , the type of goods or services offered and the level of competition from other retail outlets.

2.11 Revealed (RP) And Stated Preference (SP) Discrete Choice Models

2.11.1 Introduction

Disaggregate models are based on the choices made by individuals and have been developed to overcome the problems of aggregate models, which are based on the choices of groups of people (Ortuzar and Willumsen, 2000). Despite the problems experienced with aggregate models, disaggregate models only became a serious alternative during the 1980's.

Discrete choice models, also called individual choice models, estimate the probability of individuals choosing a given option based on their socio-economic characteristics and the relative attractiveness of the option compared to others. The attractiveness of alternatives is represented by their so-called utility, or benefit, derived from their attributes (Ortuzar and Willumsen, 2000). In view of their behavioural basis and policy testing sensitivity, discrete choice models have become very popular among transport planners, as well as planners in other fields such as town planning, geography and market research. Typical choices may relate to mode choice, route choice, parking choice, choice of residential area or shopping location. In transport planning, models simulating short-term choices such as mode choice and, to a lesser degree, route choice , have been the most popular applications.

Various survey techniques can be used to develop discrete choice models. Two main types of survey techniques are distinguished, i.e. RP and SP. RP surveys collect information on respondents' actual choices, whereas SP surveys collect information on respondents' preferences in alternative hypothetical choice situations.

In this section a brief description is given of the theoretical basis of discrete choice models, different types of models and survey techniques, the properties of discrete choice models, the advantages and disadvantages of SP models, and recent trends in the development of SP models.

2.11.2 Theoretical framework of discrete choice models

Discrete choice models are generated from random utility theory (Domencich and McFadden, 1975; Ortuzar and Willumsen, 2000) which states that:

- Individuals act rationally and always try to maximise their personal utility, subject to constraints.
- Each individual has a set of available alternatives and the utility of each alternative is measured in terms of a set of attributes.
- The utility consists of a measurable part, V_{jq} (utility of alternative j of individual q), which is a function of the measured attributes, X_{jq}, and a random part E_{jq}, which reflects the variance in tastes of the individual and any measurement errors. The utility is therefore given by:

$$U_{jq} = V_{jq} + E_{jq}$$

- The most common model assumes that Vjq is measured in terms of constant coefficients , C, across individuals, which can vary across alternatives, such that:

$$V_{jq} = \text{Sum}\ (C_j X_{jq})$$

By assuming different distributions for the random part, E_{jq}, various model formats can be generated. The popular multinomial logit model (MNL) assumes that the random part is a Gumbel distribution and independent and identically distributed (IID). This allows the coefficients to be estimated by means of a convenient mathematical algorithm based on the observed set of attributes of each alternative.

In terms of a simple example, assuming two alternatives and two attributes, the MNL model states that:

$P_1 = \exp(V_1) / [\exp(V_1) + \exp(V_2)]$

Where: P_1 = probability of choosing alternative 1

$V_1 = C_t Xt_1 + C_f Xf_1 + K_1$ (utility of alternative 1)

$V_2 = C_t Xt_2 + C_f Xf_2 + K_2$ (utility of alternative 2)

X_{t1} and X_{f1} are the attributes, t and f, measured for alternative 1

X_{t2} and X_{f2} are the attributes, t and f, measured for alternative 2

C_t and C_f are the coefficients of attributes t and f, respectively

K_1 and K_2 are constants for alternatives 1 and 2

The MNL model suffers from the so-called independence of irrelevant alternatives property (IIA), which indicates that the relative probabilities of any two alternatives are unaffected by the presence of any other alternatives (Ortuzar and Willumsen, 2000). In the case of similar or correlated alternatives, the model yields incorrect results. The probit model (MNP), which assumes a normal distribution for the random term of the utility function, overcomes this problem. This model is difficult to calibrate, and nested logit models have therefore been formulated to overcome the IIA property in terms of logit models. The correlated alternatives are grouped together to form composite alternatives at the top of the hierarchy. The logit model is applied in a sequential manner, by first estimating the non-correlated coefficients of the alternatives at the lower nests, and subsequently estimating the coefficients of the composite alternatives at the higher nests.

Estimation of elasticities

Similar to any mathematical model, discrete choice models allow one to estimate the elasticity of the dependent variable, say probability of choosing alternative 1 in the example above, with respect to changes in any of the independent variables, i.e. X_{t1} or X_{f1}. The elasticity is typically defined as the percentage change in the dependent variable as a result of a one per cent change in the independent variable. The direct elasticity is defined as the elasticity of an alternative in view of a change in the value of one of its own attributes. The cross elasticity is defined as the elasticity of an alternative with respect to a change in the value of one of the attributes of a competing alternative. The elasticities of different independent variables provide a good measure of the relative importance of the variables. Variables with an elasticity of greater than one are typically very elastic, i.e. have a high impact on the dependent variable, while variables with an elasticity lower than one are typically not elastic.

Point elasticities can be calculated with the model by determining the slope of the relationship between the dependent variable and any independent variable at a specific set of values of the independent variables. Average elasticities are calculated by applying the model to a set of values of the independent variables and determining the ratio of the percentage change in the dependent variable to a small percentage change in the independent variable.

From the definition of elasticity it is clear that the elasticity is a function of the relative shares of the alternatives, the coefficients of the utility functions of the alternatives, as well as the values of the independent variables. The size of the model's coefficients is only one of the factors that influence the elasticity, and therefore it is inaccurate to regard the relative size of various coefficients as a proxy for their relative elasticities.

2.11.3 Features of discrete choice models

Ortuzar and Willumsen (2000) mention the following beneficial features of discrete choice models:

- The models are based on theories of individual behaviour and not physical analogies forming the basis of aggregated spatial interaction models. The models are therefore also more likely to be transferable over space and time.
- The models use the inherent variability in the data, and are less likely to suffer from biases due to correlation in aggregated data.
- The utility function allows any number and specification of the explanatory variables to be used. This allows for a more flexible representation of the relevant

policy variables. Aggregate models are often based on fixed predetermined variables, such as generalised costs.

- The models are relatively cheap to develop based on survey data of a limited sample of transport users.
- Very efficient calibration software programs are available on the market allowing for quick calibration of a large number of models. The software output reports various statistical performance criteria of the model, and also estimates elasticities of the independent variables.
- The models are easy to apply, typically in a spreadsheet, and a large number of sensitivity tests can be conducted.
- The models can be incorporated in conventional transport network models such as EMME/2 or SATURN to provide a sound theoretical and behavioural basis for these models, although at an aggregate level.

2.11.4 RP and SP survey techniques

Various survey techniques can be used to provide the necessary input data for the model calibration. Initially RP surveys were very popular. These surveys obtain information from respondents on the actual choices they made and the values of the attributes of the alternatives that they considered, as well as the socio-economic characteristics of the respondent.

RP surveys typically suffers from various problems (Ortuzar and Willumsen, 2000):

- Observations of actual choices may not provide sufficient variability to calibrate reliable models.
- RP variables, such as travel times and costs, are often correlated, which yield poor models.
- The observed behaviour may be dominated by a few factors, making it difficult to determine the relative importance of secondary variables.
- RP surveys do not allow the planner to study responses to new policies that have not yet been implemented.

During the 1970's, planners found large differences between observed and predicted choices based on SP models (Ortuzar and Willumsen, 2000). A limitation of SP models is the potential difference between what people say they will do and what they actually do. This problem was reduced during the 1980's as a result of improved SP survey design and requirements for trained survey staff and strict quality control. Three types of SP survey techniques are distinguished (Ortuzar and Willumsen, 2000):

- Respondents are asked to rank combinations of attributes that describe a service or product. This approach presents all choices at once, but the number of alternatives need to be limited in order to prevent fatigue of the respondents. The data also represent judgements that may not correspond to real life choices.
- Respondents are asked to rate the alternative services or products on a scale indicating their strength of preference. This approach is not preferred as the responses depend on the scales and the labels attached to them.
- Respondents are asked to choose one of the alternatives, or indicate a degree of preference. This approach is the closest to actual choices analogous to RP surveys.

During the past decade, stated preference (SP) and stated response (SR) survey techniques and models became very popular to evaluate policy and investment issues relating to new transport alternatives of which users had no experience (Stopher and Zmud, 2000). The wider range of techniques addressing the approach to obtain responses from a target sample in a hypothetical simulated context, is termed stated response techniques and they include the SP as a specific technique within the SR approach (Lee-Gosselin, 2001).

The origin of the SP and SR work dates back to the 1970's when attempts were made to introduce various attitude and preference methods into transport research and modelling (Stopher and Zmud, 2000). During the 1980's this work fell into disfavour due to difficulty in using these techniques in forecasting models, and due to problems in designing appropriate survey techniques. In the early 1990's the emergence of SP methods using the survey data in logit choice models gave impetus to the current popularity of SP and SR models.

2.11.5 Advantages and disadvantages of SP models

The advantages of SP models relate mainly to overcoming the drawbacks of RP models. These are, according to Pearmain (1991):

- The researcher can precisely control the choice offered to respondents ensuring high quality data to calibrate good statistical models.
- The effects of variables of interest can be isolated from the effects of other factors.
- Where a policy is completely new, SP techniques present the only basis for evaluation and forecasting.
- As respondents are asked to consider a number of situations, each respondent provides a number of observations, compared to the single observation per respondent provided by the RP survey. This result of this is that statistically significant models can be calibrated from a smaller sample size.
- With the advent of cheap and lightweight personal computers, collection of the survey data with laptop computers is possible, ensuring real time validation of data and allowing attribute levels to be presented in terms of the respondent's personal experience.

The main problem with SP techniques is that the respondents' stated preferences may not correspond with their actual preferences in real life. Reasons for such divergence are (Ortuzar and Willumsen, 1990):

- Policy response bias if the respondents believe that they can influence the outcome of the experiment.
- The difficulty of designing the experiment and interviewing respondents so as to obtain reliable preferences on the variables of interest.
- Fatigue or boredom on the part of the respondent.

- Complexity of the survey that may result in the respondent not understanding what is required.
- Self-selectivity bias when respondents, on purpose or subjectively, cast their existing behaviour in a better light.

To overcome the above problems, experienced planners with a very professional approach to the market research and the design of the experiment, are required. Techniques to scale the SP model with RP data collected simultaneously, are also recommended to overcome any SP biases.

2.11.6 Compensatory and non-compensatory models

During the early 1980's there was growing criticism against linear utility functions associated with compensatory decision-making processes i.e. a bad aspect can compensate for a good aspect (Ortuzar and Willumsen, 2000). Non-compensatory models were therefore proposed for decision-making processes characterised by perceptions of discontinuities. Good aspects are therefore not allowed to compensate for bad aspects, which are ranked higher in importance. Such alternatives are eliminated earlier in the search process.

By applying multi-criterion decision-making procedures that maximise a set of objective functions subject to a set of constraints, various decision models can be formulated (Ortuzar and Willumsen, 2000).

- The first type of model is based on the compensatory rule where the preferred option is selected by optimising a single objective function in terms of linear transformations of the set of attributes of each alternative. This yields the conventional linear utility function addressed by the MNL model.
- Various non-compensatory rules can be formulated by converting the constraints into thresholds and ranking the objective functions:
  - The elimination-by-aspects (EBA) model considers the highest ranked

attribute first, and eliminates all the alternatives which do not satisfy the threshold level of that attribute. The process is repeated for the second highest ranked attribute, and so on, until only one alternative is left, or a group of alternatives are left. In case more than one alternative is left, compensatory rules are applied to select the best alternative.

- There are many ways in which the above search strategy may be modified. A cyclic process may be used whereby the thresholds are sequentially modified until a unique alternative is found. A mechanism may be applied in which the decision-maker curtails the search at any point according to a pre-specified rule.

2.11.7 Habit and hysteresis effects

During the 1980's the influence of habit, or inertia to change, on the choice process received attention among transport planners and econometricians (Ortuzar and Willumsen, 2000). The influence of habit also relates to the phenomenon of hysteresis, which is an asymmetric response to increasing and decreasing attribute values. These phenomena were termed state dependence in the econometric field (Heckman, 1981).

State dependence is a specific concern in time-series models using panel data, as opposed to cross-sectional data often used in discrete-choice models. Daganzo and Sheffi (1979) applied the MNP model to time-series data by means of mathematical transformations and assumed that the utility of an alternative in one period also depends on its choice in the previous period. Johnson and Hensher (1982) applied this procedure and found that elasticities derived from the panel data model were very different and lower than those obtained from various cross-sectional models.

The influence of habit results in asymmetries in the logit curve or a hysteresis curve. For example, if the cost of an alternative increases by a certain amount, the absolute change in the probability of choosing this alternative is different to that resulting from a decline in cost by the same amount. If the effect of habit is present, choice is therefore not only a function of the utilities of alternatives in one period, but also of the way in which these utilities obtained their values.

2.11.8 The measurement of attitudes and their relationship with behaviour

The relationship between attitude and behaviour, and how to account for attitudes in the modelling of choices, are often debated. Central to this debate are the differences between attitudes expressed in terms of stated choices and real choices. A brief review is given here on the measurement of attitudes, followed by a review of a few studies to highlight some empirical evidence of the relationships found between attitudes and behaviour.

Measurement of attitudes

Development of the theory on the measurement of psychological attributes with no relevant correlation to any physical measure had been well developed by the late 1950's (Torgerson,1958). Various uni- and multi-dimensional scaling methods had been developed providing internally consistent measures correlating well with empirical data. Multi-dimensional scaling methods represent a number of attributes of an object on a single scale indicating the relationship between the various attributes. Psychometric scaling methods are often used to study the differences between groups of people or changes over time.

The use of multi-dimensional scaling methods have become very popular in transport planning to measure the attitudes of users towards various transport modes. The methods of paired comparisons and categorical judgement are often used to measure users' satisfaction with transport modes, degree of preference between modes, or importance attached to different attributes of transport modes. (Levin, 1979; Falk, 1978; Ortuzar and Willumsen, 2000). The method of paired comparisons involves asking respondents to compare pairs of attributes with one another and to state whether the one attribute is, for example, more important than the other (Torgerson,1958).

The method of categorical judgement involves asking respondents to rate each attribute on a five- or seven-point scale in terms of importance or satisfaction.

The theory of categorical judgement is based on the following assumptions (Torgerson,1958):

- A psychological continuum of an attribute of interest exists, and this continuum can be divided into a number of ordered categories.
- Owing to various factors, the attribute is not associated with a specific value on the scale, but follows a distribution. The scale value has a certain mean and dispersion on the scale. Likewise, the category values also follow a normal distribution, with a certain mean and dispersion. The category intervals are not necessarily the same.
- A person judges a specific attribute to be below a certain category boundary whenever the value of the attribute is less than that of the category boundary.

By assuming that the variation of the category boundaries is constant for all category boundaries, the category boundaries and scale values are given by the following equation:

$T_g - S_j = X_{jg} A_j$

T_g = *mean location of g'th category boundary, with g=1,2…,m*

S_j = *scale value of attribute j =1,2…..n*

X_{jg} = *unit normal deviates corresponding to the proportion of times,* P_{jg}, *attribute j is sorted below boundary g.*

Torgerson (1958) reviewed various methods of calculating mean scale values of attributes and category boundaries, from the observed proportions, Pjg, provided by a sample of respondents who rated various attributes of an object on a number of specified categories.

Research indicated that care should be taken when applying attitudinal scaling methods developed in western countries to other cultures in developing countries (Van der Reis, 1984; Van der Reis and Lombard, 2001) for the following reasons:

- The definition of concepts and meaning of words differ between cultures.
- Less-literate people have difficulty in distinguishing between categories if too many categories are used on a rating scale.
- Respondents from some cultures are not used to, or unwilling to state their true attitudes and feelings.

Research by Van der Reis in South Africa indicated that the use of 5-point rating scales using simple word descriptions for categories gave the most reliable results among less-literate people compared to seven-point scales often used in western countries, and compared to using pictorial scales (Van der Reis, 1984).

Research into choice behaviour often makes use of psychometric scaling techniques to measure the differences in attitudes of consumers to explain their choice behaviour with respect to different products or services. (Torgerson, 1958, Van der Reis 1984; Falk, 1978; Louviere, 1979; Ortuzar and Willumsen, 2000). The following three approaches can be distinguished:

- Using multi-variate statistical techniques to analyse the differences in attitudes between market segments. (Louviere, 1979; Falk, 1978; van der Reis, 1984).
- Using attitudes measured in terms of rank order or ratings, such as in stated response models, as the dependent choice variable. (Ortuzar and Willumsen, 2000; Stopher and Zmud, 2000).
- Using attitudinal measures as independent variables in discrete choice models to explain choices. Value judgements, such as comfort, convenience, safety and quality, are sometimes used to include qualitative factors in choice models. (Louviere, 1979; Hunt, McMillan, *et al*, 1994; Ogden and Young, 1983; Ortuzar and Willumsen, 2000).

Relationship between attitude and behaviour

The extensive research by social scientists and psychologists into the relationship between attitudes and behaviour indicated very weak relationships (Levin, 1979). Levin (1979) gave three main reasons why transport planners seemed to be more successful than social scientists in establishing significant relationships between attitudes and behaviour. The first reason is that in social research, attitudes are often specified in vague terms, whereas behaviour is very specific. Secondly, attitudes interact with other situational factors to explain behaviour. This is often ignored by social scientists. On the other hand, transport planners model the interaction of a comprehensive set of choice factors in very specific terms to explain travel behaviour. Finally, the objectives of attitudinal research in the social sciences are concerned with the processes by which attitudes are formed, whereas the objective of this research in transport planning is to predict travel behaviour. A given attitudinal model may therefore be more readily accepted by the transport planner than by the social scientist.

Some transportation researchers included importance ratings of individual attributes and satisfaction ratings of the various alternatives in a utility model using regression analysis (Levin, 1979). Although successes to predict modal split had been reported, the models lacked a proper explanation of how causal factors combine to influence travel behaviour under changing circumstances. Levin (1979) reported on the development of a SP mode choice model to demonstrate how this model overcame the limitations of earlier attitudinal transport models. A 20-point rating scale was used to indicate the degree of preference for bus and car based on a three-factor, three-level factorial design. The study indicated a strong relationship between the stated preferences and actual mode choice. Importance ratings of modal attributes also indicated a significant relationship to actual mode choice, but to a lesser extent than the stated preferences.

Attitudinal data in terms of satisfaction ratings of modal attributes on a five-point scale indicated that attitudes are not simply the cause of behaviour. Instead, attitudes, behaviour and constraints on the availability of alternatives are mutually influencing each other (Golob, Horowitz and Wachs, 1979). It was also found that the attributes, which indicated significant differences in the satisfaction ratings between two modes, exactly matched the significant attributes in the MNL mode choice model.

Levin (1979) found that respondents placed greater weights on factors that support their current bias towards their chosen mode. He labelled this an "inertia" effect implying that mode choice attributes need to change substantially before travellers would change from their current mode of travel. This supported the results of the research by Golob that choice, or behaviour, affected attitudes, and *vice versa* (Golob, Horowitz and Wachs, 1979).

Early research in SP also found a good correlation between stated and revealed preferences of consumers in the context of residential location and shopping destination choices (Louviere, Wilson and Piccollo, 1979). Multiple regression was used to relate the degree of preference on a scale of 1 to 100 to various combinations of attribute levels of alternatives. A relationship was subsequently established to transform the stated preferences to revealed choices. More sophisticated ways of scaling between SP and RP models have now become common practice, as indicated in Section 2.11.4 (Ortuzar and Willumsen, 1990).

2.11.9 Recent developments in SP techniques

In a review of a workshop on SP and SR applications conducted at the 2000 International Association for Travel Behaviour Research Conference (IATBR), Stopher and Zmud (2000) summarised problems and issues discussed and research needs identified at the workshop. In view of the problems and issues, the workshop defined the following research needs:

- More effort should be spent on validation by checking the consistency of responses, validating the models with RP data, other attitudinal data and other results.
- Minimum standards of survey design in terms of attribute specifications, choice sets, constraints, sample design, etc are needed.
- Issues relating to the data collection procedure such as the use of computers and the internet, assessing and controlling representativeness of the sample and the magnitude of attribute change to trigger a behavioural response, should be resolved

- Research is needed on the validity of underlying compensatory behaviour of SP and how to deal with alternative lexicographic (making choices on one attribute only) and non-compensatory behaviour. A need was also expressed to integrate attitudinal and socio-economic data into SP models.
- There is a need to explore applications in areas where SP has mostly not been used, such as measuring induced or suppressed demand, understanding and modelling behavioural change and learning, and application to more complex and long-term choices such as locational choices. Research into the most appropriate applications for SP is also necessary, recognising that SP is not a solution to all transport problems.

It was concluded that SP applications began with concerns to predict responses, while it has now evolved into concerns with understanding decision and behavioural processes. There is a need to look at more complex issues, and also to look at additional data to SP, such as attitudinal data, measuring constraints, the effects of habits and uncertainty.

2.12 Application Of Discrete Choice Models To Housing And Retail Location

2.12.1 Introduction

This section reviews literature on the application of discrete choice models to choices of residential and retail activity location. Choices relating to housing and retail location are made infrequent, every 3 to 7 years, and are more complex and more difficult to model, compared to short-term transport choices. Although the dissertation focuses on retail location, literature on housing location, and one example of freight facility location, are also reviewed in order to assess their contribution to the modelling of spatial choices. The review of literature on non-retail location aspects therefore focuses on the modelling methods, which were found to be relevant to the modelling of retail location.

The review covers the identification of issues relevant to spatial choices, housing location choices, retail location choices, and finally an application on the location

location choices, retail location choices, and finally an application on the location choice of freight facilities.

2.12.2 Issues in discrete choice models of spatial location

Research into the application of discrete choice models to urban planning by Longley in 1984 indicated the need to explore the application of these models to the field of urban geography and spatial behaviour as a higher priority compared to just refining the techniques within the traditional application contexts of micro-economics, transportation and psychology (Longley, 1984).

There is a number of issues that need to be considered in the application of discrete choice models to spatial decisions (Longley, 1984; Hunt, McMillan, *et al*, 1994; Arentze and Timmermans, 2000):

- In spatial choice situations the number of alternatives is often too large for practical modelling purposes. Various ways of reducing choice sets had been proposed, with the most useful one the classification of alternatives on some broad areal categories and inclusion of alternative specific constants.
- RP data of spatial choices present various problems to discrete choice modelling due to the infrequent nature of choices, the large number of potential alternatives, and various constraints acting on households restricting their choice sets. RP data often describe the compromises households make, due to habit and disequilibrium in the market, and not their real preferences. SP experiments overcome these problems as the planner is not restricted by rarely occurring choices made in the past, alternatives that are not necessarily part of the respondent's existing choice sets can be explored. Actual preferences can also be explored.
- Utility functions of spatial choices need to incorporate a larger number of attributes due to the more complex nature of these choices.
- The incorporation of spatial constraints is a controversial issue in urban geography, debated between supporters of choice-base and constraint-based approaches. Government policy, land-use planning and personal characteristics

are typically acting as constraints. For example, public housing policy in Britain resulted in a clustered spatial pattern. At a personal level, blue collar workers indicated a reluctance to aspire to home-ownership.

- Segmentation of the market is important to explain differences in spatial choice behaviour adequately . However, more complex and different segmentation criteria, compared to conventional socio-economic criteria, need to be considered to differentiate between behaviour patterns. Attitudinal criteria such as habits, aspirations and prejudices play an important role.
- When faced with large choice sets such as in the spatial context, individuals may resort to different decision-making processes compared to those used when faced with smaller choice sets. The choice process may be based on a more crude rationalisation process compared to the utility maximisation process. SP data allows the planner to explore alternative choice processes before fitting the discrete choice model.
- The debate in transportation literature on how the apparent differences between actual (measured) and perceived attribute values should be treated, as well as the inclusion of qualitative attributes, is even more of a problem in spatial choices. Behavioural research indicated that consumers' spatial behaviour is often influenced by subjective images of shopping or housing opportunities. It is difficult to relate these variables to quantitative data such as floor space and density. However, for practical purposes it may be assumed that sufficient correlation exists between qualitative factors influencing choices and appropriate qualitative factors.
- Time-series or panel data have mostly been used to study the dynamic nature of short-term travel choices. There is a lack of RP panel data on housing choices and residential mobility to be used for discrete choice models. A further problem is that the households do not make instantaneous decisions when housing preferences or socio-economic circumstances change. The decision process to move house is often a protracted process, which may or may not lead to change in residential location. Revealed preferences therefore present a lagged response to changes in socio-economic circumstances.

- Studies on the spatial and temporal transferability of discrete choice travel models indicated that models were less transferable than initially hoped. Spatial transferability had been hampered by lack of contextual measures in terms of spatial structure. It was also regarded as important to include the interaction between short-term travel choices and long-term spatial choices in any study of temporal transferability.
- Early SP studies on spatial choices (residential location and shopping destination) found good correlations between SP and RP choices (Louviere, Wilson and Piccolo, 1979). These results are promising in view of the difficulty of obtaining RP data on spatial choices.
- Feasible choice sets are easy to determine when the number of alternatives is very limited such as in mode choice studies. In view of the more complex spatial choice sets, feasible choice sets are a function of a number of socio-economic factors. Louviere (1979) defined variable feasible housing choice sets as a function of existing residential location, family size, and household income, amongst others. Home loan qualification criteria also restrict feasible housing choice sets.

2.12.3 Housing location choices

The housing location process consists of two broad distinct choice processes (Longley,1984). Changing circumstances may lead to a decision to relocate, described as residential mobility. Once this decision is made, the subsequent step is to choose another house in a desired location. Longley criticised the lack of integration between models of residential mobility and housing choice (Longley, 1984).

Discrete models of housing choice received a fair amount of attention from planners. Some studies developed joint travel and residential choice models in response to the need to relate travel to the spatial and temporal contexts (Lerman, 1977; Landau, Prasker and Alpern,1982). Other studies focused more on the housing market developing models of residential mobility, residential location, dwelling unit choice and tenure choice. (Louviere,1979; van Lierop and Nijkamp, 1982; Onaka and Clark, 1983; Longley, 1984; Hunt, McMillan, *et al*, 1994; Ortuzar and Rodrigues,2000).

Residential mobility, tenure and housing choice models included a wide range of variables. Hunt *et al* identified more than 50 attributes found in various studies to influence residential location choices (Hunt, McMillan, *et al*, 1994). Typical variables are categorised below:

- Household characteristics such as stage in the family life-cycle, household size, typical home loan allocation criteria, such as income and socio-economic status of head of household, residential activity, such as length of stay at existing house.
- Financial and budget considerations, such as investment valuation, cost of house, cost of moving, household budget.
- Dwelling unit characteristics, such as housing type and size, number and types of rooms, age and condition of building, and related health risks.
- Neighbourhood characteristics, such as population composition, income level, and safety.
- Needs and preferences expressed by household to acquire larger or smaller house, or to meet local authority criteria for council housing.
- Accessibility of house to work, education and shopping facilities.

Longley explored a wide range of RP models calibrated on the English House Condition Survey of 1976 (Longley,1984). The data limited the study to residential mobility and various tenure options in terms of owner occupation, rent from the private sector, and rent from the local authority.

Longley proposed a hierarchical, or sequential model structure, which seemed more realistic than a simultaneous model as it was hypothesised that households would not be capable of undertaking the complex housing choice process as a single decision. The proposed hierarchy consisted of the choice between renting and ownership at the upper level, with renting choice split between renting from the private sector versus renting from the local authority, followed by the housing type, and geographical location at the root level. A simple nested model of tenure choice of the upper two levels of the proposed hierarchy was tested and compared to a simultaneous MNL model. The nested model did not provide a better fit of the data. However, it was concluded that the nested model was not more expensive to calibrate, while it provided better theoretical insights.

Due to the advantages of SP techniques, especially to address the rarely revealed spatial choices, they became popular in spatial and geographical contexts. The limiting number of alternatives and attributes that can be incorporated in SP experiments is a potential concern in applying SP to spatial choices, which need to address a larger number of alternatives and attributes. Early studies did not regard this as a problem as indicated by Louviere (1979). He successfully conducted SP experiments among university lecturers and households who had to assess 27 alternative housing descriptions on up to 13 attributes. Preference was indicated on a 20 point scale and multiple regression was used to estimate the coefficients of the utility function. The study indicated significant differences in the coefficients of various interpersonal groupings.

Recent experience in SP techniques recommends a much smaller number of alternatives and attributes to ensure a high quality of responses – in the order of two to three alternatives and two to three attributes per alternative (International Conference on Transport Quality and Innovation, 2001). The trade-off between quality and quantity therefore becomes an even more critical issue in spatial choices.

In sympathy with the need to limit the number of attributes suggested by previous research, Hunt *et al* conducted a SP residential and accessibility choice study focusing on only 5 attributes of interest (Hunt, McMillan, *et al*, 1994). These were cost of house per month, number of bedrooms, access to work, access to a shopping centre, and access to a light-rail station. Although a wide range of alternatives, 48, was generated in terms of different combinations of variable levels, respondents were each asked to rank four alternatives, drawn randomly from the total set. The logit model was estimated by means of the rank explosion technique. It consists of translating all the ranks into various binary choices and then estimating a MNL model.

Monetary values of the various attributes were estimated from the ratio of the coefficient to the cost coefficient. This allowed trade-off money values of what households would be willing to pay to be closer to a shop, to work, or the light rail, or to have an extra bedroom. All these variables were statistically significant. Access to shops was found to be more than 2 times less important than access to work.

Various socio-economic variables were entered into the utility function to determine whether these were significant in explaining residential choice. These included income, household size, and levels of accessibility to light rail.

Hunt *et a*l concluded that although the model was very useful to assess the impact of transport on housing, coefficients may have been higher than expected due to the fact that people may have selected more expensive alternatives more readily than under real life circumstances (Hunt, McMillan, *et al*, 1994). Another reason may have been that respondents felt compelled to consider all attributes because values for these attributes were specified and they were asked to consider them.

Ortuzar and Rodrigues (2000) applied a SP model to residential location choices in order to estimate households' willingness to pay for reduced air pollution. In order to target families who have recent and more frequent experience of relocation, households who occupied their residence for less than two years were selected. Tenants instead of home-owners were selected as tenants are more mobile. All members of families were requested to jointly rank each of 10 residential locations. Four factors, each with three levels, were used i.e. travel time to work, travel time to education, days of air pollution alert, and rent. The levels were described in terms of households' own experience. The current location was also included to validate the SP results.

The SP model was estimated by means of the rank explosion technique. Various model segmentations were estimated according to income level, households' level of sensitivity to air pollution, and type of dwelling. The models provided a good fit to the data and the monetary values of accessibility compared well with those found in other studies. This gave confidence in the monetary values estimated for air pollution. A dummy variable was used to estimate the influence of the current location or the inertia to change. This was found to be very significant, similar to other studies.

2.12.4 Retail location choices

Discrete choice models have also become popular in retail market research and planning to study consumers' choices of shopping locations and shopping patterns, and the locational choices of retail firms. This review first covers the choices of retail firms, and subsequently that of consumers. It seems that in the context of discrete choice models, consumer choice studies are more prominent in literature than studies of retail firms.

Locational choice of retail firms

Miller and Lerman (1981) have developed a mixed continuous/discrete choice model for the retail clothing sector in Greater Boston, USA. It was assumed that the retail firm makes three inter-related choices: where to locate, how much floor space to rent and how many employees to utilise. It was further assumed that firms select the best "location bundle" to maximise profits. The choice model was therefore specified in terms of the choice of discrete shopping geographical area, choice of store size and the employment intensity, i.e. employees per floor area. The model consists of cost and revenue functions and various transformations are made of exogenous retail data to estimate multinomial logit and probit models.

The model used cross-sectional RP data obtained from a retail census and information collected from shopping centre managers. The original intention to collect information from individual retail firms could not be realised due to the reluctance of retail managers to provide propriety data. The necessary data was therefore obtained from external sources and some data had to be estimated using standard ratios. The following data were collected for eight major retail clothing centres:

- total clothing store floor space
- total retail floor space
- average clothing store wage rate
- market potential in terms of revenue
- clothing store employment density
- rent of clothing store.

It was acknowledged that other micro-location attributes, such as parking availability, access to subway stops and quality of location also played a role. The model structure and lack of disaggregated data did not allow these variables to be pursued. However, location specific constants captured these effects in an aggregated sense.

To estimate probit models, assumptions had to be made about the co-variance structure between locations of different sizes, to reduce the number of parameters to be estimated. Compared to the logit models, the probit models indicated somewhat poorer fits to the data and the calibration was not completely well-behaved. The estimation procedure seemed to be very sensitive to the initial values assumed for the parameters. The probit models indicated that certain coefficients compared well with those estimated by the logit model, while others varied by a factor of more than two. The probit models indicated that the assumption of independence between locations (IIA) did not hold.

The model calibration results indicated the following:

- All the coefficients were significant and plausible.
- Probit models seemed to be a feasible analysis tool even for a relatively large number of alternatives. It also allows some of the restrictive assumptions of the logit model to be relaxed.
- Larger centres are more profitable than smaller centres.
- Clothing stores in an individual location tend to compete with each other and not

to re-inforce each other.

- The revenues of smaller stores are inelastic with regard to shopping trips to the centre in which they are located, and conversely, revenues of larger stores are elastic. Revenues are highly elastic with respect to store size.

The study identified the following research needs:

- Inclusion of other important factors such as pricing, quality of stores, shopping centre and goods sold, accessibility, and cost of moving.
- Addressing the interaction between the retail firm and the consumers' behaviour.

Meyer and Miller (1984) applied CBD retail activity models to Denver to test the impact of restricting car use in CBD's. The US Clean Air Act of 1970 requires metropolitan areas that do not meet air quality standards to adopt transportation control plans to limit car emissions. Typical policies are to restrict parking supply in the CBD and to improve public transport to the CBD. Planners were concerned that such policies may reduce the access to retail activity in the CBD relative to suburban shopping centres and hence endanger the viability of the CBD.

An aggregate and a discrete choice model were applied to determine whether both models would give the same results. The aggregate model was based on a time-series data base developed previously for Denver. A simple linear regression model was calibrated on the data to estimate retail sale in any zone as a function of the relative accessibility of the zone to households by car compared to all other zones, the proportion of households in the zone with households in the lowest 15 percentile, and the number of white-collar workers per unit area in the zone. Transit accessibility was found to be insignificant and was therefore excluded from the model.

The discrete choice model consisted of three sub-models. The two discrete choice models simulated residents' shopping choices both from home and from work. The third sub-model represented retailers' aggregate response. The change in retail employment in a zone was estimated as directly proportional to the change in shopping trip-making to the zone obtained from the discrete choice models. The modelling system was iterated until it converged to relatively small changes in the output. The discrete choice models were transferred from another city and updated to the conditions in Denver.

Three policies were tested. Two policies assumed reduced parking space in the CBD so that shoppers would respectively have to walk an extra 2.5 and 5 minutes from their parking space to the shops. The third policy tested a 5 minute decrease in waiting time for transit to and from the CBD.

The increase of 2.5 and 5 minutes in walking time from car parking space resulted in a 17 and 33 per cent decrease in CBD retail sales predicted by the aggregate model. The disaggregated model predicted a much larger decrease of 30 to 43 per cent in retail employment. The improved transit frequency generated only a 5 per cent increase in shopping trips.

Both models therefore predicted a high sensitivity of CBD retail activity to reduced access of car to the CBD, while increased transit access resulted only in marginal increases in retail activity.

The study demonstrated the benefits of developing a discrete choice model for the specific problem and not to model the whole city. The model was policy sensitive and its ease of calibration, making good use of existing data, allowed the planners to focus on the policy testing rather than on model development.

Several weaknesses were also identified:

- In the disaggregated model, cumulative changes in the shopping centre attractiveness dominate the overall predictions of retail activity.
- The disaggregated model only measures attractiveness of the retail location in terms of the size of the centre, ignoring many other factors such as the type, quality and price of goods on sale, the quality of the neighbourhood, safety and ease of movement, and accessibility for pedestrians.
- The models also ignore various options to improve the attractiveness of the CBD

as indicated by empirical evidence showing that well-planned car-restricted zones can be of net benefit to the CBD.

- There is also a lack of understanding of the decision-making process of the retailer responding to the car restraint policies. For example, the retailer may decide to increase advertising, reduce profit margins, cut costs through reduced inventory levels and improve staff efficiency. The models treat the retailer in an aggregate *ad hoc* fashion ignoring the range of responses of the retailer.
- The modelling results may be regarded as being too sensitive to changes in the transport system.

Ogden and Young (1983) developed a discrete choice model of managers' preferences for the location of freight facilities. The same approach could have been applied to retail firms, and was therefore useful to include in this review. The purpose of the study was to come to a better understanding of the factors affecting the location of freight facilities such as depots and freight forwarding facilities.

A survey was conducted among a small sample of senior managers of freight facilities in Melbourne, Australia. The authors wanted to test both a compensatory model and a non-compensatory model. For this purpose they asked the managers to rate two locations in terms of 19 locational characteristics on a psychometrical scale of 1 to 100. The managers rated their satisfaction with the locations in terms of each of the factors, and also rated how important these factors were in selecting a location. The total satisfaction with each location was also rated.

The compensatory model was a logit utility maximisation model, while the non-compensatory model was an elimination by aspects model (EBA). It was found that the EBA model provided a slightly better fit than the logit model and that both models provided consistent and good results. Five factors were found to be significant in explaining locational preferences:

- Proximity to existing customers.
- Proximity to arterial roads.

- Availability of alternative sites.
- Cost of truck fleet operation.
- Proximity to labour.

Although the models provided a better understanding of locational choice factors, a limitation of the methodology was that relationships between measures of satisfaction and physical measures, such as travel time and cost, were lacking and required further research.

Locational choice of retail consumers

Discrete choice models also offer a powerful tool for retail firms to determine what attributes of shop location, lay-out and goods are important to consumers, and what their relative elasticities are. Timmermans referenced a number of multinomial logit models, using RP and SP techniques that were applied to the spatial shopping patterns of consumers (Timmermans, 1996). Only a few studies are reviewed here.

Arnold, Oum and Tigert estimated MNL models of consumer choices in the retail food market (1983). The consumer surveys were conducted over a seven year period in six major markets in North America and Europe. The study was motivated by the explosion in the type of supermarket and the need to understand consumer preferences for strategic and tactical planning purposes in the food industry. The models indicated significant changes over the seven year period in a single market and significant differences between markets and cultures.

Across most markets the logit coefficients were consistently high on a small set of store attributes including locational convenience, low prices, fast check-out, friendly service, best weekly specials and shopping environment. Location and price were the most dominant attributes. These results compared well with independent attitudinal surveys requesting respondents to provide the most important and second most important reason for shopping at the preferred supermarket.

The RP survey requested respondents to provide qualitative ratings of available supermarket alternatives. Only the best supermarket on each attribute had to be chosen by the respondent, for example the supermarket with the easiest access, lowest prices, etc. The selected supermarket was identified as the one used most frequently. Up to 27 attributes were included in the various samples.

SP models were also applied from an early stage to consumers choices of shopping destinations. SP and RP models using a limited number of key variables were developed by Louviere *et al* to simulate the choice of shopping destination for out-of-town shoppers (Louviere, Wilson and Piccolo, 1979). The variables tested were all found to be significant including number of stores, travel time, price of clothes and intervening opportunities (number of competing stores). The SP experiments combined with the RP data proved to be very useful in exploring shopping behaviour, which was not previously possible by using only RP data.

Timmermans developed a sequential mode choice and shopping destination choice model for Eindhoven, in the Netherlands, using a stated choice technique (Timmmermans, 1996). He distinguished between earlier studies, which used rating and ranking techniques applying deterministic rules to predict preferences, and later techniques which requested respondents to choose among alternatives and applied probabilistic models. He used the term "stated choices" for these techniques, which were better to use to predict market shares and consumer behaviour.

The previous research of Timmermans indicated that the major determinants of consumer spatial shopping behaviour were the size of the shopping centre, price of goods, parking facilities and accessibility in terms of distance travelled. The shopping travel mode choice model between car and bus included car parking costs, travel times, bus fare, and bus frequency. The shopping destination model described shopping centres in terms of different sizes, price levels, parking facilities and distance intervals. Respondents were requested to first choose their mode of travel and then the shopping centre in view of the chosen mode. When calibrating the mode choice and destination models independently, all the variables were found to be significant. The sequential mode and shopping choice model indicated that mode choice did not influence shopping destination. However, the sequential model provided a better fit to the data than the separate models.

In recent years, activity-based models (ABM) became popular to model the short-term shopping activities of consumers, including shopping destinations. Arentze and Timmermans (2000) contrasted two main approaches for ABM. The one is the popular utility maximisation approach, which is becoming more complex with numerous nests of choices within a hierarchical structure. The other one is the constraints-based approach, which is based on decision rules subject to spatial and temporal constraints.

The state-of-the-art ALBATROSS model follows the constraints-based approach and models the shopping destination choice of consumers as part of their daily activities (Arentze and Timmermans, 2000). The model distinguishes between daily and non-daily shopping. Shopping locations are classified into rank order according to appropriate floor area. It was assumed that the location decision is made when all other activity dimensions are known, i.e. schedule position, travel party, duration, starting time, trip chaining, transport mode and locations of fixed activities (home and work). The feasible shopping location choice set is determined from the schedule position, speed of travel (dependent on transport mode), available facilities at location, opening hours of facilities and the minimum duration of the shopping activity. Generic rules are used to select a specific location from the feasible choice set. The rules formulate different ways of trading-off travel time and the rank order of the location.

In order to evaluate the performance of the ALBATROSS model, it was compared to a nested utility maximisation model, which was developed by an independent study team from the same data set and based on the same assumptions (Arentze and Timmermans, 2000). A nested MNL model was used as the main choice simulation technique. Both models were validated against the empirical data. It was shown that the ALBATROSS model provided a ten per cent better explanation of the observed activity diaries than the utility maximisation model.

Arentze and Timmermans (2000) identified several limitations that needed to be improved in the ALBATROSS model:

- Pricing and level-of-service attributes were ignored.
- Various attributes describing the attractiveness of the micro-location were ignored.
- The model was calibrated on cross-sectional data and ignored changes over time.
- It was envisaged that destination choice could be expanded by means of a non-compensatory EBA model.

<u>Summary of significant retail location factors</u>

The modelling results indicated the following significant locational choice factors of businesses:

- Accessibility factors:
  - Regional car access in terms of travel time or proximity to customers
  - Access to main road
  - Access to labour
  - Local car access in terms of walking time between parking place and destination
- Regional attraction factors:
  - Retail employment or employment density as a measure of the demand for shopping or shopping trips
  - Revenue as a measure of the market potential
- Local attraction factors :
  - Size of the shopping centre and size of the retail outlet in terms of floor space
- Rent of floor space
- Availability of alternative sites

Consumer choice of shopping location is a key consideration for retail firms and the need for interactive firm and consumer choice models was therefore expressed. The following consumer locational choice factors were found significant in separate consumer choice models:

- Accessibility factors such as travel time, distance and convenient location
- Number of retail outlets and facilities
- Attraction factors of local environment and retail outlet:
  - Size of shopping centre
  - Level of service, i.e. number of check-out points, friendly service
  - Shopping environment
  - Shopping hours
  - Availability of parking
- Characteristics of goods offered, i.e. price and weekly specials
- Space and time constraints in terms of feasible locations depending on activity schedule, speed of transport mode and home / work location
- Number of competing locations

For the modelling of the choices of both retail firms and consumers the need was expressed to include more local attraction factors such as the quality of the environment, accessibility, and the price and quality of goods. The models that included qualitative ratings of various factors generally included more local attraction factors compared to models using quantitative data. However, the use of qualitative factors presented problems to determine elasticities and to use the models to test policies.

2.13 Conclusions On International Literature Review

A brief summary is given here of the strategic conclusions that assisted in the achievement of the objectives of the dissertation in terms of four focus areas. The first two focus areas relate to the planning and policies of the main role players in the urban system, i.e. the planning authority, retail firms and consumers. The first focus area relates to suburbanisation trends and the evaluation of various policies from the metropolitan planning authority's point of view. Policy impacts based on empirical evidence and on the application of land-use transport models are summarised. The second focus area summarises the locational choices of retail firms and retail consumers, which are strong determinants of suburbanisation. The last two focus areas relate to the planning and modelling techniques that planning authorities use in urban planning, for example to address suburbanisation, and retail firms use in their own planning to select locations for their retail outlets.

Suburbanisation trends and evaluation of policies to address suburbanisation from the planning authority's viewpoint

The literature review on suburbanisation identified this trend as a worldwide phenomenon of urban areas having major impacts on the structure of the cities and travel patterns. The forces driving suburbanisation are strong and relate to trends in the development of the modern economy, transport systems focusing on the private car mode, space requirements of growing cities due to increased urbanisation, and increased mobility and accessibility demands from the urban population. Suburban sprawl increased accessibility for high-income car users and further promoted car travel, while the poorer and public transport captive groups experienced a decline in access to jobs and shopping opportunities. Suburbanisation also has a wide range of social, energy, environmental and traffic impact effects that must be addressed.

A wide range of policy options is available to urban authorities to strengthen the CBD relative to suburban growth. Policies managing the growth into higher density suburban nodes are more successful and acceptable than policies trying to oppose suburban development. Policies can be aimed at making the CBD more attractive and suburban development less attractive. Typical large-scale investments in rail-based projects have not been successful in managing suburbanisation and scarcity of resources in a developing country such as S.A. makes it undesirable to follow this example. Supporting existing rail and road networks has a much greater chance of success.

A wide range of zoning and regulatory measures based on increased formal co-operation between urban authorities and the private sector is available and successful. South African authorities are very slow in implementing these policies that seem to work in other countries.

Policies of planning authorities can only be effective if they are implemented in a co-ordinated way as part of an effective and comprehensive planning process. The focus of planning changed from large-scale infrastructure actions based on a single cost criterion, to a management and decision-orientated planning approach focusing on the information needs of a wide range of decision-makers in the public and private sector, i.e. developers, firms, residents, government, etc.

A wide range of policy tests conducted with a large number of aggregate land-use transport models was reviewed to assess their suburbanisation impacts. This could not have been done by observing empirical trends. The main conclusions from the policy tests are the following:

- Accessibility was found to be of varying importance to different land-uses. It was an essential location factor for retail, office and residential uses.
- The most promising land-use and transport policy from an urban sustainability point of view is pricing policies, followed by regulatory policies, such as lowering car speeds. Investment programmes may have positive local effects, but their overall effect on sustainability is negligible. Land-use policies need to address both employment and population to be effective.
- Land-use and transport policies are only successful in terms of sustainability if they make car travel less attractive. Increasing urban densities and mixed uses without making car less attractive, have only little effect as people will continue to maximise opportunities within their time and money constraints. However, these land-use policies are still important preconditions for reduced long term car-dependence.
- Dispersed retail and leisure facilities increase travel distances and private transport share. Preventing such dispersed developments would be more effective than integrated developments.
- In contrast, urban densification policies have a more limited effect to obtain a shift

from car to public transport compared to directly addressing the relative costs and travel times between the competing car and public transport modes.

- There is no evidence that car constraining policies in the CBD are detrimental to the economic viability of the CBD, except where massive retail developments at peripheral greenfield locations have been approved at the same time.
- Transport policies improving the attractiveness of public transport have in general not lead to a major reduction in car travel. It attracted only little development at public transport stations, but contributed to further suburbanisation.

Locational choices of retail firms and consumers

To estimate the aggregate response of retail firms to land-use transport changes for urban planning purposes, it is necessary to understand how individual firms select the best site, or network of sites, for their outlets. The optimum site selection from the perspective of retail firms constitutes and important part of the logistical and marketing management of retail and a wide body of literature exists on this subject.

The review of retail literature indicated the importance of the best location of retail outlets to the commercial performance of retail firms. Locational choice is not very flexible due to various constraints such as long-term rental agreements, costly furbishing and advertising. Commercial factors such as profitability, market share, market potential, competition, and net present value are the most important factors considered in location choice. However, the commercial factors are very much dependent on customer preferences, one of which is being located in a convenient position relative to the customers' locations.

The following factors are important considerations in optimum location choice, which impacts on the direct commercial factors:

- Accessibility factors in terms of travel time, distance, the road network, physical barriers, traffic and pedestrian volumes, traffic composition and congestion.
- Consumer preferences relating mainly to the price and type of goods or services offered and the site specific attributes such as the shopping environment, size of shopping centre, the store lay-out, service levels, and parking availability,

- The spatial profile of consumers in terms of density, distribution, income.
- The type of goods or service categorised in terms of their degree of speciality, price and frequency of purchase
- The physical environment such as the CBD versus suburban retail areas, ribbon developments, street-front shops versus stand-alone shopping centres of various sizes.
- The retail structure determined by the type, size and mix of various retail outlets at sub-regional and micro-level.
- Rent of retail space, which is related to the accessibility to the customers at a sub-regional and micro-level, the type of goods or services offered and the level of competition from other retail outlets.

Models calibrated on retail firms' and consumers' choices confirmed the importance of a number of the above location choice factors such as accessibility, market potential, rent of floor space, competing locations, consumer preferences in terms of accessibility, service levels, characteristics and prices of goods.

<u>Planning and modelling techniques of metropolitan authorities</u>

A wide range of models available to metropolitan planning authorities to evaluate suburbanisation management policies, has been reviewed, including:

- Historic land-use and retail models based on central place theory, bid-rent theory and various types of gravity models.
- Interactive land-use transport models based on a zonal representation of the urban area.
- Activity-based models based on activity diaries of households using utility maximisation or constraint-based theories.
- Disaggregate, behavioural models such as discrete choice models based on RP and SP survey data. The models ranged from utility maximisation, compensatory models to non-compensatory models.
- Attitudinal scaling techniques that are often used in discrete choice models to compare differences in attitudes and behaviour between different market segments.

The aggregate land-use transport models suffer from various problems in view of their limitations to simulate the dynamic nature of urban systems and to simulate the behaviour of the various role players in the urban system. The models are also too coarse in terms of their zoning system to provide impacts at a detailed level, and also lack the sensitivity to model certain impacts such as social equity aspects.

Despite these problems, the interactive land-use models provided useful results in view of applications of one model to one city. A reasonable similarity was found between the impacts of suburbanisation predicted by the models and the empirical evidence provided by the review of suburbanisation trends. The models gave plausible results and a good fit to cross-sectional data at one point in time, but a lack of trend data prohibited validation of models to predict changes over time.

The application of different models to the same city, or the same model to different cities, gave a more stringent evaluation of these models. Differences in policy test results, and between modelled and observed trends, could be traced back to the differences in model structures and theories used by the models. A major application of one model to three cities concluded that the differences in modelled results between the cities were plausible in view of the differences in their urban form and the characteristics of their private and public transport systems.

Model calibration was found to be a very long and painstaking process. The ideal of accurately simulating the features of a city by means of a quick and efficient calibration process, was found to be very premature.

The general disappointment in large-scale aggregate urban planning models gave rise to two trends in modelling approaches. The first trend was towards small-scale problem-specific models with a behavioural basis, such as discrete choice models. This trend was motivated by the high cost and complexity of the large-scale models, uncertainty about the accuracy of their predictions, and the changing focus of transport planning from large-scale infrastructure policies to managing the existing transportation system.

The second trend was based on the search for more behaviourally accurate large-scale land-use transport planning models capable of addressing a wider range of policy options. To address these needs, models therefore became more disaggregated in terms of their spatial and decision-making units. Activity-based models, simulating households' activity choices and schedules, have been selected as the most beneficial way to overcome the limitations of the conventional models.

Two approaches are popular in activity-based models: the use of discrete choice models, based on utility maximisation principles, and constraint-based approaches simulating choices by means of heuristic rules, using decision-tables. A comprehensive research study indicated that the constraint-based approach provided a small (10 per cent) but significant improvement on the utility maximisation approach in representing activity choices.

Discrete choice models have been applied to a wide range of urban choice situations for urban planning purposes. If the urban planning market is divided into four segments i.e. short- and long-term choices versus consumer and supplier choices, the most popular applications were aimed at short-term consumer choices such as travel choices of transport users and shopping destination choices of consumers. The next most popular application was long-term consumer choices such as residential choices of consumers. Only a limited number of applications of long-term supplier choices, such as the location choices of businesses, were found.

A number of issues that need to be considered in the application of discrete choice models to spatial decisions have been identified. A review of residential choice models assisted mostly in this regard. This includes the larger number of choice sets, number of locational choice factors, number of market segments, and the rarely revealed, infrequent, choices. Due to the advantages of SP techniques to overcome the limitations of RP techniques, especially to address the rarely revealed spatial choices, they became popular in spatial and geographical contexts as well. The limited number of alternatives and attributes that can be incorporated in SP experiments to obtain reliable results, is an issue that needs to be addressed in the SP design, in view of the need to address a large number of alternatives and attributes. Another issue is the difference between RP and SP choices, but there exists some evidence of good correlations between RP and SP in the spatial context.

In view of the more complex nature of spatial choices, some planners hypothesised that spatial choices follow non-compensatory behaviour. However, one business location study found that both non-compensatory and utility maximisation (compensatory) models provided good fits to the choice behaviour of managers, while the non-compensatory model only gave a small improvement on the utility maximisation model. One can also argue that the main objective of the private sector is one of utility maximisation (maximise profits and market share, optimise location), and therefore that utility maximisation would be more appropriate. A very comprehensive retail location study found good performance from a utility maximisation model.

Although the application of SP models poses various practical and theoretical problems, the many advantages offered by these models motivate continuous development of market research and modelling techniques, and wider applications, evident from various international conferences. An international workshop of travel behaviour experts identified various research needs of the future development of stated response models. The needs included the much more challenging market research aspects compared to analytical modelling aspects, understanding decision-making processes of transport users, the appropriate role of the models, and the need to address the incorporation of attitudinal and socio-economic factors, and more longer-term and complex choices including locational choices.

<u>Planning and modelling techniques of retail firms</u>

Whereas metropolitan authorities would typically apply simulation models to represent urban activities, retail firms would focus more on optimisation techniques to find the best site, to maximise profit or achieve the highest market share. Similar techniques are often used by retail firms to estimate consumer demand for alternative shopping locations, and to estimate sales potential. These include multiple regression analyses, multi-criteria methods, gravity models and discrete choice utility maximisation models. The latest research into the modelling of business managers' decision process to select the best site for a specific facility, makes use of a constraint-based approach based on decision tables.

3. IMPACTS OF URBAN DENSIFICATION STRATEGIES ON LAND-USE AND TRANSPORT PATTERNS: REVIEW OF SOUTH AFRICAN EXPERIENCE

3.1 OVERVIEW OF CASE STUDIES

In this chapter case studies in South Africa relating to the problems of urban sprawl and suburbanisation, and the evaluation of various urban densification strategies from the metropolitan planning viewpoint, are reviewed. Finally, a brief review of the retail sector of South Africa is given, including the impact of retail trends on suburbanisation and proposed solutions, in order to provide the necessary retail background for the empirical research of the dissertation.

The National Department of Transport's research study on the impact of suburbanisation in 1991 set a comprehensive framework for South African studies, and therefore this study is presented first. Reference is also made to research conducted by Terblanche (1989) on the impact of large-scale retail developments. The first comprehensive application of an integrated land-use transport model in South Africa was the MEPLAN model implemented in Cape Town during the late 1980's. The model and its application to evaluate urban corridor development in Cape Town in 1991 are reviewed secondly. A more pragmatic approach followed on the East Rand to develop an integrated land-use transport sketch planning model and to test various urban densification strategies from 1989 to 1996, is discussed next.

More recently, metropolitan authorities started to develop land development objectives (LDO's), also called integrated development plans (IDP's). In terms of the Local Government Municipal Structures Act (Act No. 117 of 1998) various authorities evaluated spatial development frameworks for their areas. A study conducted in the Greater Pretoria Metropolitan Area from 1997 to 1999, which is one of the most comprehensive and quantitative IDP evaluations in South Africa, is reviewed.

A brief summary of research on nodal development trends and a model to evaluate the development potential of nodes on the West Rand concludes the review of studies relating to metropolitan land-use transport planning.

The chapter is concluded with a review of the retail sector of South Africa, including the availability of secondary data sources, the role of retail in the national economy, trends, problems and solutions to address retail suburbanisation.

The author was intimately involved in three of these studies, i.e. the NDOT research study, the East Rand study and the Pretoria study. The involvement related to the development of aggregate models, as well as the evaluation of strategies and policies with the use of the models.

3.2 NATIONAL RESEARCH INTO THE IMPACT OF SUBURBANISATION ON MOBILITY: PRETORIA CASE STUDY

3.2.1 Introduction

The purpose of this two-year research study conducted for the NDOT during 1991/92 was to assess the impact of suburbanisation on mobility in metropolitan areas (Cameron, Van Zyl, Naude and Loubser, 1991). The study was motivated by the slow reaction of authorities to address two major urban spatial trends in South Africa. These were the decentralisation of businesses from the CBD to suburban nodes to serve the sprawling residential areas, and the outward development of black townships situated on the periphery of urban areas resulting in ever-increasing commuter distances. Related to this trend was the impact of the abolition of the Group Areas Act that allowed township residents to locate closer to work opportunities. As a typical metropolitan area in South Africa, Pretoria was selected for a case study. The specific objectives of the study were the following:

- Determine the effects of suburbanisation on the mobility of the urban population.
- Determine the differences in travel patterns between various suburban nodes and the CBD of Pretoria.
- Monitor changes resulting from the abolition of the Group Areas Act.
- Model the impact of accelerated suburbanisation and test policies and strategies to address this.
- Make recommendations regarding appropriate policies in response to suburbanisation and amendments to the planning system of authorities.

To achieve the objectives of the study, surveys were conducted among business managers, shoppers and employees at three suburban shopping centres and one centre in the CBD. Traffic surveys were also conducted at the centres, and the PREMET model data base of the former Pretoria City Council was used to contrast travel patterns attracted to the various survey areas. The model was also used to test corridor development strategies formulated to address the problems of suburbanisation. The activity nodes selected for the surveys were two regional centres, Menlyn and Verwoerdburgstad, one community centre, Hatfield Plaza, and the Sanlam centre in the CBD.

Research by Terblanche (1989) on the impact of large-scale retail developments is compared to the NDOT research. The changing profile of retail in South Africa and the widespread impact of large-scale retail developments motivated his research. He conducted empirical research on the impact of the Brackenfell hypermarket in Cape Town and interviewed a sample of shoppers to establish their shopping patterns. The main purpose of the research was to assist policy formulation by government with respect to large-scale retail institutions and to design a system for the processing of development applications.

A brief review is given here of the differences in travel and activity patterns between suburban and CBD nodes, factors considered by business managers to locate in either the suburbs or the CBD, evaluation of the corridor strategies, and recommendations made regarding policies and amendments to the planning system.

The results of the international literature review on suburbanisation trends that had been done as part of the study, have already been described in Chapter 2.

3.2.2 Travel and activity patterns

The following conclusions were drawn from the surveys relating to the travel and activity patterns:

- Relatively minor differences were found in the usage patterns of the suburban and CBD centres. The duration of shopping visits was shorter in the CBD and the smaller suburban centre in Hatfield compared to the two large regional suburban centres. Saturday morning shopping arrival and departure profiles showed a more rapid build-up and decline at the two regional suburban centres compared to the community suburban centre and the CBD centre, probably due to the fact that the Hatfield and CBD centres are part of a much larger business area.
- The arrival and departure profiles of office workers were similar for the centres with a short lunch hour peak that was more pronounced in the CBD and Verwoerdburgstad.
- Shopping trip generation rates were much lower than the rates reported by the Department of Transport Guidelines of 1988 (Cameron, Van Zyl, Naude and Loubser, 1991). The peak hour shopping trip generation rate (trips per 100 m^2) in the CBD was 40 to 60 per cent higher than in the suburban centres.
- Office trip generation rates of the CBD and the suburban centres were fairly similar, and also similar to the DOT guidelines, although the DOT guidelines suggested a somewhat higher trip generation rate for the CBD.
- The apparent decline in shopping trip generation rates was attributed to extended shopping hours, while the office trip generation rates that had become similar to that of the CBD, were attributed to the increased decentralisation trend.
- Roads in the vicinity of the centres were more congested in the CBD compared to the suburbs, except for Menlyn where congestion was also higher.
- In total 14 per cent of all trips generated in the Pretoria metropolitan area, and 24 per cent of work trips, was destined for the CBD, indicating the high level of decentralisation. Of all shopping trips, 16 per cent of high-income trips and 31 per

cent of low-income trips was attracted to the CBD, indicating the higher popularity of the CBD as a shopping destination for low-income groups. Shopping also attracted a significant proportion of home to work trips, i.e. 20 per cent.

- The trip attraction and mode choice patterns indicated that low- and high-income groups enjoy different levels of mobility and supply of public and private transport modes. Low-income groups are dependent on public transport and their destination choices are influenced by the availability of public transport services. The CBD is better served by public transport and therefore attracts a higher number of shopping trips from low-income groups, while high-income groups prefer the suburbs that are more easily accessible by car. While the mobility of higher-income car owners was improved by suburbanisation, the poorer public transport captive people have experienced reduced mobility as suburban areas, with the exception of Hatfield that lies on the radial axis between residential areas in the CBD, are poorly served by public transport. Bus services do not serve suburban developments directly from townships, and low-income people often have to transfer to reach their destinations.
- Retail businesses dominated the regional suburban centres, while the service sector dominated the CBD and Hatfield centres. The average size of the businesses ranged between 10 and 16 employees per firm. Rental for retail space was some 20 per cent higher in the suburbs than in the CBD, while the reverse was true for office rentals, especially in Hatfield where rentals were some 50 per cent lower due to an over-supply of office space.
- The shopping catchment areas of the centres were influenced by the size of the centre, the nature of the wider activity node, and the location relative to the main road network. The average shopping trip distance was 23 km for the CBD, 16 km for the two regional suburban centres, and 9 km for the Hatfield centre.
- Research by Terblanche found that the market area of the Brackenfell hypermarket (Cape Town) stretched over several local authority boundaries, and 75 per cent of the customer base lived within 20 minutes travel by car from the hypermarket (Terblanche, 1989).
- The shopper survey indicated that suburbanisation had largely responded to the needs of the middle- and higher-income car-owning households. Suburban

centres offer clear advantages in the form of low access cost and travel times, and ease of access by car. The high accessibility of suburban centres frequently attracts neighbourhood shoppers for convenience goods. A much higher percentage of shoppers visit suburban centres four or more times a month compared to the CBD centre. The vast majority of shoppers prefer to shop in the suburbs, even those who visited the CBD centre, although some preferred to shop in the CBD

The Brackenfell study found that the main reasons of the hypermarket shoppers for not shopping in the Cape Town CBD included lack of parking, congestion and long travel times. A large percentage (39 per cent) said that they never visited the CBD, not even for speciality shopping.

Public transport trips by shoppers to suburban centres are virtually non-existent. Although Hatfield has good rail and road public transport access, the centre appeared to serve a predominantly local market with some specialised functions generated by the nearby university. It therefore has high potential to serve captive public transport users as part of a corridor development strategy.

The Brackenfell study also indicated that most shoppers, i.e. 95 per cent, travelled by car.

- The research by Terblanche found that the trend towards an increased number of working women, and the increasing need for free time, contributed significantly to the success of large-scale decentralised retail developments (Terblanche,1989). Important demand factors such as the wide choice of products under one roof, convenient location, and ample parking for the consumers who are mostly car owners, matched the supply trends of retailers to meet the needs of consumers. Supply trends are decentralised locations to provide convenient location, more choice of products, longer shopping hours, good local access, and plenty of parking.

3.2.3 Locational preferences of business managers

A sample of 100 managers was interviewed at the various centres to determine their locational preferences. The results can be summarised as follows:

- Information on the previous location of businesses indicated that decentralisation was only evident among office businesses with 6 to 30 per cent of suburban office businesses having been located in the CBD previously. The trend of retail decentralisation was mainly in the form of chain stores opening new branches in the suburbs.
- The average length of stay of retailers at the current location was in the order of 5.3 to 5.8 years for the CBD and suburban centres, with the exception of the recently opened Hatfield centre where the average stay was 2.8 years. Suburban offices indicated shorter lengths of stay (1.1 to 3.9 years) compared to the CBD (6.7 years) as a result of decentralisation and also the fact that the Menlyn offices opened only a few years previously.
- Reasons given for relocation were to obtain more office space, to move to a better environment, to have more parking space and to pay cheaper rent. Transport factors were also frequently mentioned.
- There were distinct differences in the reasons given in preference of business location in the CBD and in the suburbs, and there were also differences between office and retail. The most frequent reasons given in favour of the suburbs were more parking space, better environment, proximity to home, better access to transport infrastructure and less traffic congestion. Reasons given in favour of the CBD were conglomeration benefits and proximity to clients.

  Retailers mentioned less traffic congestion and cheaper parking in favour of suburbs more frequently than office managers, while proximity to clients and better access to transport infrastructure were more frequently mentioned by office managers in favour of the CBD

The above results confirmed earlier findings by Prinsloo (1983) in a study on the spatial structure and mobility of the service sector in Pretoria, that businesses that depend more on person-to-person contact, such as financial and legal firms, tend to favour the CBD. Engineering and IT firms, that are less dependant on personal contact, tend to prefer the suburbs.

3.2.4 Evaluation of corridor development strategy

The PREMET model, calibrated for the base year 1991, was used to test a decentralisation trend scenario and a corridor and infilling scenario.

The trend scenario was characterised by the following changes:

- Major outward population growth on eastern, western and northern perimeters of the city.
- Employment growth, mostly in the informal sector, in the northern, western and eastern parts of the city associated with growth in low-income population areas.
- Increase in density, but limited to 16 to 25 dwelling units per hectare (du/ha) according to the structure plans.

The corridor scenario was characterised by the following changes:

- Both population and employment growth in rail and adjacent road corridors, permitting mixed uses along corridors and infilling of vacant land.
- Corridors targeted were:
  - Rail and road corridor linking Mamelodi in the east with the suburban node in Hatfield and the CBD.
  - Rail corridor and road between Atteridgeville in the west and Pretoria West industrial area and the CBD.
  - Rail and road corridor between commercial and light industrial areas in Lyttleton to the south and the CBD.
  - Road corridor extending north from the CBD via Paul Kruger Street to Pretoria North.

Generally the corridor scenario indicated small improvements in the aggregate performance of the transport system relative to the trend scenario. A small, counter intuitive shift from taxi and bus to car and rail occurred , but it is explained by the fact that the supply of road-based public transport was not increased in sympathy with the corridor developments. The model indicated the following changes:

- An increase in non-home-based work passenger trips by the corridor scenario (+2.1 %) due to shorter trips resulting from increased accessibility of some high-density employment areas. This indicated increased mobility.
- A decrease of 3.3 per cent in travel distance and of 0.5 per cent in travel time.
- A decrease of 1.5 per cent in congested vehicle kilometres.
- An increase in peak hour car volumes along radial routes for the corridor scenario and an increase in peak hour car volumes along orbital routes for the trend scenario.

It was concluded that congestion levels may increase in the core area with the corridor scenario, although some of the increased volumes will be contra-flow. Such private transport congestion should be tolerated to stimulate public transport.

Similar results were reported by DeCorla-Souza in the USA (1992) testing centralisation, decentralisation and transit corridor developments in four cities. He also reported marginal improvements in system performance criteria, but suggested that more refined impact estimates could be made using micro-simulation modelling techniques.

3.2.5 Land-use and transport policy guidelines

The structure plans of the planning authorities that were based on the rather static central place theory, which determined the optimal location of retail centres and catchment areas, were criticised. Emphasis on a strong hierarchy of business centres and nodes served by a well developed road network, especially limited access freeways in Verwoerdburg's case, fails to consider economic activities that are becoming more footloose, and also fails to differentiate between the behaviour and constraints affecting diverse urban market segments. The structure plans will fragment and isolate activity nodes from each other and tend to increase dependence on private transport. There is also a lack of linkages with the public transport captive market that supports existing activity areas rather than proposed theoretical public transport spines.

The report proposed the following guidelines:

- The structure planning approach should be reviewed to accommodate social, economic and political changes in S.A.
- Integrated guidelines to direct the spatial distribution of decentralised businesses must be formulated taking market forces into account. Interventions must aim to rationalise investment decisions and not force change on locational distribution of activities.
- Public transport must be improved in terms of network systems and operations to strengthen the CBD and link the CBD with decentralised nodes. Decentralised nodes must be confined to radial corridors centred on the CBD, at the expense of private transport convenience, if necessary. Orbital or tangential corridors, based on private transport demand, can support the basic structure.
- Future growth of the urban area must be arranged in a form that can be served by cost-effective public transport and infilling between isolated townships and developed areas must be pursued. The structural changes should capitalize on available spare capacity on the road network for public transport and utilize the existing railway network that provides good linkages between most townships and business areas.
- The CBD plays an important role in urban corridor development as a large nodal point where public transport services terminate or pass through. A compact and centralised urban form will promote public transport. A balanced approach to restricting car in the CBD and provision of good public transport access to the CBD will be critical as excessive restrictions or congestion may force cars and employment to desert the CBD. Congestion can be relieved by directing through-traffic to by-pass the CBD. Through-traffic is significant in Pretoria's case, in the order of 30 per cent.

- A policy option that has not been pursued in Pretoria, is the creation of mixed-use areas with a strong residential component in the central city. This will reduce commuter distances and stimulate employment in the CBD. This strategy was successful in Toronto and San Francisco. A survey of low-income residents in Hillbrow indicated that they are more affluent than people living in the townships, they have shorter travel times and costs, and have greater options with respect to discretionary spending. No negative sentiments about high-rise flats were raised.
- Densification has a number of advantages and has become an acceptable policy in South Africa as indicated by the structure plans of authorities. Proposed net unit densities of 16 to 25 du per ha in residential areas will still not be sufficient as efficient public transport requires densities in excess of 30 du/ha. Wider application of proposed densities for medium (26 to 60 du/ha) and high-density development (greater than 60 du/ha) can support the CBD through viable public transport.

  Densification and mixed land-use along corridors will make public transport more attractive due to higher frequencies and shorter travel times, while car will be restrained due to higher congestion and increased parking costs.

The research results of Terblanche supported the results of the DOT research. He indicated that two main negative trends characterised the South African retail spatial profile: the biased decentralization from the CBD towards high-income suburbs, and the changing customer profile of the CBD. This profile is characterised by an increasing share of CBD workers and decline of external customers in the CBD retail market.

Terblanche argued in support of limited and flexible intervention by government at a metropolitan level to control large-scale retail developments based on international and local experience (Terblanche, 1989). He proposed that:

- The policy should only apply to developments larger than 20 000 m^2 GLA.
- The policy should address both desirability and necessity.

- Developers must conduct an impact analysis and apply for approval by the metropolitan authority.
- The following aspects should be evaluated:
  - Characteristics of the development.
  - Analysis of the market area within 30 minutes travel time, including impact on market share of existing retail areas. The analysis should estimate per capita spending for each 10 minute interval time isochrone.
  - Traffic impacts including public transport.
  - Analysis of all impacts using benefit cost analyses or weighting and rating impacts from the viewpoint of all role players. Impacts should include government expenditure, property values and taxes, and job creation.

3.2.6 Conclusions

The study concluded that land-use planning and responses of the planning system to decentralisation trends had affected the majority of the urban population adversely. The report recommended that land-use and transport planning should be devolved to regional authorities to overcome problems of fragmented and uncoordinated planning, that planning should be more flexible with shorter time horizons, and that existing procedures and standards should be rationalised.

3.3 EVALUATION OF ACTIVITY CORRIDORS IN CAPE TOWN

3.3.1 Introduction

A two-year research project was conducted for the National Department of Transport on the channelling of urbanisation along activity corridors (Naude, 1991). The research was motivated by the various problems caused by urbanisation such as 0low-density sprawl and dormitory towns, long journey times, high cost for authorities to provide public transport to new settlement areas and suburban developments in high-income areas away from older areas well-served by public transport.

The report is summarised here in terms of the concepts and benefits of activity corridors, the evaluation of a corridor strategy for Cape Town using the MEPLAN model, the assessment of the MEPLAN model as a planning tool, and finally the evaluation of alternative planning approaches.

3.3.2 Concepts and benefits of activity corridors

The concept of urban corridors is not new and was initially referred to as ribbon development. The concept was revived in Cape Town and many planners believed that urban activity corridors could become major urban structuring elements to guide future growth and reassert the development role of public transport.

Ideally corridors have the following characteristics:

- A main road or activity spine that accommodates different travel modes, carries large volumes of traffic, and provides connectivity between passing traffic and roadside establishments.
- A parallel limited-access right-of-way for fast-moving traffic such as a freeway, railway line or busway. A large number of major traffic generators along its length and major commercial/employment nodes at the ends of the corridor.
- Large population within walking distance of the main road and public transport.
- A realistic spacing and strong interconnection between radial, orbital and tangential corridors to form a logical network of corridors.

The expected benefits of corridors are the following:

- Accommodate urban population growth and social mobility pressures.
- Establish a greater variety of housing options.
- Contain urban sprawl and haphazard location of major traffic generators.
- Contain and channel vehicular traffic and promote public transport.
- Create complementarity between different transport modes.
- Create complementarity of business development in potential competing locations.

- Create opportunities for new businesses to become visible and accessible to passing traffic.
- Reduce travel distances, transfers and costs for the passenger and reduce investment and subsidy costs for the authorities.
- Create jobs due to increased market thresholds from increased densities.

A detailed analysis of the urban system of Cape Town was conducted to define detailed organising principles, or a conceptual design, for successful corridors. These organising principles were:

- The width of the corridor is ideally based on walking distance, in the order of 2 kilometres.
- The minimum gross density within the 2 km width is 100 persons per hectare or 40 dwelling units per hectare to support the corridor.
- A wide variety of metropolitan and local activities should be focused on the corridor, varying from large commercial centres to the informal trader and various social services (health, education, and recreation). Activities should focus outward to the spine.
- The corridor should be well integrated with the metropolitan transport network, incorporate a variety of modes, including rail, and achieve a balance between transport capacity and the urban activities so that the transport capacity is fully utilised, and traffic congestion on the activity spine is limited to acceptable levels.
- Activity spines must be continuous and as direct as possible, and public transport services as well, so that transfers are avoided.
- The activity spine must conform to the image of the "high street" with direct access to adjacent land-uses and with slow-moving pedestrian-friendly traffic.

3.3.3 Evaluation of corridor strategy with MEPLAN model

The conceptual design principles of corridors were applied to Cape Town and it was concluded that a major new metropolitan node was needed in the south-east of Cape Town in the vicinity of the Philippi industrial area southwest of the Swartklip interchange between the N2 and R300 freeways. This would serve as an anchor point for the development of a corridor linking the south-east with existing nodes at Claremont, Bellville and the CBD.

The corridor strategy was tested with the Cape Town integrated land-use transport model MEPLAN, also known as the Echenique model. The model is described and evaluated in the next section.

Two alternative activity corridors in Cape Town's south-east were tested assuming different rail alignments and node positions as follows:

- Base case scenario assuming rail line between Khayelitsha, Blue Downs centre and Blackheath industrial area, and allocation of public sector space in Blue Downs and industrial growth in Blackheath.
- Alternative scenario assuming rail line between Mitchells Plain, the airport and Delft with large industrial public sector and industrial space allocated in North Delft.

The model had to be recalibrated following the addition of two new zones. In essence the scenarios were simulated in the model by adding the new rail lines to the transport network of the model and allocating industrial and public sector floor space to the new development nodes. This increased the attractiveness of the new node to land-use activities and also reduced the disutility of travel to the new nodes.

The model estimated the following land-use transport impacts:

- A major shift from mainly bus and taxi to rail in the Delft area (share of rail increased from 6 to 23 and 15 to 43 per cent), while the share of rail decreased in Blue Downs and Khayelitsha. However, there was no change in the overall share of rail between the two corridor alternatives despite the fact that Delft had a lower socio-economic status than Blue Downs.
- Households were attracted to employment opportunities in Delft and households increased with 4000 to 5000 comparing the scenario with and without the rail to Delft.

- The commercial and service sector employment increased in Delft compared to the base case, but the results seemed arbitrary as areas far away from Delft also experienced increases in employment. This was attributed to the recalibration of some parameters for the Delft scenario.
- In total the employment in the new areas increased by more than 35 000, whereas the population increased by 30 000.

3.3.4 Description and evaluation of MEPLAN model

The international review in Chapter 2 referred to various applications of the MEPLAN model. It can be regarded as one of the more sophisticated conventional interactive land-use transport models internationally. The model was implemented in Cape Town during the late 1980's as part of a major project (Crous, 1989). The MEPLAN model is an extension of the well-known Lowry-model based on the gravity principle that defines accessibility of an area, or interaction between the area and all other areas, as a function of the levels of activity at all other areas, weighted by some measure of the cost of travel.

In MEPLAN the economic base model was changed to an input-output model that represents the input-output interactions between the various economic sectors of the urban economy. By specifying a geographical location to each economic activity and an inter-zonal matrix of accessibility levels based on the transport network, the economic interactions are transformed into spatial-economic interactions. The interactions are finally disaggregated into passenger and freight flows on the transport network.

The model is calibrated for the base year and predictions of the future activities and flows are made by specifying the growth in the final demand in terms of export demand, government expenditure, and private formal and informal consumption expenditure. The allocation of final demand activities to geographical areas by the planner is critical as changes in these allocations could produce a wide range of model results.

Another critical input parameter is the externally specified floor space, price constraints and the household's or firm's budget. These parameters had to include the effect of the Group Areas Act that prevented certain population groups to live in certain areas.

Various criticisms of the model and its application in Cape Town were made, and these are listed below. Many of these criticisms were also voiced by international planners in view of typical interactive land-use transport models, as indicated in Chapter 2.

- The model was used largely as a black box without interaction with decision-makers, and without using the model in an interactive way to understand the relationships between inputs and outputs.
- The model was too sensitive to certain input parameters such as specification of final demand.
- Policy testing was time consuming and therefore also costly as adjustment of input parameters had to be done for each policy test.
- Poor graphic display of results compared to the EMME/2 model.
- Computational limitations on the number of zones requiring changes in the zoning system for localised policy tests. The model was calibrated for 40 zones in Cape Town, which was regarded as too coarse.
- In terms of the corridor testing, it was felt that the allocation of household activities was somewhat arbitrary, that some results were not so conclusive and the planner had to interpret the results in terms of what would be realistic.

It was finally concluded that the use of the MEPLAN model for further policy tests would be worthwhile as it had already been calibrated, but if it had to be implemented for any new study area, the cost of calibration would outweigh the benefits.

3.3.5 Evaluation of alternative planning approaches

The report evaluated three urban planning approaches:

- An evolutionary physical planning approach.
- Integrated land-use transport planning using a typical integrated model.
- An economic interaction management approach that is a synthesis of the first two approaches.

<u>The evolutionary physical planning approach</u> develops and tests corridor development by analysis of historical trends, defines detailed organising principles, or conceptual design, of the corridor and then applies the conceptual design to a specific urban area. This approach was tested in Cape Town and lead to the conceptual design of corridors summarised in Section 3.3.2, and the formulation of alternative corridor scenarios for the south-east of Cape Town summarised in Section 3.3.3.

The evolutionary physical planning approach was derived from problems experienced with the mechanistic planning or systems engineering approaches that impose a rigid form on the city. It was felt that the functions of different infrastructure elements and urban spaces should evolve over time. Greater control could be exercised on the strategic level, but at micro level the urban system should be left to evolve over time.

For example, the main road that develops into an activity spine is seen as such a micro-element that should not be upgraded to overcome congestion as this would destroy the multi-functional nature of the road. A higher order by-pass would be a more appropriate intervention.

The evolutionary planning approach also advocates that the city should be seen as a complex social system and that a strict hierarchy of transport systems, such as the conventional road hierarchy, should not be rigidly imposed. A hierarchy of primary, secondary and tertiary activity corridors would still be needed but allowance should be made for overlap and greater connectivity between the corridors.

The integrated land-use transport planning approach was tested with the application of the MEPLAN model to test alternative corridor scenarios. This approach was felt to be outdated and belonging to an era that assumed urban systems operated like a mechanical system reacting to external imposed policies. This did not allow for internally generated change that few models would be able to simulate.

Models such as MEPLAN rely on "snap-shot" information about the current system and lacks distinction between short-term and long-term supply versus demand relationships. The model therefore makes predictions that may not conform to people's real behaviour.

Urban development is often the result of political decisions that cannot be predicted, but have to be managed.

The economic interaction management approach does not try to predict the future but instead focuses on the pro-active and participative management of cities as generators of economic interaction opportunities, using a variety of physical planning strategies and using explorative sketch planning models rather than large integrated models.

The main aims of this approach in the context of the report are:

- Identify latent economic interaction potential with and among the poorer communities.
- Diagnose the obstacles to improved utilisation of this potential.
- Establish participative management procedures.
- Develop an integrated urban restructuring strategy .

3.3.6 Conclusions

Evaluation of the three planning approaches in Cape Town concluded that a logical synthesis of the physical planning and integrated modelling approach into a management approach that recognizes the socio-economic dynamics of cities, would be the most successful approach.

3.4 INTEGRATED LAND-USE TRANSPORT PLANNING ON THE EAST RAND

3.4.1 Introduction

Land-use transport planning on the East Rand followed a pragmatic approach based on sketch-planning techniques and extensive interaction between planners and decision-makers in the region. A summary of the development and application of the highway land-use forecasting model (HLFM2), an integrated land-use transport sketch-planning model, to test urban densification scenarios, is provided here (Wilmot and Van Zyl, 1995; Van Zyl, 1996). The HLFM2 model was also used interactively with the EMME/2 transport model to evaluate the impact of scenarios on the transport network in more detail.

A summary is given here of the HLFM2 model and its development for the East Rand, the formulation of urban densification policies and the results of the policy testing.

3.4.2 Description and development of the HLFM2 model for the East Rand

Various integrated land-use transport models were evaluated and the HLFM2 sketch-planning model was finally selected as a quick-response relatively cheap model. It was more appropriate for a rapidly changing developing region with limited financial resources.

HLFM2 combines a Lowry-type land-use model with a simplified transport sketch-planning package, Quick Response System 2 (QRS2). The model relies on standard relationships to simplify the calibration process and has therefore low data demands.

The HLFM2 model is provided with default parameters that can be adapted for the local study area. The parameters were adapted for the conditions on the East Rand, but special adaptations were needed to apply the model for a region in a developing country such as South Africa.

HLFM2 assumed region-wide residential land consumption rates, but these varied significantly on the East Rand, especially between low- and high-income areas. Varying land availability from zone to zone accommodated this.

Another problem was that the model only operated on one mode, typically private transport on the road network. To represent the large proportion of public transport trips, especially from the townships, the road network was assumed to represent all modes of transport and was coded with average speeds across all modes.

To represent the impact of the former Group Areas Act, the facility of the model to constrain population in selected zones, was applied. The impact of abolishing the Group Areas Act could therefore be tested as well. When the Act was later repealed, the population constraints were removed.

The model was initially calibrated for 1985 and consisted of 65 internal and 25 external zones. As part of a large-scale transportation study involving a home interview survey and the calibration of an EMME/2 transportation model, the HLFM2 model was recalibrated for 1991 and the more reliable land-use and travel data improved the calibration significantly.

A further improvement in the modelling system was made in 1995/96 when the HLFM2 model was again updated and was used interactively with the detailed EMME/2 transport model (Van Zyl, 1996). This overcame the problem of the coarse uni-mode transport network of HLFM2. The HLFM2 model was used to estimate the future distribution of land-use activities, and these outputs were specified to the more detailed EMME/2 model to estimate the traffic volumes on the road network as well as the passenger volumes on the bus, taxi and train route networks. This allowed more detailed performance criteria to be estimated from the EMME/2 model, such as modal split, vehicle and passenger kilometres, levels of service on the road network, and accessibility of employment opportunities.

3.4.3 Testing of urban densification policies

Although a number of different policies was tested, only the urban densification policies are reported here. A typical trend policy that assumed further urban sprawl and outward growth of the major townships situated on the four corners of the region, was formulated. The urban densification policies consisted of infilling of vacant land between the townships and the formal employment areas, and a corridor development policy.

A short planning period of 5 years was used to obtain more reliable estimates. Various external factors driving the model were estimated such as the supply of land in various zones, growth in the basic employment (agriculture, mining and industry), and declining employment rates due to increasing unemployment. To obtain realistic output, the average household incomes in each zone had to be adjusted to accommodate changing income profiles due to the relocation of population. This was achieved through an iterative process until assumed and assigned income profiles were balanced.

Planning and modeling on the East Rand followed an integrated and highly participative approach (Van Zyl and Sandilands, 1995). A series of workshops was held with stakeholders and planners of the various authorities in the region to resolve potentially conflicting viewpoints, to obtain commitment to a co-ordinated strategy and also to obtain expert input for the various analytical tools used for planning. Visions for the future development of various sub-regions in terms of densification, land for infilling, and pressure points where different role players compete for the same land, were defined. Growth scenarios in the external factors, such as regional population and employment growth, land supply, and basic employment growth, were formulated during workshops.

The following changes between the trend and densification scenarios were obtained:

- The results of the land infilling and corridor development scenarios were very similar.
- The trend scenario predicted population growth of 1.5 and 4.5 per cent per annum for the low- and high-income groups, and employment growth of 0.9 per cent per annum assuming no growth in basic employment.
- The trend scenario predicted a growth in traffic of 3.3 per cent per annum and increased trip times of one to two minutes. Congestion would increase along the already congested freeways.
- The corridor scenario indicated total population and employment growth similar to the trend scenario's, but the high population densities in the township zones clearly dissipated and shifted towards more central zones.
- The corridor scenario reduced trip times by approximately 7 percent (3 min) compared to the trend scenario. This was a much higher reduction compared to the change between the base year and the 5 year estimate for the trend scenario. Although the system-wide improvement in transport efficiency is relatively small, the aggregate vehicle operating and time cost saving over 5 years was estimated to exceed the cost to provide low-cost housing of R366 million to reduce the housing backlog.

3.4.4 Conclusions

Although the model results had to be interpreted in terms of the simplifying assumptions, it was concluded that the application of a sketch-planning tool provided rapid, objective and quantitative responses to policy options that would not be achievable with a subjective process using experience and judgement, or with a more sophisticated model. The model demonstrated the benefits of urban densification policies to decision-makers in the region.

3.5 TESTING OF LAND DEVELOPMENT OBJECTIVES (LDO) AND TREND SCENARIOS FOR THE GREATER PRETORIA METROPOLITAN AREA

3.5.1 Introduction

The PREMET transportation demand model based on the EMME/2 model was comprehensively updated for the 1996 base year with the purpose of testing an integrated development plan (IDP) and trend scenarios with the model. This was probably one of the most comprehensive modelling exercises to test a spatial development framework for a metropolitan area since the Local Government: Municipal Structures Act (Act No. 117 of 1998) was promulgated. The Act required metropolitan authorities to formulate IDP's. (The IDP was also described in terms of land development objectives and hence the term LDO scenario used in the study.) The study therefore was the best opportunity to demonstrate the benefits of an urban densification strategy and the capability of a detailed and sophisticated application of the EMME/2 model.

This section describes the base year model, and the formulation and testing of the trend and LDO scenarios.

3.5.2 Formulation of land-use scenarios

The approach in Pretoria during recent years was to develop estimates of future land development, population and employment distribution by means of the expert judgement of town planners with intimate knowledge of the study area, as opposed to applying land-use models. The spatial development framework developed as part of the land development objectives (LDO), or integrated development plan (IDP), for the Greater Pretoria Metropolitan Area (GPMA) was formulated through extensive public participation as required by the Act, with input from all the authorities in the area, and it was formally approved by the different councils.

The spatial development framework indicating existing and future land-use, areas of densification, corridor development and land infilling, had to be translated into future population and employment distribution by traffic zone. For this purpose use was made of a geographic information system (GIS) and a spreadsheet model. Control totals for the population and employment of the whole study area were first estimated for each scenario and these were then allocated to the various sub-regions and zones. Shifts between zones therefore had to be balanced with the overall growth in the whole study area.

3.5.3 Description of EMME/2 model

The EMME/2 model was based on the conventional four-step transportation modelling process described in simplified terms as follows:

- Trip generation was based on trip generation and attraction rates applied to the economically active population and categorized by trip purpose (home-based-work, home-based-other and non-home-based) and low and high-income population groups.
- Trip distribution was based on a two-dimensional gravity model balancing trip productions and attractions.
- Modal split distributed the trips among four modes, i.e. car, bus, mini-bus taxi and train.
- Car trips were assigned to the road network, and bus and train trips were assigned to their route networks based on appropriate frequencies. Taxi was treated as a pseudo-private mode and assigned to the road network.
- A special requirement was to adjust the public transport supply according to the demand for each scenario, and a special macro was developed to automate the adjustment of the specified frequencies of bus and train services in an iterative way.

3.5.4 Formulation of LDO and trend scenarios

The land-use changes and socio-economic growth rates formulated for the different scenarios were estimated for two planning horizons, i.e. 2005 and 2015 as follows:

- The trend scenario followed historical growth rates in population (4 and 3.8 % per annum for 2005 and 2015) and employment (2.7 and 2.6 % per annum). The percentage formal workers would decline and the percentage informal and unemployed would increase.
- The trend land-use scenario assumed a decentralised and deconcentrated urban structure, with retail and offices continuing to relocate from the CBD to the eastern suburbs, Pretoria North and Centurion in the south. Market-driven commercial development would continue along major transportation routes in the east. Urban sprawl would continue to the far east, to the north and south, with no significant increases in densities.
- The LDO scenario assumed an ideal vision of the area, with increased economic growth and job creation, with co-ordination and integration between various role players that would improve efficiencies and stimulate growth. It was also assumed that Parliament would be relocated to Pretoria with a multiplier effect on job creation.
- The LDO scenario assumed higher population growth rates of 4.2 and 3.6 per cent for 2005 and 2015. Employment growth would also be higher at 4.1 and 3.5 per cent per annum.

The LDO scenario was simulated as follows:

- Limit urban sprawl and encourage densification and compact city.
- Stimulate the CBD as primary activity ode.
- Provide secondary activity nodes closer to poorer communities.
- Develop activity corridors and spines along Voortrekker Road, Church Street. West and Pretoria Road, with mixed land-use and increased densities.
- Construct the east-west PWV2 freeway to the north of Pretoria.

- Develop Mabopane-Centurion activity corridor including the PWV9 north-south freeway.
- Focus on six strategic development areas.
- Increase density along railway system.

The following transport changes were made to support the LDO scenario:

- The road networks in the model were extended for the design years adding some 21 per cent to the total lane kilometres.
- Public transport routes were adjusted according to demand by adjusting frequencies on existing routes, and adding new routes for the LDO scenario to support new developments. Routes with little demand were deleted for the LDO scenario. An integrated public transport system was not tested, as the model could not simulate multi-modal trips.

3.5.5 Performance of LDO and trend scenarios

A brief description of the main conclusions on the performance of the transport system under the various scenarios, is given below:

- Trip production was significantly higher in the central area and lower in the outer areas under the LDO scenario compared to the trend scenario. Total trip production was higher for the LDO scenario due to the higher population and employment growth. The higher travel demand of the LDO scenario therefore put the transport system under more pressure and this needs to be considered when making comparisons
- Bus and train routes of the LDO scenario were reduced by almost 50 per cent in number, but route lengths increased, compared to the trend scenario. Bus headways were reduced by almost 50 per cent while train headways were only reduced by 5 per cent.
- The LDO scenario could not achieve a shift from car to public transport and car remained the preferred mode. The reasons for this result were the higher travel demand and higher average incomes under the LDO scenario. To achieve a shift from car to public transport, car would have to be restrained and public

transport promoted more than just improving service levels.

- In terms of the public transport market share, there was a shift from mainly taxi to bus, with the government subsidised bus services benefiting most from the LDO scenario with an increase in share from 23 to 38 per cent. The share of the municipal bus operator increased from 9 to 11 per cent, taxi decreased from 48 to 33 per cent, and train from 20 to 18 per cent.
- The utilisation of bus and train increased dramatically with that of bus improving by 45 and 67 per cent, and train by almost three hundred per cent. This indicated the huge inefficiencies in the current supply of bus and train services.
- The LDO scenario showed a significant decrease in average trip distance and travel times of all vehicle trips of 9 and 23 per cent respectively, despite the increased travel demand. This demonstrated the improved efficiency of the transport system as the result of large-scale densification. Travel times of government subsidised bus decreased by 13 per cent, and municipal bus and train by 4 and 3 per cent.
- The proposed road projects were prioritised in terms of benefit-cost ratios for each scenario and significant changes in the rank order of roads were apparent between the two scenarios. Some of the projects, such as the PWV9 and the R101, were equally important for both scenarios, while other roads changed rank order. The LDO scenario indicated higher volumes and congestion in the central areas due to the increased densities and more centralised urban structure.

3.5.6 Conclusions

The comprehensive and detailed testing of an urban densification strategy for the GPMA using a sophisticated transportation model in terms of South African standards, indicated significant improvements in the efficiency of the transportation system in a number of respects. However, a shift from car to public transport could not be achieved in view of the specific strategy that was tested namely the various densification improvements and changes to the supply of public transport to satisfy demand. Although the higher growth in employment and income, and hence travel demand, of the LDO scenario relative to the trend scenario contributed to the continued popularity of car, a much larger range of supporting policies to restrain car and promote public transport is needed to achieve a shift from car to public transport. The report therefore expressed the need for further policy testing to refine the LDO scenario.

The greatest limitation of the model was its inability to test strategies to integrate public transport services. Improving the model in this respect and testing an integrated public transport system together with the urban densification strategy, will demonstrate additional benefits of the densification strategy.
The results also highlighted the huge inefficiency of the subsidised modes, bus and train, and the need to continuously adapt the supply to meet changing demand conditions.

3.6 A Decision-Support Nodal Model to Analyze Activity Nodes

3.6.1 Introduction

A very relevant study relating to urban densification and corridor development is the dissertation by Van der Merwe (1999) on nodal development. The dissertation indicated that there was a lack of any explanation of nodal development in the urban context and of any decision-support models to assist in the analysis of nodal development. The dissertation analysed activity nodes in the Western Metropolitan Local Council area to the west of the Greater Johannesburg Metropolitan area. An accessibility net nodal (ANN) model was formulated to explain the phenomenon of nodal development and to assist in the prioritisation of nodes for development.

A brief description of the criteria for assessing nodal development, the ANN model and its application, and policies to promote nodal development, is given here.

3.6.2 Criteria for assessing nodal development

The following criteria that characterize nodal development and that serve as a framework for the identification and evaluation of potential future nodes and their development, have been identified. The criteria that form the basis of the ANN model were derived from the multiple nuclei theory and the net of mixed bead theory. These theories highlighted the fact that employment concentrations outside the CBD are closely associated with higher-order transportation routes.

Criteria:

- The level of accessibility of the area for nodal development, provided by the higher-order transportation network.
- Proximity to the intersection of two or more major transportation routes.
- The location and growth of employment-generating uses – existing uses generally attract new activities.
- The presence of vacant land at the nodal location.
- The presence of higher-density residential land on the periphery of the main nodal area.
- The presence of home offices is often a pre-cursor of nodal development.
- The presence of a shopping centre or other retail facilities attracts non-residential uses.
- The presence of existing offices.
- The existence and implementation of official policies setting certain development parameters such as floor area ratio, coverage, height, etc.
- The presence of a modal interchange could attract further development.
- Physical constraints hamper nodal development.

3.6.3 The ANN model and its application

The following specific measures of the above criteria were formulated to quantify the total attractiveness of a node:

- Number of intersections.
- Growth within nodes (percentage growth in retail and office space relative to total employment growth).
- Existing non-residential uses (0,1 weighting).
- Vacant land (0,1 weighting).
- Higher-density residential development (0,1 weighting).
- Shopping centres (2=regional centre; 1=local centre, 0=no retail).
- Home offices (0,1 weighting).
- Physical constraints (-1,0 weighting).
- Approved council policy (1,0 weighting).

Each existing node or potential node is "weighted" according to the above criteria and all weights are finally summed to obtain a total "weight" for each node.

The model is applied as follows:

- Define the accessibility net, or road and rail network.
- Quantify the criteria and assess how each criterion is represented in each node.
- Determine total attractiveness of each node.
- Formulate policies to overcome limitations of potential nodes.

3.6.4 Policies to promote nodal development

In terms of the granting of concessions that is the traditional approach to attracting investments and promoting certain activities at identified locations, the following typical concessions were identified:

- Reduced taxes and tax redemption.
- Cheaper land such as land owned by the local authority.
- Development of infrastructure such as roads and other services.
- Marketing the location through surveys, advertising and direct approaches.

3.6.5 Conclusions

It was concluded that nodal development does occur in modern urban areas, that such nodes can be identified, that future nodes can be predicted, and that the impact of the predicted node can be evaluated. The public sector can effectively identify, direct and influence economic development through the use of the ANN model.

3.7 THE PROFILE OF THE RETAIL SECTOR IN SOUTH AFRICA

3.7.1 Introduction

Information on the retail sector from secondary data sources was useful to

- determine the secondary data sources available to planners for monitoring retail trends and levels of decentralisation;
- understand the role and nature of the retail sector nationally and at metropolitan level; and
- relate the profile of the retail survey sample in Cape Town to the national profile.

This section describes the retail data sources and the profile of the retail sector in terms of the role of retail in the national economy, retail trends, problems and solutions to address retail suburbanisation.

3.7.2 Data sources

A comprehensive investigation of possible data sources revealed that spatial retail data suitable for land-use and transport planning purposes are virtually non-existent. Information from Statistics South Africa (Statistics SA) is only available at national level and limited summary data is available at provincial or metropolitan level. The research by Terblanche identified this problem already in 1989 and proposed that metropolitan planning authorities should co-ordinate retail research activities to ensure that adequate data are available for land-use planning and control (Terblanche, 1989).

At local government level, some data is available from *ad hoc* studies, but the level of detail and scope of the data is not sufficient to meet normal planning needs. There is no system to collect data on a regular basis to monitor trends.

The best data for monitoring purposes exist in the private sector, based on sample surveys, but even this has certain limitations for planning purposes.

It is evident that very little attention is given to the attractors of transport, or non-residential land-uses, such as retail, industry, and service sector (offices), in contrast to the attention given to the generators of transport, such as the household or residential land-uses. In order to estimate the demand for travel and trends in the urban structure, it is equally important to analyse and understand the nature of non-residential activities.

From Statistics SA the following surveys provided useful information:

- The Population Census.
- The October Household Surveys (OHS).
- the Survey of Employment and Earnings (SEE).
- The Labour Force Survey (LFS).
- The retail trade sales survey.

Statistics SA is currently in the process of developing an integrated and updated business register, which can be used as a comprehensive sampling frame for sample surveys among businesses. They are presently reclassifying all businesses, some 700 000 businesses nation-wide, and also surveying the largest 40 000 business enterprises to identify their activities and branches. This business register will hopefully provide a means to determine the spatial distribution of businesses accurately, and therefore also the level of urban decentralisation in the various urban areas.

In the next sections the national data from Statistics SA, and general qualitative information from news media articles, are summarised. Quantitative retail data for Cape Town are summarised in Chapter 5 to relate the Cape Town retail profile to the sample survey data.

3.7.3 Profile of the retail sector

<u>Role of the retail sector in the national economy</u>

According to the LFS (2000), of the 10 main sectors the trade sector (including wholesale and retail) is the sector that provides the highest number of employment opportunities (21 % of total employment), followed closely by agriculture (19 %). This is in terms of formal and informal employment. In the formal sector, which is the subject of this study, trade provides employment to 19 per cent of the total workforce. This sector therefore accounts for the most commuter trips. Employment in the trade sector is growing by approximately 1 per cent per annum.

Retail sales showed a healthy growth rate, i.e. 7.1 per cent per annum in real terms from 1990 to 1998. In contrast, the population grew by 2.2 per cent over the same period. Retail expenditure *per capita* therefore increased.

<u>Retail trends, problems and solutions to address retail suburbanisation</u>

In view of the lack of retail data, information was extracted from the printed news media and discussions with selected stakeholders in the retail industry. The problems caused by suburbanisation are very topical and are often debated in the news media. Various solutions to the problems were proposed and these are discussed.

A letting agent of retail space in Cape Town CBD indicated that the main market for retail in the CBD was workers, tourists and low-income people doing their main shopping in the CBD. The results of Terblanche's (1989) research in Cape Town support these qualitative observations. The agent said that they did not monitor statistical trends in retail space, but that there was an increase in vacant space in the CBD. The total vacant space was, however still small. The development of shopping centres in the townships will further impact negatively on the CBD. The foreshore conference centre, currently under construction, and a plan to link the CBD with the Water Front development by means of canals, will help to revitalise the CBD.

One of the oldest and well-known chain shops in Cape Town followed the example of two other shopping groups to move out of the CBD. The group also has shops in various suburbs and will move its CBD shop to the Water Front. The reasons for this move were crime, informal traders competing with cheap, inferior products, the blocking of sidewalks and informal parking attendants harassing customers (Die Burger, 11 July 2001).

Concerns about the decline of the CBD motivated public and private sector stakeholders to form the Cape Town Partnership in 1999 (Die Burger, 11 July 2001 and 10 July 2001). The aim of the partnership is to revitalize the CBD. The partnership indicated that 16 per cent of the available 155 000 m^2 GLA was vacant. This was regarded as not bad, but unacceptable. The partnership is in the process of compiling proposals regarding the following to the CMC:

- Provision of a central market for hawkers and regulation of hawkers by means of permits.
- Control of any sale of products in the CBD by means of permits.
- Training of 50 parking attendants to provide parking services and regulation of this service by means of permits.
- Provision of an inner-city distribution system including the proposed Roggebaai channel between the CBD and the Water Front.
- Better support of the existing metropolitan spatial development framework and new commitment by all stakeholders.
- Requiring proof from developers that their proposals will not have a negative impact on the established business districts, and that they considered locations in the CBD.

* Formulation of clear guidelines for the location and extent of developments. (Seven established nodes for priority development were identified.)
* A property tax plan to provide additional funds to attract developers to the CBD.

The proposal by the Cape Town Partnership for developers to conduct impact studies of retail developments is in line with the planning controls recommended by Terblanche (1989).

Ratepayers in Cape Town CBD have become the first in the country to sign a service delivery contract setting standards. Cape Town city council will pay penalties if it does not deliver according to minimum set standards (Business Day, 2000). The go-ahead was also given by ratepayers to establish a City Improvement District. A mandatory levy of 9 per cent on property tax will be used by the Council to improve security and improve services. Immediate benefits are 145 additional security personnel patrolling the streets, and the doubling of refuse removal and street cleaning services.

The CBD of Cape Town is regarded as the only one in the country with the potential not to decline irreparably, according to an urban economist (Rapport, 17 Sept, 2000). Johannesburg is trying to prevent the CBD decay by the creation of business improvement districts according to the American model. This helps to prevent the symptoms of decline, but crime is still a problem. The trend of suburbanisation with the resulting decline in property values, has not been stemmed. The actions are regarded as too late for Johannesburg to make the city attractive and address structural causes of urban decay. Cape Town has two strengths, namely the wealthy suburbs close to the CBD and time to effect structural changes. The act on property tax also makes it possible for city councils to raise funds from a 10 per cent levy on property tax to revitalise the CBD (Rapport, 17 Sept 2000).

The only solution for Johannesburg is seen as an integrated African city attracting the middle class (Business Day, 20 September 2000). Redeveloping demarcated precincts with mixed uses and controlled access and security is proposed. This will, however, require a great deal of seed money.

An article by a visiting urban planning expert commented on efforts to revive the Johannesburg CBD (Business Day, August 1995):

- Development of up-market retail and office space, cultural and sports precincts and convention centres are typical of remedies tried elsewhere, some of which failed in USA cities. Even if these are successful, they often do not improve the lives of nearby living poor.
- Identify the strengths of the CBD and reinforce these, subject to demand estimations, without trying to recreate the good old days. The WITS medical school is one strength of the CBD. Health services can provide export industries to external areas.
- Counter the decline in retail by development of outlets providing unique merchandise such as crafts and ethnic foods.
- Ensure public safety and manage street hawking.
- Ensure that benefits of revival reach all citizens by linking new development to job training and placement programmes.

Crime has caused widespread decay in East Rand towns despite millions spent by councils to revive the CBD's (Rapport, 13 August 2000). Many buildings in parts of the CBD's are standing empty, and hawkers took over empty spaces. The newly created Greater East Rand Business Chamber has committed itself to revive the CBD's.

One property developer believed that the high rate of development of new shopping centres has not increased the retail chains' profit, but only shifted customers from existing to new shops (Finansies en Tegniek, 23 February, 2001). Turnover of retail outlets in large shopping centres indicates that retail groups struggle to be profitable. The concern among some experts in the property market is that large centres such as the new Gateway centre in Umhlanga, will merely shift customers away from existing centres and even the CBD of Durban. Most analysts reckon that South

Africa's population growth is not sufficient to support all the new shopping centres. The total retail floor area of centres larger than 10 000 m^2 increased from 200 000 m^2 30 years ago, to 6 million currently distributed among 235 centres.

Changing buying patterns and demographic profiles have an increasing impact on the profitability of shopping centres (Finansies en Tegniek, 12 January 2001). Some existing centres need to reposition themselves to survive. The dramatic growth in convenience centres was mainly driven by a number of emerging family grocery stores competing with each other. In a number of areas there is an oversupply of convenience centres. The increased popularity of larger centres to the detriment of the smaller ones, can be ascribed partly to the focus on the right shopping mix by the larger centres.

Despite difficult business conditions for retail, the building of shopping centres is continuing, but will increasingly have to comply with stricter investment standards (Beeld, 10 February 1999).The popularity of regional centres providing recreation, and convenience centres within residential areas, will put pressure on medium-size community centres. Regional centres are unlikely to be developed in townships due to lack of transport infrastructure, perceived safety risks, and lower rents that can be obtained in these areas. Centres developed in townships will be mainly convenience centres.

Financial institutions have reverted back to their red line districts in CBD's where they will normally not consider providing bonds for residential accommodation. In some areas it is so bad that credit worthiness and securities from the potential buyer mean nothing due to rapidly declining property values. Ignoring the principles of good management control of sectional title properties, is a contributing factor.

3.8 SYNTHESIS OF SOUTH AFRICAN STUDIES EVALUATING URBAN DENSIFICATION STRATEGIES

Topics reviewed

In this chapter the results of a national research study into the impact of suburbanisation on travel patterns and the mobility of the population are reviewed. The NDOT research is compared to another research study, which focused on the impact of large-scale retail developments and policies of metropolitan authorities to address these. The differences between the CBD and the suburban activity nodes are pointed out. Factors impacting on the locational choice of business managers are also determined. Guidelines to promote urban densification are formulated on the basis of the research results. Subsequently a number of studies that evaluated typical urban densification strategies and various land-use transport planning techniques in typical metropolitan areas in South Africa such as Pretoria, the East Rand, the West Rand and Cape Town, are reviewed. A brief summary is given here of the main conclusions drawn from a comparison of the various studies relating to the problems of urban decentralization, planning guidelines to address these problems, factors impacting on locational choices of businesses, and typical impacts of densification strategies. A critique of the various modelling approaches is also given. Finally, conclusions are drawn on retail trends, problems and solutions to address retail suburbanisation.

Problems of suburbanisation and proposed planning guidelines

The national research study indicated that there are significant differences in the travel patterns attracted by CBD and suburban activity nodes, and also between the markets they serve. Suburbanisation benefited the higher-income car-owning population group, and impacted negatively on the poorer, previously disadvantaged, and public transport captive communities. Public transport services are geared towards the CBD and serve suburban nodes poorly, resulting in a decline in the accessibility of suburban nodes for, and the mobility of, public transport captive users. Trends in the retail profile of South Africa indicate an increasing proportion of working women and an increased demand for free time contributed significantly to the success of decentralised shopping centres, which are aimed to serve the high-income, car-owning market. These trends impact negatively on the CBD, bias retail decentralisation towards high-income suburbs, and have significant impacts on suburban areas.

The proposed land-use transport planning guidelines to address the problems of suburbanisation involve various urban densification and spatial strategies that would support the CBD and public transport, and interventions that recognise changing market conditions and market forces. In order to influence market forces to achieve a more balanced spatial structure and attract development towards priority nodes and corridors, it will be necessary to understand these market forces and to develop a methodology to determine how these forces can be influenced. This was the basic motivation for the research conducted for the purpose of this dissertation.

<u>Locational choice factors of business managers</u>

There were distinct differences between the reasons given by business managers for preferring the suburbs to the CBD. Reasons in favour of the suburbs were:

- more parking space;
- better environment;
- proximity to home;
- better access to transport infrastructure; and
- less traffic congestion.

Reasons in favour of the CBD were:

- agglomeration benefits; and
- proximity to clients.

These factors are typical of the factors that were found to be the important considerations for retailers in the international literature review.

From the study, the author identified the need to develop a behavioural model of managers' locational choices, based on the typical factors mentioned by them, in order to quantify the impacts of land-use transport policies on locational choice and hence on suburbanisation.

Urban densification strategies and impacts

Three of the four studies that modelled the impact of urban densification strategies could be used to define typical differences between a trend or urban sprawl scenario and an urban densification scenario involving corridor and nodal development, and land infilling. Unfortunately the Cape Town corridor study compared two alternative corridor strategies and not the corridor strategies and a trend scenario. The Cape Town study could therefore not be used to compare urban densification and suburbanisation scenarios.

In general, the urban densification scenarios indicated small but positive impacts relative to the total urban scale. If the reduction in travel distances and times is used as a measure of the aggregate performance of urban densification, the following typical results are obtained:

- East Rand metropolitan area - corridor and infill scenario: 7 per cent reduction in trip time over 5 year period.
- Greater Pretoria - corridor scenario: 3.3 and 0.5 per cent reduction in trip distance and time over a 10 year period.
- Greater Pretoria - comprehensive corridor, nodal, and infilling scenario: 9 per cent and 23 per cent reduction in trip distance and time.

From the above it seems that more comprehensive strategies and longer planning periods for densification to take place, indicate a higher impact. The size of the urban area and the urban structure probably also play a role. The East Rand consists of a number of smaller CBD's with no strong centre, while Pretoria has one strong centrally located CBD.

In view of the quantum of the impact, it must be appreciated that the changes were given as averages for a large number of trips totalled over the whole urban area. Relatively small percentage changes can therefore be expected. However, at a sub-regional level much higher changes can be expected and modelling results should also reflect the impact at these localized levels to indicate which sub-areas benefited.

The mobility study that tested the first corridor scenario for Pretoria mentioned the need to adjust the public transport supply according to the changing demand. This was tested during a subsequent LDO scenario for Pretoria and the results indeed indicated more significant modal shifts and improved efficiencies in favour of bus where supply was mostly adjusted. This demonstrated an important principle namely that any urban densification strategy, which could have huge impacts on demand patterns, should be accompanied by co-ordinated changes in the supply of public transport services. Historically public transport supply in South Africa was mainly driven by supply considerations and not by demand. This trend will have to be reversed and the current emphasis by all levels of government on monitoring supply and demand trends of public transport, in conjunction with an integrated planning approach, is an important first step.

The Pretoria LDO scenario testing also highlighted the fact that any urban densification strategy on its own will not be sufficient to cause a shift from car to public transport, especially if there is a simultaneous increase in travel demand and growth in real income. Additional policies to restrain car and promote public transport will be necessary. This finding confirms similar findings by international studies reviewed in Chapter 2.

The need to adjust transport infrastructure, similar to public transport services, in view of changing demand patterns, was also demonstrated by the Pretoria LDO scenario testing. However, infrastructure development takes longer and also requires a longer planning horizon than public transport services that can be adjusted on an annual basis. Road and rail reserves need to be protected, but this can also lead to costly freezing of valuable land that could have been developed.

The answer lies in formulating an integrated structure or framework of the urban area, prioritising corridors and nodes to be developed in a phased manner, and using transport infrastructure to provide a catalyst for development. Typical examples of where higher-order roads, especially freeways, promoted corridor development, are the N1 eastern by-pass of Pretoria and the N1 western by-pass of Johannesburg. However, these freeways were built from a national freeway perspective and not as part of an integrated development plan for Pretoria or Johannesburg. In fact, the freeways promoted further decentralisation.

The various studies reported a wide range of different strategies that may be pursued to promote urban densification. In terms of the evolutionary physical planning approach that emphasises the beneficial characteristics of the activity spine, it needs to be considered that the modern trend of developers is to build shopping centres and not the conventional street-front shops that is advocated. The shopping centres are obviously geared towards the car mode, while the openness and visibility to passing traffic is now pursued by the informal traders and the home offices.

Critique of planning and modelling approaches

Some criticism of the planning and modelling approaches is relevant: Two integrated land-use transport models were applied – the one a simplified, sketch-planning model applied on the East Rand, the other one a sophisticated, complex model applied on Cape Town. The third approach applied a conventional transport model on Pretoria that was based on land-use and socio-economic trends provided by experienced town planners making use of a simple spreadsheet.

Judging purely from the assessments of the users of the two integrated models, ignoring possible different standards and criteria applied by the users, the sketch-planning model was regarded as beneficial while the complex model was evaluated as having more negative aspects than positive ones. The sketch-planning model was regarded as cheap and quick to calibrate. It did not require much data , it was transparent, but it still gave plausible results. The complex model was expensive and took long to develop, policy testing took long, it was less transparent, and it still gave some implausible results. In view of the limited expertise, capacity and financial resources of authorities in a developing country such as South Africa, the simplified and cheaper modelling approach must be the preferred one. As indicated in the review, the simplified model requires more manual interaction from the user, but this is not time consuming and it is still transparent.

The conventional transport modelling approach was given a positive review. The limitations that were identified related to the lack of the ability to model an integrated public transport strategy, and not to the modelling approach *per se*.

A limitation of the conventional transport modelling approach is that it relies on the town planner's expertise to provide the subjective land-use trends and land-use transport interactions. While this approach gives realistic results and is more transparent, to the town planner at least, the model is not fully repeatable. If the town planner is not available, the modelled scenario cannot be repeated in exactly the same way, and after the lapse of time, the planner may forget certain assumptions and apply some new ones. The quantifiable interaction between land-use and transport in terms of the feedback from transport to land-use cannot be explicitly modelled, as far as models can be calibrated to simulate these effects. The ISGLUTI study emphasized the importance of considering longer-term feedback effects of land-use on transport. (See Chapter 2.)

In view of Naude's (1991) comments on the three planning approaches, the review of the modelling approaches above supports his combined approach that utilizes simplified and transparent analytical techniques. However, it must be added that no modelling technique can be raised to the status of a planning approach. Any model, whether it is a quantitative and subjective model, or a qualitative model, is merely a tool assisting decision-making in an overall planning approach. It seems that the suppliers of MEPLAN proposed an approach where the model dominated the planning approach, which is wrong. Naude also emphasized a planning approach that is highly interactive with stakeholders and decision-makers, and that considers social and political realities.

The greatest limitation of the integrated models, pointed out by Crous and Naude (Naude, 1991), is the lack of proper trend data over time on which the dynamic interaction between land-use and transport can be modelled. Unless such data are available, the models cannot be calibrated and validated to simulate realistic trends and this limits the models' credibility. This limitation was also emphasized by international experience.

The accessibility net nodal (ANN) model developed by Van der Merwe (1999) is also very useful for corridor development as similar factors impact on corridors compared to nodes, and also in view of the fact that nodal development plays a major role in corridor development. A useful refinement of the model will be to apply more qualitative criteria providing the quantum of land-use areas, densities, employment, etc. The model also assumes that all the criteria have equal weights, and therefore contribute equally to development. It will be easy to determine importance weights from an attitudinal survey of experienced stakeholders and historic trend data. Although the model provides a good method to determine development potential, it does not quantify the probable extent of development that can be expected. Again, this highlights the need for a locational choice model.

Finally, a recommendation regarding the reported modelling results. The various studies reported the performance of the different scenarios in different ways and at different levels of detail. This made comparisons between the studies very difficult. Development of standard land-use and transport criteria relating the input changes to outputs will be very important to increase the usefulness of the modelled results to authorities for cross comparison purposes.

<u>Summary of retail trends, problems and solutions to address retail suburbanisation</u>

Empirical evidence from secondary data sources was summarised to define the role of the retail sector in the national economy, and to contextualise the retail sample survey conducted for the purposes of the dissertation. Spatial retail data were found to be virtually non-existent showing how little attention is given to attractors of transport as opposed to the generators of transport. The integrated business data base that Statistics SA is busy developing is an important step in addressing a proper sampling frame for surveys of economic activity.

Trade plays a very important role in the national economy as it is the highest provider of employment of the ten main economic sectors. Trade therefore also attracts the highest proportion of commuters Retail sales grow by 7 per cent per annum while expenditure *per capita* increases in real terms.

The problems caused by suburbanisation and the decline of the Cape Town CBD featured prominently in media reports quoting crime, uncontrolled hawkers and parking attendants as possible reasons. These problems motivated the establishment of the Cape Town Partnership among stakeholders to address the revitalisation of the CBD.

In other cities in the country the decay of CBD's as a result of mutually supporting trends of suburbanisation, crime and uncontrolled hawking in CBD's may be difficult to reverse unless huge sums of money are invested in the CBD's.

Property analysts in South Africa are concerned about the local trend of developers providing shopping centres at a rate outstripping total demand. However, this trend seems to be similar to international retail trends reported by Price and Blair (1989). They reported that due to high investment costs in shopping centres, required rents were high and that precluded participation by smaller, independent retailers. The supply of retail facilities therefore became increasingly managed and the balance of supply shifted to shopping centres relative to shops in high streets. Consumers seemed to favour this trend, although it was doubtful whether the needs of the poor and immobile sections of the community were met. Supply factors were therefore playing an equally important role compared to demand factors.

Typical policies that are pursued to revitalise CBD's are:

- Inner city distribution systems.
- Controlling suburban development to be focused on limited priority nodes.
- Compulsory CBD impact assessments by developers to indicate that there is demand for suburban centres and that they will not impact negatively on the CBD.
- Tax incentives and the use of income from special levies to improve the CBD.
- Organising businesses in city improvement districts.

4. REVIEW OF REVEALED AND STATED PREFERENCE MODE CHOICE STUDIES IN SOUTH AFRICA

4.1 INTRODUCTION

This chapter reviews the main RP and SP studies conducted locally among public transport captive commuters in order to identify transport mode choice factors that are important to consider in corridor development strategies, and also to identify problems and possible solutions relating to the application of SP models in Southern African countries. The applicability of SP techniques to less-literate population groups is a specific concern in developing countries and a South African research project in this regard is also briefly reviewed. The testing of the performance of SP models for spatial choices under local circumstances is one of the objectives of the dissertation and SP modelling applications are therefore important from this viewpoint.

A critical problem that all South African spatial development plans try to address is the integration of low-income townships lying on the periphery of urban areas into the urban fabric. Integrated public transport plans to provide improved mobility to the large majority of public transport captive commuters as part of corridor development strategies, are typical solutions put forward for the South African problem. As part of a national demonstration project, a comprehensive programme to restructure public transport in Durban and Cape Town was initiated in 1999. A critical component of this programme was major user preference studies involving market research, the development of SP mode choice models and the testing of integrated public transport proposals. An important objective of this review is therefore to identify appropriate policies from the public transport users' perspective.

The work reported here is based on a paper written by the author for an international conference on survey methods (Van Zyl, Lombard and Lamprecht, 2001). The review is further supplemented by the Durban and Cape Town user preference studies (TRC, CSIR, Stewart Scott, April 2001; TRC, Stewart Scott, July 2001). The author was solely responsible for the modelling work of the Cape Town study and shared the modelling work of the Durban study on an equal basis with another party.

In view of the fact that SP survey techniques were developed as a result of the limitations experienced with RP techniques, RP surveys and models are reviewed first. Questions about the transferability of RP models based on the findings of a national research study, are also discussed.

SP mode choice studies are outlined in terms of the key SP design parameters, questionnaire design and interview techniques, problems experienced and the quality of responses to SP surveys. Possible solutions to typical survey problems are offered. The factors impacting on the mode choice of low-income public transport users are subsequently summarized in terms of the statistically significant variables and monetary values.

Finally, a brief review is given of research conducted by two local universities, the University of Pretoria and the University of the North, and the Technical University of Eindhoven (the Netherlands) on the applicability of SP techniques to the mode choices of less-literate commuters (Arentze, Borgers, Chauke, Del Mistro, *et al*, 2002).

The chapter is concluded with a summary of the main conclusions, including a motivation for the selection of SP techniques as the preferred modelling technique to analyse the spatial choices of retail managers.

4.2 Background to the Application of SP and RP Mode Choice Models in South Africa

In the past, changes to public transport services in South Africa were driven mainly by supply considerations with less regard given for user needs and preferences. Since the publication of the White Paper on Transport Policy in 1996, the Government has prioritized the development of public transport to meet the needs of users. All levels of government are, therefore, currently in the process of restructuring public transport according to the principles proposed by 'Moving South Africa', the National Department of Transport's 20 year strategic framework, and the National Land Transport Transition Act, 2000 (Act No. 22 of 2000).

In view of the necessity of evaluating policies and strategies so as to meet the needs of public transport users, planners and decision-makers are looking at SP techniques to provide the answers. There are, however, concerns that SP techniques cannot be transferred directly to the South African situation without some adaptation of the survey and market research techniques. Problems such as users' perceived captivity to a specific mode, lower literacy levels compared with developed countries, and the view that utility maximization techniques are less appropriate to African cultures, need to be addressed.

Internationally, SP modelling is popular due to its powerful policy testing capability and relatively inexpensive survey requirements. In contrast, in South Africa, SP has not been applied extensively. The rather limited travel choices and the historical emphasis on supply-based and private transport policies, are among the underlying reasons.

Surveys of transport users' observed travel choices (revealed preferences), or stated preferences when offered alternative hypothetical travel choices, provide the basic data required for the calibration of discrete choice models. These assist in the understanding of travel behaviour enabling the prediction of travel choices under conditions beyond those observed.

In SA, discrete choice models were initially developed with information from RP surveys. The data requirements of RP models are modest and the data are relatively easy to obtain from respondents. Respondents who have alternative travel options are requested to provide information on the perceived travel characteristics of alternative modes. In South Africa, mode choice has been the most common context for RP models due to its impact on the provision of transport infrastructure and the allocation of public transport subsidies.

Rapid growth in the minibus-taxi industry in South Africa since 1980 provided a concomitant growth in travel choices for low-income captive bus and train users. The basic choice behaviour underlying mode switching was the focus of the development of discrete choice models.

Recently, SP models have been applied in South Africa to test users' preferences for new travel options and to overcome some of the limitations of RP models. Through various initiatives National Government, in co-operation with provincial and metropolitan governments, is in the process of restructuring public transport to meet user demand and preferences within existing financial constraints. The new National Land Transport Transition Act, 2000 (Act No 22 of 2000) provides for transport authorities to develop integrated transport plans (ITP's) in which emphasis is placed on demand-driven integrated public transport services and infrastructure. To assist in the implementation of the Act, the National DOT, in partnership with provincial and metropolitan government, embarked on major SP studies to assist the public transport restructuring processes in Durban and Cape Town.

Although modest and flexible in terms of data quantity and sampling requirements, RP, and particularly SP models, require high-quality data on a sample of transport users' travel behaviour and preferences. The numerous and acute problems experienced in surveys among the large proportion of less-literate population, are well reported by Van der Reis (1997). These problems relate to sampling procedures, respondent selection bias, questionnaire design problems relating to language, culture and numeracy, and interviewing problems. Research identified an 18 per cent underestimation of trips as a result of these problems during various home interview surveys.

In 1979 Stopher initiated a debate on concerns that modern transport planning techniques are based on Western concepts of economics and psychology and that these may not be transferable to developing countries (Stopher, 1979). Recently, differences of opinion on the number of SP attributes and choices that can be included in an experiment were highlighted at the IATBR conference in Brisbane. These differences relate to contrasting experiences in developing and developed countries (Louviere and Hensher, 2000; Ortuzar and Rodrigues, 2000). South African experience as discussed here, can contribute to the debate.

This section focuses on the questionnaire design and interviewing issues, which are crucial to the credibility of SP experiments. Problems addressed relate to semi-literacy and illiteracy, numeracy, language, cultural and perceptual differences and the lack of facilities in deprived communities, typical of the majority of settlements that are captive to public transport.

4.3 RP SURVEYS AND THE TRANSFERABILITY OF RP MODELS

RP discrete choice models were first introduced in South Africa in 1977 to assist in the improvement of bus services in the high-income car-owning communities of Randburg and Sandton in Johannesburg. The most important mode choice issues, however, relate to those of low-income public transport captive communities recently impacted by the rapid growth of minibus-taxi services. Accordingly, subsequent RP studies focused on demand for minibus-taxi services (SA Roads Board, 1990).

A few of the major RP studies conducted in South Africa were:

- A RP survey among all population groups in Cape Town as part of a household survey to calibrate a generic mode choice model for the strategic land-use/transport model for the Cape Metropolitan area (SA Roads Board, 1990).
- The national passenger panel (NPP) established by the NDOT in 1988, quantified change and significant trends in mode choice, as well as the factors influencing mode choice (Van Der Reis, Lombard and Loubser, 1993). The NPP Survey of 1989 was subsequently used to calibrate discrete choice car ownership and mode choice models.

Successful RP mode choice models were calibrated for the above-mentioned studies, indicating that utility maximizing of choice behaviour does exist to a significant degree among the African cultures in South Africa.

The RP studies conducted in different areas and among people of different cultures, allowed the NDOT to conduct a major research project to determine whether the parameters of RP models are transferable between areas and cultures (SA Roads Board, 1990). The main motivation of the study was to determine how survey costs could be minimised by transferring models estimated in one location to be applied in others.

The main conclusions of the research were:

- Discrete mode choice models can be transferred between areas and cultures. The most successful method was to update the model parameters with a small sample of local disaggregate data. This was done by estimating a scaling factor and new constants from the local data.
- The research indicated a 95 per cent success rate using the above method, compared to a 50 per cent success rate if all parameters are transferred (full transfer) without any scaling.
- International experience indicated that a sample size of 20 per cent of the normal sample size would be sufficient to ensure successful transfer. The South African study indicated that the local sample size needs to be higher than 20 per cent, but further research is needed in this regard.
- Transferring models between cultures within the same areas, or between areas within the same culture, is more successful than between cultures and areas combined.
- It was not possible to determine factors influencing transferability apart from the fact that good quality local data is important.
- The transfer of models between different segments of the NPP 1989 data set indicated that models are partially transferable between low- and high-income groups, and between isolated and integrated townships, but not between low and high travel time categories.

4.4 Review of SP Surveys

Six SP studies conducted since 1992 among low-income public transport captive communities are reviewed here. These are:

- Study of rail commuters in SOWETO for the South African Rail Commuter Corporation (SARCC, 1992).
- Study of rail demand among residents in Daveyton and Etwatwa for the SARCC (1996).
- Research study of rail and taxi users along the Daveyton-Dunswart corridor conducted by the CSIR Transportek (1999).
- User preference study of bus, taxi and train users for the Durban Metropolitan Council (TRC, CSIR, Stewart Scott, 2001).
- User preference study of bus, taxi and train users for the Cape Town Metropolitan Council (TRC and Stewart Scott, 2001).

SP design parameters

The complexity and size of the SP experiment are determined by the following variables:

- sample size;
- interview method;
- alternatives tested;
- number of variables and levels of each variable;
- number of choices per experiment and number of experiments; and
- total choices per respondent.

Critical issues are the number of choices that can be made by less literate respondents, as well as the number of alternatives and variables that can be considered, while still providing reliable responses.

Choice contexts and interview methods

In all the studies a binary choice was offered to respondents to simplify the SP experiments. Some studies conducted more than one experiment to test more variables or more modes.

The choice context mostly compared an existing mode with an improved mode. In some cases, both modes did not refer to the current modal attributes experienced by respondents, but to typical attribute values. Respondents' willingness to switch between modes seemed to depend on whether the user's current mode was compared to an alternative mode, or whether two hypothetical modes were used. This is discussed further in a subsequent section in view of the results of the surveys.

Three interview methods were used:

- In the Soweto and Daveyton-Etwatwa studies, respondents were recruited to attend a group interview session at a central location. SP choices were presented one-by-one on an overhead projector, and respondents were asked to indicate their choices on a form. Interviewers assisted respondents, where necessary.
- In the Daveyton-Dunswart study respondents were interviewed one-on-one at a central location. Each choice was presented on a separate card.
- In the recent Durban and Cape Town studies computer aided personal home interviews (CAPI) that offered the ability to validate responses in real time, were conducted. In Durban Phase 1, each choice set was presented on a separate card, while the Durban Phase 2 and Cape Town choice sets were presented on screen. This allowed attribute levels of both alternatives to be based on the values reported by the respondent.

The above interview methods all seemed to have worked reasonably well, although the interviews at locations away from home suffered from time limits.

In all the studies, the alternatives were described verbally, using plain language. None of the studies used pictures to illustrate travel options, because of a concern that pictures may influence choices in an unknown way. Pictures and symbols may also be interpreted differently by some cultures (Van der Reis, 1997).

Focus group discussions and pilot tests during the Soweto study revealed that presentation of SP choices in tabular or matrix format was confusing to respondents. Choices were therefore presented on individual show cards.

Complexity and size of SP experiments

The earlier studies (Soweto and Daveyton-Etwatwa) presented a fairly large number of choices per respondent, ranging from 36 to 74. The more recent studies were much more modest in terms of demands placed on respondents and the number of choices varied between 9 and 16.

The earlier studies also conducted various experiments, and total choices per experiment varied from 6 to 46 per experiment. In the five SP studies the number of variables tested ranged from three to six, and the number of levels per attribute ranged from two to three.

In all cases, the variables and levels tested were determined through focus groups and/or pilot surveys.

The way in which variables and levels are presented is critical to the success of the SP experiment. The following lessons were learned from the SP studies:

- The Soweto study found that the inclusion or exclusion of certain options could confuse and/or annoy some respondents:
- When the dominant option (all rail attributes are improved but fare remained constant) was not included during focus groups, some respondents expressed annoyance. They wanted to indicate their support for improved services at existing fares and this option was re-included in the final design.

- Some respondents regarded the inclusion of a fare increase without improvements to service levels as unfair and therefore these alternatives were excluded from the final design in order to improve acceptance of the survey as a whole.
- Safety from crime on train was found to be such a dominant factor that less important attributes were ignored. This was overcome by conducting different experiments including and excluding the safety attribute.
- In the Durban and Cape Town studies, no problems of annoyance about the unfairness of certain options were encountered.
- Fare and in-vehicle times were so dominant that it was suspected that the other variables were often ignored. To avoid this problem, the dominant factors were presented at the bottom of the show card for the Durban Phase 2 and Cape Town studies. The number of SP variables was also limited to the most important ones, and other significant variables were presented as fixed, controlled information.

Perceived illogical combinations of attribute levels or unrealistic levels were questioned by some respondents. Explanations resolved these problems.

4.5 Quality of Responses to SP Questions

Reluctance to switch modes

A phenomenon, which had a major impact on the results of the Daveyton-Dunswart and the Durban Phase 1 studies, was the reluctance of a large proportion of the respondents to switch modes under any circumstances. In both these studies, the respondents' existing mode was compared with an existing alternative mode and many respondents chose only their current mode with which they were familiar.

In the Daveyton study a train/taxi mode choice model could, therefore, not be calibrated. A successful SP experiment testing comparisons within one mode was subsequently conducted.

In the Durban Phase 1 study, a large sample was available and non-switching respondents (27 per cent in the first experiment and 20 per cent in the second) could be excluded from the data set. A dummy variable was subsequently created, measuring the reluctance to switch. This variable was highly significant and improved the overall fit of the model.

The non-switching problem was particularly severe in Chatsworth (43 per cent) where residents had very negative perceptions about trains and where trains are used by a small proportion of residents. Bus and taxi users were therefore very reluctant to choose train in the SP experiment.

In Phase 2 of the Durban study, the levels of time and fare for Chatsworth respondents were specified differently to the rest of the sample in order to overcome the reluctance to change problem. A smaller percentage of Chatsworth respondents (21 per cent compared with 43 per cent in Phase 1) indicated a choice for their current mode in all choice situations.

Only seven per cent of the sample as a whole never switched from their current mode, which was a significant improvement on the Phase 1 study, partly explained by the more appropriate levels of travel time and fare for Chatsworth. Another factor may have been the fact that the respondents were encouraged to base their choices on the description of the alternatives on the SP cards and not on general perceptions of the alternative.

In summary, the following should be considered to minimize the problem of reluctance to switch modes:

- Identify potential problems prior to the survey during focus groups and pilot tests.
- Increase the difference in attribute values between the modes.

- Encourage respondents to make their choices on the basis of the attributes as presented in the choice set and not on the basis of their experience of any of the alternatives.
- Vary the levels of the attributes of respondents' current mode.

<u>Performance of models</u>

In this section the performance of choice models and possible factors influencing performance are reviewed. Without conducting carefully designed research to quantify the impact of specific factors on model performance, it is difficult to make conclusive statements from the empirical evidence of a few studies.

Table 4.1 also indicates the variables found to be significant in the various studies as well as the overall significance of the models in terms of the Rho-Square value.

Three of the five models indicated a very good fit with a Rho-Square value greater than 0.2, i.e. the Soweto study, the Durban Phase 2 study, and the Cape Town study. These studies differed significantly with respect to interview method and location, number of variables, number of choices per experiment, number of experiments and the total number of choices per respondent.

The Durban Phase 1 SP models performed worse than the RP models calibrated from the same sample of respondents. This is contrary to international experience that indicates superior performance of SP models to that of RP models.

Various changes were made to the SP design for the Durban Phase 2 study based on factors that were suspected to have caused the poor performance of the Phase 1 model. These changes had the desired result – the SP models performed very well and much better than the RP models.

The empirical evidence suggests that the following factors played a significant role in the improved performance of the Durban Phase 2 SP model, and this was later confirmed by the Cape Town study:

- Changing the SP context from comparing existing transport modes to comparing the current mode to a new improved mode.
- Overcoming the 'reluctance to change' behaviour of respondents by:
  - having large ranges between minimum and maximum levels; and
  - making levels of the new improved train services more attractive to residents who displayed very negative perceptions towards trains.
- Limiting the number of variables to four and the number of choices per respondent to nine.
- Moving the dominant cost variable from the top of the show cards to the bottom, forcing respondents to consider all other variables before the cost variable.
- The larger variation in the modal characteristics presented on the SP show cards. In Durban Phase 2 and Cape Town the time and cost values of both alternatives were based on the reported values of each respondent, while fixed time and cost levels were used in the Durban Phase 1 study based on average values obtained from prior public transport surveys.

Finally, a significant scaling factor of 0.58 between the SP and RP models was found by combining the two data sets in a nested model. In view of the successful track record of RP models in South Africa and the significant scaling factor found in the Durban study, it seems that the international practice of combining RP and SP models is even more crucial in choice studies among less literate communities.

4.6 SIGNIFICANT FACTORS IMPACTING ON MODE CHOICE

Table 4.1 indicates the variables tested in the various SP studies. These variables were identified as important factors impacting on mode choice in focus groups, pilot studies and other background information. In SP studies it is important to identify and test only the important factors in order to minimise the number of SP choices. In a developing country it is even more critical to limit the SP choices in order to ensure reliable responses. However, this approach requires more controlled information to be provided on less important variables that may influence choices. Alternatively, larger samples will permit sub-sets of respondents to be exposed to these variables without increasing the number of SP choices.

Table 4.1: Variables found significant in each SP study

(Note: * = variable tested; ✓ = variable significant at 95 % confidence level)

Variables	**Soweto**	**Daveyton-Etwatwa**	**Daveyton-Dunswart**	**Durban**	**Cape Town**
Fare	* ✓	* ✓	* ✓	* ✓	* ✓
Total travel time	* ✓	*	* ✓	* ✓	* ✓
Walking time		* ✓		* ✓	*
Frequency /Wait time	* ✓			*	* ✓
No of transfers			* ✓	* ✓	* ✓
Standard of feeder	* ✓				
Method of payment: Coupons v cash Smart card			* ✓	*	* ✓
Train: Guards Train: CCTV				* ✓ * ✓	* ✓ * ✓
Taxi safety				* ✓	
Safety	* ✓				
Crowding	* ✓				* ✓
Skip-stop train					* ✓
Reluctance to switch				* ✓	* ✓
Income (or proxy)		* ✓		* ✓	* ✓
Significance of model (Rho.Square)	>0.2	0.1 - 0.15	0.1 – 0.16	0.05 – 0.27	0.09-0.29

The SP variables tested are mostly typical of important factors found elsewhere in the world. A few variables that may be unique to South Africa are safety from crime on trains, safety from accidents in minibus-taxis, skip-stop train services and the use of smart cards. The skip-stop train service was tested among Mitchells Plain commuters in Cape Town specifying that the train will not or will stop in Khayelitsha. The variable was significant and positive for not stopping. Focus group results indicated that Mitchells Plain commuters regarded the train stopping in Khayelitsha as a security risk, which was confirmed by the SP test.

The smart card ticketing system on a midi-bus was also tested among Mitchells Plain taxi-commuters and was found to be significant, but negative. The smart card was therefore regarded as a negative factor among taxi users who are used to pay cash. A discount on the smart card was not tested - a discount together with proper marketing may overcome negative perceptions.

Table 4.1 also indicates the variables that were found to be statistically significant from the SP responses. Some of the variables identified as important during focus group discussions, prior to the survey, were not significant. In some cases this may be an experimental effect, but this could not be proved. Factors which may have played a role, are:

- The fact that important factors dominate less important factors.
- Fatigue that causes variables lower down on the show card to be ignored.
- The inability of respondents to consider a large number of factors with the result that they respond only to a selected few variables.

4.7 Comparison of Monetary Values of Mode Choice Factors between Durban and Cape Town

Table 4.2 compares the monetary values of variables in the Durban and Cape Town SP models. The monetary value of any significant variable in the mode choice model is estimated by calculating the ratio of the variable coefficient to the fare coefficient. The monetary values allow the relative impact of variables measured in terms of the same unit in different market segments or in different study areas to be compared .

The monetary values can be interpreted as what users would be willing to pay to obtain one unit of the relevant variable, or alternately, if fare was valued at R1.00, what would be the equivalent Rand value of one unit of the specific variable.

Table 4.2 indicates that users value bus and train travel time similarly, while travel time of taxi is valued somewhat higher, especially in Cape Town. This is probably due to the fact that taxi is regarded as a more convenient mode of travel. Cape Town users also value travel time higher than Durban users.

Table 4.2: Comparison of monetary values of mode choice variables in Durban and Cape Town (SP models)

Variable	Durban	Cape Town
Total travel time (R/hr):	R4.3	
Train	R0.8 to R1.8	R0.7 to R4.3
Bus	R0.8 to R1.8	R1.7 to R4.3
Taxi	R0.8 to R1.9	R4.1 to R6.5
Waiting time (R/hr)	R3.9	R5.6
Walking time (R/hr)	R3.0	
Crowding – train (R per level)		R0.4
Skip-stop train (R for service)		-R0.4 to – R2.5
Transfers (R for transferring)	R0.8 to R1.3	R0.4
Method of payment (R for smart card)		R0.5
Train security:		
Guards (R per level)	-R0.2 to –R0.3	-R1.0
Panic buttons and CCTV	-R0.5 to –R0.7	-R1.0 to R3.0
Reluctance to switch (R for current mode)	-R1.3 to –R4.7	

In the Durban Phase 1 study, the RP and SP model indicated that the values of walking and waiting time were similar or even less than those of in-vehicle time. This is contrary to the results of studies in developed countries where out-of-vehicle time values are much higher than in-vehicle times. Research conducted by the University of Leeds on the value of time from 143 studies in Britain since 1980, indicated that walking and waiting were valued equally, and both were valued 60 percent higher than in-vehicle time (Wardman, 1990).

Focus group discussions in Durban also supported the evidence that respondents value the different time components of a trip similarly, and that only the total door-to-door time really matters.

The assumption that all time components have similar coefficients enables the simplification of the SP experiments. More attention can therefore be given to the testing of other non-time variables, which are often important. This approach was followed in the Durban Phase 2 study, as well as Cape Town, which allowed the testing of two different train security variables.

In contrast to the Durban results, the Cape Town values of out-of-vehicle time were found to be higher than those of in-vehicle travel time, especially from the RP models.

Values of time of the public transport users in Durban and Cape Town were found to be very low, below R7 per hour in SP models, and below R20 in the RP models. The value of time of car users in South Africa determined from RP and SP route choice studies, typically ranged between R50 to R90 per hour depending on the trip purpose (Van Zyl and Oberholzer, 2001). This can be explained by the much higher income of car users and the higher convenience and comfort of car travel compared to public transport.

In terms of train security measures, it was found in both Durban and Cape Town that technological measures such as panic buttons and CCTV surveillance were regarded as much more valuable than security guards. Security was also valued much higher in Cape Town than in Durban.

Elasticities of mode choice with respect to the independent variables were estimated by applying the mode choice model to the SP sample data. The elasticity is defined as the percentage change in the market share of a mode in view of a one per cent change in the value of a specific attribute of the mode.

Elasticities of demand for a mode with respect to cost and in-vehicle time were found to be much higher (0.5 to 0.9) than with respect to other variables such as walking and waiting time, safety and security, frequency and modal transfer (less than 0.2). In both Durban and Cape Town, fare displayed a very high significance (t-value) compared to any other variable, indicating the high cost-sensitivity of public transport users. This trend seems to be similar to the relative elasticities found in a SP study conducted among peak period public transport users in Santiago (October, 1996). In the Santiago study, the lower the income, the higher the elasticities of cost and time became relative to other variables such as safety, vehicle comfort, waiting time, bus occupancy and variability of waiting time.

4.8 RESEARCH ON THE APPLICABILITY OF STATED PREFERENCE TECHNIQUES TO MODE CHOICES AMONG LESS-LITERATE COMMUTERS

The concern that research methodologies used in developed countries might not always be transferable to developing countries, motivated a research project in South Africa to test various hypotheses regarding the performance of SP mode choice models among less-literate commuters. (Arentze, Borgers, Chauke, Del Mistro, *et al*, 2002). The research was funded by SANPAD and conducted by the Technical University of Eindhoven (the Netherlands), the University of Pretoria (S.A.), the University of the North (S.A.) and consultants.

Personal interviews were conducted with a sample of 356 commuters recruited in Mamelodi near Pretoria. The SP experiments involved mode choices between two or three alternatives (mini-bus taxi, bus and train) in view of either three or five attributes. The SP questions were also presented in two different formats, i.e. verbal descriptions and verbal descriptions supported by pictorial material. In-depth qualitative interviews were also conducted with 26 of these respondents.

The main results of the tests of the hypotheses were:

- The main hypothesis that the less-literate are less able to cope with SP data collection methods was not proven statistically. However, the qualitative research indicated a much higher percentage of invalid responses among the less-literate (school up to grade 7) than among the literate (grade 8 and higher) respondents.

- The hypothesis that the quality of response is affected by the complexity of the model is substantiated in respect of the number of attributes, but not in respect of the number of alternatives.
- The hypothesis that the method of presentation affects the quality of the response was substantiated by the statistical analyses for both literate and less-literate groups. The use of pictorial material, in fact, reduced the model fit. However, the less literate was more affected than the literate, providing further support for the argument that increasing complexity would affect the less-literate more than the literate.
- Finally, the hypothesis that response quality declines with fatigue could not be proven statistically.

The following conclusions were drawn:

- SP data can be collected from less-literate respondents provided that the choice tasks are not too complex. The relatively low level of model fit (adjusted Rho-square value of 0.177) and the high number of invalid responses identified in the qualitative interviews, indicated that SP can be problematic in this context.
- A high degree of care needs to be taken during interviews to ensure that respondents give reliable responses based on the presented hypothetical situations rather than to be polite, to appear intelligent or to use values from own experience.
- The possibility that mode choices are based on non-compensatory rules need to be investigated further.
- The reasons for the apparent discrepancies between the statistical analyses and qualitative research also need to be investigated further.

4.9 CONCLUSIONS ON RP AND SP MODE CHOICE STUDIES

Implications of mode choice factors of public transport captive commuters for urban densification policies

The review of important mode choice factors of low-income captive public transport users indicated that elasticities of choice factors differ between metropolitan areas and that the demand for strategies such as an integrated rail service may differ between areas. In strategic terms, the rank order of factors impacting on the mode choice of public transport captive commuters is similar.

The factors are briefly described below:

- User costs: any decrease in average travel distance as the result of an urban densification strategy, and the resultant reduction in operating costs and fares, would benefit users most. Subsidisation policies and adjustment of supply in line with demand, supporting urban densification, will be relevant policies. This will imply that subsidies for long-distance travel should be reduced and that subsidies for short distance travel should be increased in a phased manner. This should be co-ordinated with land infilling providing low cost housing closer to jobs. Proper fare structures sensitive to travel distance and integrated between modes should ensure that the benefits of a reduction in travel distance due to urban densification, are passed on to users.
- Door-to-door travel time: Integrated public transport strategies should ensure that total travel time does not increase. Shorter travel times resulting from urban densification and policies to increase the speed of line-haul modes operating along corridors, such as HOV lanes and signal priority measures, are important. Estimation of realistic time elasticities will indicate higher demand for these time reduction strategies than typically indicated by SP models.
- Out-of-vehicle time components of travel (walking, waiting and transferring): Although out-of-vehicle and in-vehicle time may have similar impacts in some areas, such as Durban, out-of-vehicle time may display a higher impact compared to in-vehicle time in certain areas, such as Cape Town. Higher frequencies, short transfer times, limiting the need for transfers, and greater coverage will be important in areas such as Cape Town.

- Rail security and bus/taxi road safety: Addressing these factors effectively will be critical for any public transport strategy devised in support of urban densification strategies. Typical densification strategies are designed around the existing rail network and providing feeder services to rail to capture the demand of current bus and taxi users. These policies will fail if the current negative perceptions of rail and the lack of rail security are not addressed.

  Large-scale new rail-based projects are not appropriate for South Africa in view of overseas experience and local conditions. Densification along existing rail lines will be much more successful.

<u>Performance of discrete mode choice models</u>

RP and SP surveys meeting the requirements of discrete mode choice models have been conducted in South Africa among less literate communities with a reasonable degree of success. The studies bear evidence of various problems experienced in satisfying the specific data requirements of RP and SP models. It is believed that future studies can improve the performance of models, provided that cognizance is taken of typical problems and the possible solutions identified from past applications. The SANPAD research project and the empirical studies indicated the need for high quality market research survey procedures, simple SP designs limiting the number of attributes and using verbal descriptions without supporting pictorial material. The local experience is also in line with international experience, i.e. to keep SP designs simple, unless the target market is very sophisticated, such as shippers of freight who are used to deal with complex choice contexts.

Research also needs to be done on alternative non-compensatory modelling techniques and their survey requirements, to determine whether these techniques would be more appropriate to the travel choice behaviour of local communities. Alternative techniques are elimination-by-aspects models based on SP travel surveys and activity-based models based on activity diaries.

With the extension of South Africa's empirical database of mode choice behaviour, the transferability of RP and SP models need to be revisited. Further research into the minimum sample size required to transfer choice models, can result in significant savings in future survey costs.

<u>Selection of SP techniques to address the need for a behavioural locational choice model</u>

The international literature reviewed in Chapter 2 indicated the trend towards more disaggregated, behavioural modelling approaches. Internationally and locally, the conventional land-use transport models have been criticised as being mechanical systems not sensitive to social and political factors and changing patterns over time. The high cost and lack of transparency have also been criticised.

In view of their disaggregated and behavioural basis, discrete choice models are very popular in both small-scale problem specific models and large-scale land-use transport models. SP techniques are favoured in view of their many advantages over traditional RP techniques. SP also offers specific advantages in modelling spatial choices as indicated in Chapter 2. The main focus of activity-based models is on modelling the activities of consumers and households, although the most recent model developments identified the need to model the spatial choices of businesses as well by using discrete choice models. International SP researchers also expressed the need for giving more attention to longer-term choice contexts. The limited number of discrete spatial choice models of businesses developed for urban planning purposes found in literature further indicate the need for more research in this context.

An appropriate spatial modelling technique for local circumstances should meet the criteria of being able to reflect the spatial choice behaviour of businesses, to be sensitive to changes in variables important for policy formulation, to be transparent and to be relatively cheap to develop and apply. The international trend towards the activity-based approach in integrated land-use transport models would not be appropriate to follow in South Africa due to its high costs and human resource requirements and limited local funding. A more appropriate approach for South Africa and other developing countries would be a more extensive use of discrete choice travel and spatial models, which can be applied to small-scale problem-specific models and large-scale urban models.

In view of the above considerations, a discrete choice SP modelling approach was selected as the ideal solution to meet the objectives of the dissertation and the criteria for an appropriate approach for South Africa. The development of such a model for the retail industry is explored in the subsequent chapters of the dissertation.

5. SURVEY OF LOCATIONAL PREFERENCES OF CAPE TOWN RETAIL MANAGERS

5.1 INTRODUCTION

In this chapter the sample survey that was conducted by the author among retail managers in Cape Town is discussed. The SP survey aspects are mentioned only briefly here as the next chapter covers all aspects of the SP part of the survey and the calibration of the locational choice models based on the survey data. Chapter 5 presents the survey objectives, survey design and results. The results include the characteristics of the retail businesses, ownership and rent, locational mobility, satisfaction with current location, accessibility and parking supply, as well as retail managers' importance ratings of locational choice factors. Finally, the survey results are compared to the retail profile of Cape Town from secondary data sources.

5.2 SURVEY OBJECTIVES AND METHODOLOGY

5.2.1 Objectives

The following objectives were specified for the survey that the author conducted

among retail managers in Cape Town:

- To quantify factors affecting Cape Town retail managers' choice of business location and in particular the choice between locating in the CBD or in the suburbs.
- To determine the relative importance of various factors affecting retail location.
- To provide information for the calibration of a discrete locational choice model of retail location between the CBD, low-income suburbs and high-income suburbs.

5.2.2 Survey methodology

The standard survey methodology was followed including the following steps:

- Define survey objectives and analysis techniques.
- Formulate questionnaire framework.
- Formulate survey specifications considering technical requirements, sample design, data format and budget constraints.
- Request quotations from professional market research companies.
- Evaluate quotations and appoint preferred market research company.
- Formulate draft questionnaire design and coding for data capturing.
- Design sample in detail.
- Obtain information on target population and draw sample.
- Brief fieldwork managers for the pilot survey.
- Pilot test questionnaire and conduct qualitative interviews.
- Debrief fieldwork managers after pilot survey and refine questionnaire.
- Conduct fieldwork.
- Encode and capture data.

Three market research companies were asked to submit quotes. Corporate & Social Research (CSR) was subsequently appointed in view of their expertise in the business market research field, their trained fieldwork staff in Cape Town, and their quote which was within the budget constraints.

CSR was made responsible for the following:

- Detailed questionnaire design and coding.
- Briefing and debriefing of fieldworkers with assistance from the author.
- Pilot test and qualitative interviews.
- Fieldwork.
- Data coding and capturing.
- Fieldwork report and basic data summary.
- Validated data file and coding manual.

5.3 SURVEY DESIGN

5.3.1 Sample area and size

The Cape Town city council area, as defined in 1995, was used to define the study area boundary, illustrated in Figure 5.1. In order to distinguish the CBD from suburbs in the analysis, it was necessary to define these areas for the purposes of the study.

The so-called city bowl defined by the mountain range was used to define the CBD area. Although old suburbs such as Green Point, Sea Point and Camps Bay could be regarded as suburban development, their close proximity to the city bowl makes them part of the central city area and they were therefore excluded from consideration for the suburban sample.

Furthermore, low-income suburbs were defined as the traditional dormitory townships of Cape Town, where most people are captive to public transport. High-income suburbs were defined as those where affluent, car-owning people live.

In view of the fact that SP models can be estimated from a relatively small sample, a sample size of 120 retail managers was deemed to be sufficient.

An area stratified sampling method was used to select an equal number of retail businesses (i.e. 40) in the CBD, low-income suburbs and high-income suburbs of Cape Town. The sample was selected from a total "population" of businesses provided by Rode's Retail report (1994), and supplemented by information obtained from the City Council of Cape Town.

The low-income suburb sample was drawn from:

- Nyanga, Langa, Khayelitsha, Gugulethu and Mitchell's Plain.

The high-income sample was drawn from:

- Bellville, Parow and Durbanville

5.3.2 Classification of shops

For sampling and analysis purposes it was necessary to characterise shops according to type of location and type of merchandise.

Shops were therefore typified according to whether they were free-standing (street-front) or part of a shopping centre, while centres were categorised according to size as follows:

- Large - 111 and more shops
- Medium - 40 to 110 shops
- Small - up to 39 shops

The Standard Industrial Classification (SIC) codes of Statistics South Africa were used to classify the merchandise of the shops. Retail, involving services such as hair salons and cinemas, were specifically excluded. The reason was that shops that sell goods put a heavier demand on transport and logistical distribution than those offering services. The relatively small sample also necessitated the exclusion of certain categories. However, in broader terms, it was felt that the sample covered a wide range of products and covered both convenience and comparative shopping (luxury) goods.

The following SIC categories were covered:

- Ladies outfitters.
- General outfitters and dealers in piece goods and textiles.
- Dealers in furniture, household requisites and appliances.
- General dealers.
- Grocers and other dealers in foodstuff.
- Shoe stores.
- Book stores and stationers.
- Dealers in miscellaneous goods.
- Jewellers.
- Sweet shops.

- Dealers in leather goods.
- General department stores.
- Gift shops.
- Home industry.
- Dealers in sport and entertainment requisites.
- Butchers.
- Chemists.
- Computer retailers.
- Retail chains, supermarkets and hypermarkets.
- Dealers in herbs and spices.
- Toys and hobby shops.
- Sewing machine and needlework shops.
- Bakeries.
- Bottle stores.

One-person shops were excluded from the sample as these were regarded as too small for the purposes of the study.

The shops were selected from the above categories according to the profile of the sampling area.

Figure 5.1 gives a map of the location of the ten shopping centres sampled, relative to the road and rail network, and the bus and taxi routes. All the centres are located on bus or taxi routes, while the following four centres also have very good rail access: Nyanga Junction, Eyethu centre, Station Plaza and Sanlam centre.

Figures 5.2 and 5.3 show photos of typical shopping centres surveyed in the high-income and low-income suburbs. The stark contrasts between the condition of the centres in the low- and high-income shopping centres, are apparent.

Table 5.1 gives the distribution of the sample amongst the different market segments and shopping centres.

5.3.3 Questionnaire design

A draft questionnaire was designed in view of the objectives of the survey and the literature review on factors impacting on the locational choice of businesses. The modelling and analysis techniques specified also played an important role in the type and format of the questions.

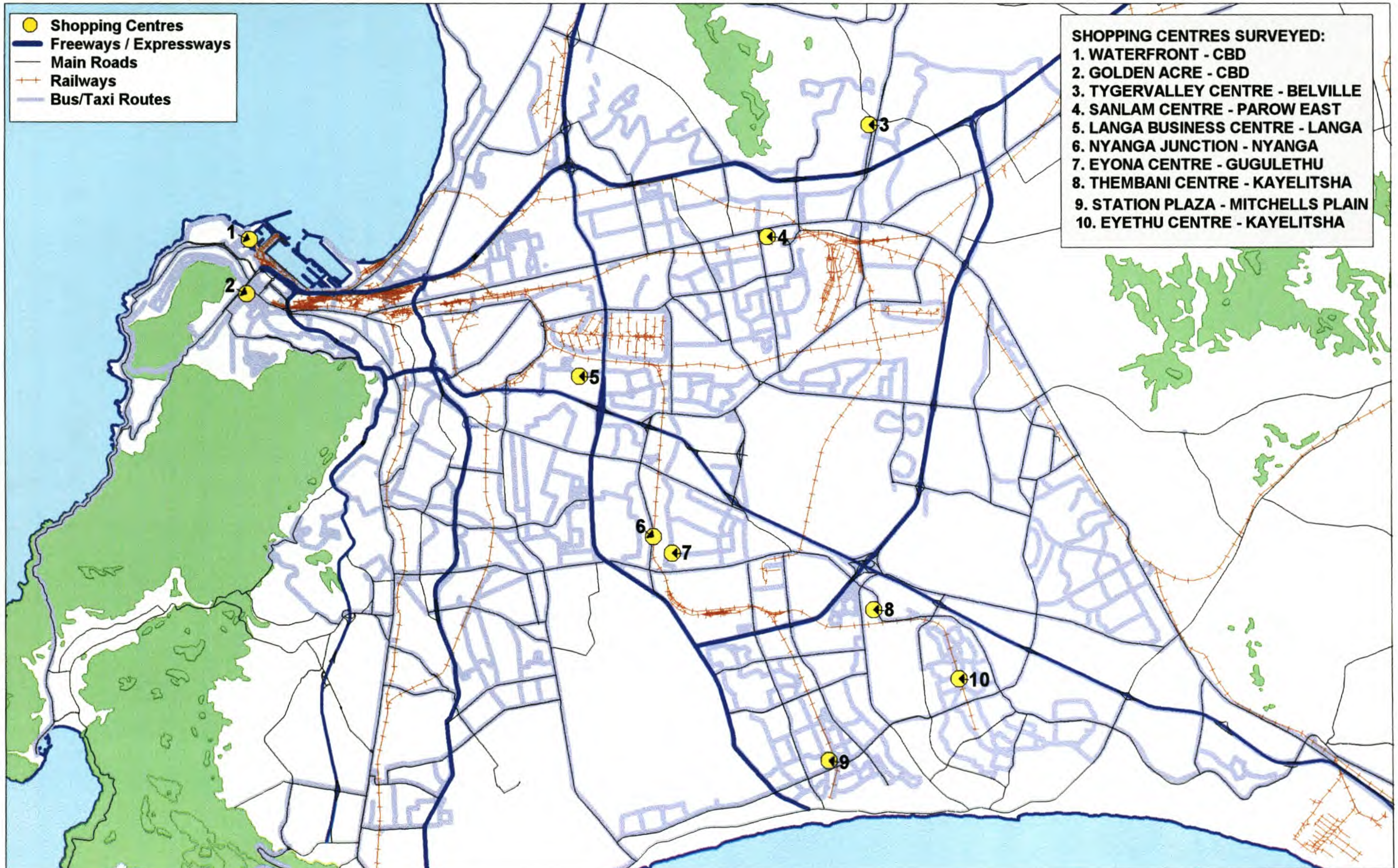
The questionnaire consisted of three main parts:

- The first part contained questions to obtain background information on the retail business such as the type of retail business, size of the shop, rent and accessibility.
- The second part consisted of attitudinal questions asking for the manager's importance ratings on a 5-point categorical judgement scale for each of a wide range of factors impacting on locational choice.
- The final part consisted of SP questions asking the manager for his preferences for alternative retail locations in view of specified characteristics of the locations.

The SP design is discussed in Chapter 6.

An important specification was that the questionnaire had to relate to a specific shop at a specific location. The main focus of the survey was also aimed at single shops of small to medium size, managed by one person. This offered a more simplified environment for the survey of locational choice. Large retail chains make locational choices at corporate head offices and this would have been too complicated to cover in the survey. Retail chains often conduct in-depth research of market potential and competition in various locations. Locational choice would therefore be made in terms of consensus decision-making at board room level based on maximising market exposure, market potential and competitive edge.

Figure 5.1 : Map of Cape Town showing the location of the surveyed shopping centres relative to the road and rail network and the bus/taxi routes



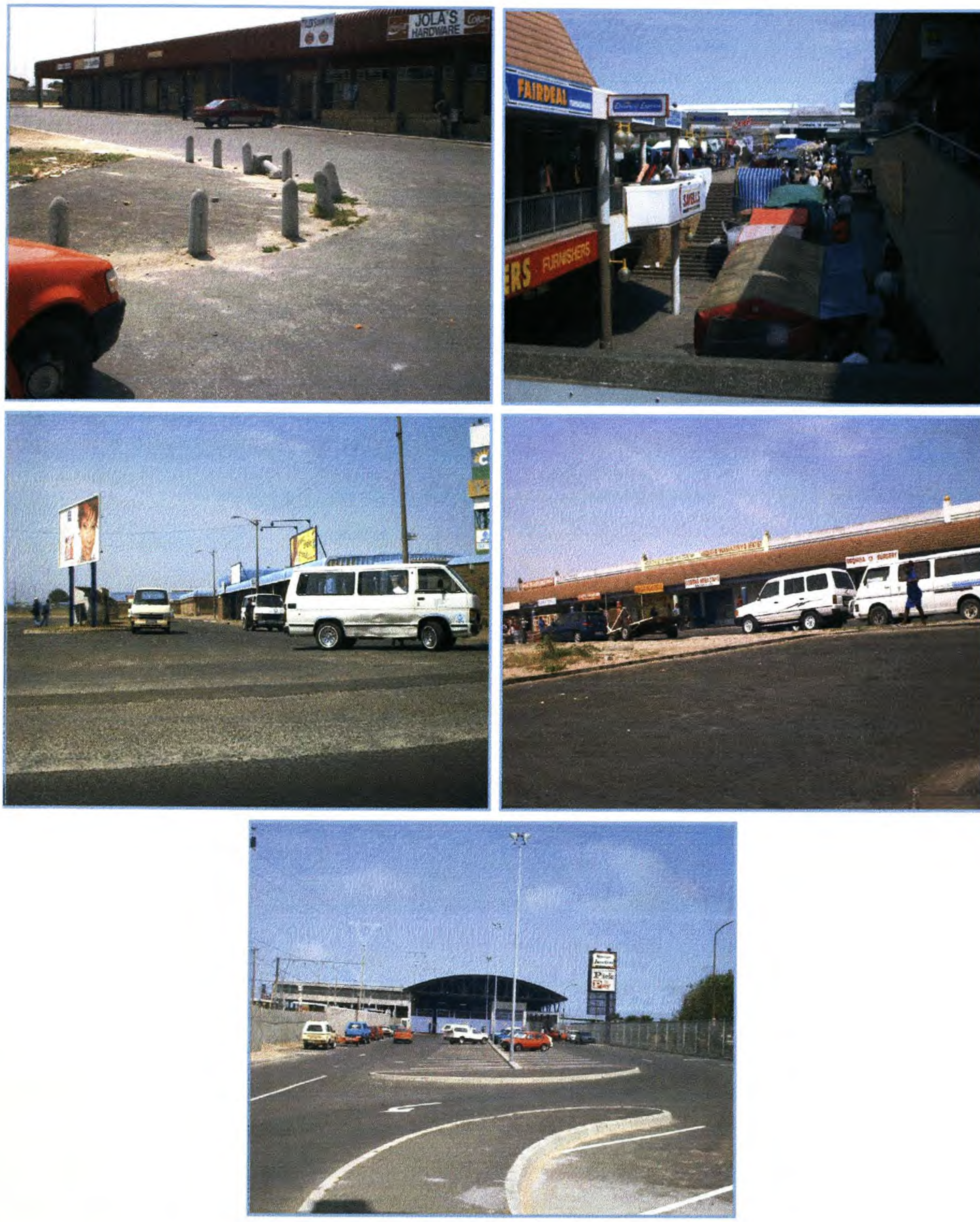


Figure 5.2: Photos of typical shopping centres surveyed in low-income suburbs

Figure 5.3: Photos of typical shopping centres surveyed in high-income suburbs

Table 5.1: Distribution of sample

NAME OF CENTRE AREA	CBD	HIGH-INCOME SUBURB	LOW-INCOME SUBURB
Free-standing (street-front)	19	6	4
Golden Acre	10		
Water Front	11		
Tyger Valley Bellville/Durbanville		23	
Sanlam Centre Parow East		10	
Fobell Centre Bellville		1	
Langa Business Centre			12
Thembani Centre Khayelitsha			7
Eyethu Centre Khayelitsha			5
Nyanga Junction Nyanga			6
Eyona Centre Gugulethu			3
Plaza Station Mitchells Plain			3
Total	40	40	40

Although SP techniques can be applied to multiple decision-making units (Ortuzar and Rodrigues, 2000) it was considered important to keep the SP experiment simple and to give it the best chance of success by applying it in a less complicated decision-making context.

The draft questionnaire was modified by the market research company in view of their experience of business surveys. The questionnaire was subsequently pilot-tested among 10 retail managers before it was finalised for the main survey.

Focus group discussions consisting of in-depth qualitative questioning of a small group of people from the target market is a popular technique to assist in the design of the SP questions. Due to financial constraints the focus group technique was replaced by informal discussions with the respondents in the pilot survey to gain an understanding of the factors they consider in retail location.

A copy of the questionnaire is included in Appendix A.

5.4 FIELD WORK

The fieldwork was conducted during March 1995 and 120 questionnaires were fully completed. Fieldworkers were debriefed after the pilot survey and again briefed prior to the main survey as significant changes had been made to the SP questions. Normal backchecking procedures were followed to ensure that the fieldworkers conducted the survey properly.

The data were captured and validated by the market research company before being handed over in the raw electronic format. A fieldwork report was provided as well as basic summary tables of the data.

5.5 RESULTS: CHARACTERISTICS OF RETAIL BUSINESSES AND FACTORS IMPACTING ON LOCATIONAL PREFERENCES

5.5.1 Introduction

This section describes the summary of the responses obtained from the survey among retail managers. The STATISTICA statistical software package was used to summarise the responses in terms of cross tabulations between interval variables, averages and ranges of continuous variables. The analyses categorised the responses according to the location of the business in terms of the *CBD*, high-income suburbs (*SUB HIGH*) and low-income suburbs (*SUB LOW*).

The results provide a basic understanding of how the characteristics of retail businesses differ according to location, differences in locational turnover and reasons for moving between locations, accessibility of businesses by means of various transport modes, parking characteristics and attitudes towards factors influencing locational choice.

5.5.2 Retail business characteristics

The main purpose of the retail characteristics presented in this section, is to obtain a profile of the businesses in the sample to interpret the locational analyses results, and not to draw conclusions about the total population of retail businesses. For this latter purpose a large random sample is required. Section 4.6.7 provides information from larger surveys to characterise the retail population. The sample profile is dependent on the choice-based sample design, the profile of the retail population, and the profile of the businesses willing to participate in the survey. It is also subject to typical sampling errors.

In order to assist the characterization of the retail businesses, the Standard Industrial Codes (SIC) used in the survey were classified into five main product categories that are often used to typify retail goods. These are fast-moving consumer goods (FMCG), household appliances, convenience goods, clothes and shoes, and speciality goods. Table 5.2 gives the classification system.

According to Table 5.3 the total sample contains mostly household appliance and clothing businesses (28-29%), followed by convenience and speciality shops (16-18%), with FMCG shops occurring the least frequent (10%). The low occurrence of FMCG shops is due to the sampling specification to exclude the large supermarket and hypermarket chains. The other categories of shops are well represented.

The CBD sample indicates the same characteristics as the total sample, with a slightly higher representation of household appliance and clothing businesses. The high-income suburbs show a slightly different profile, indicating a much higher proportion of speciality shops than the total sample. The profile of the low-income suburbs differs even more, with a much higher proportion of convenience and FMCG shops, and only a small proportion of speciality shops. The sample therefore reflects the main differences expected between low- and high-income suburbs, i.e. a high occurrence of shops selling basic consumer goods in low-income suburbs, with the shops in high-income suburbs providing for the upmarket clothing and speciality goods market

Table 5.2: Classification of businesses

Product category (key word)	SIC description
Fast-moving consumer goods (*FMCG*)	Grocers; foodstuff; gas/paraffin; supermarkets
Household appliances (A*PPLIANCES*)	Furniture; household requisites; appliances; bicycles; gen. dept. store General dealers; computers; sewing machines
Convenience goods (*CONVENIENCE*)	Butchers; bottle stores;chemists; home industries; sweets; herbs/spices Bakeries
Clothes and shoes (*CLOTHES*)	Mens' / ladies' outfitters; shoe stores; leather goods
Speciality goods (*SPECIALITY*)	Book stores; jewellers; gift shops; toys / hobbies

Table 5.3: Percentage distribution of product categories by location

	FMCG (%)	APPLIANCES (%)	CONVENIENCE (%)	CLOTHES (%)	SPECIALITY (%)	Total (%)
CBD	5	30	18	30	18	100
SUB HIGH	2.5	28	10	33	28	100
SUB LOW	23	30	25	20	2.5	100
Total	10	29	18	28	16	100

Table 5.4 gives the average size of the businesses in terms of the number of permanent and temporary employees and the total number of employees. The minimum and maximum values of total employees and the number of records used in the analysis by location, are also given.

The average business size is relatively small with approximately ten employees, of which eight are permanent and two temporary workers. However, the range in total employees is large varying from one-person businesses to large businesses with 100 employees. The difference between businesses in various locations is small, with the CBD and low-income suburbs having the same average number of employees, and the high-income suburbs a slightly lower average. The high-income suburb sample therefore contains a larger number of smaller businesses than the CBD and low-income suburb samples. However, the maximum size of businesses in low-income suburbs is smaller than than those in the CBD and high-income suburbs.

Table 5.4: Average number of permanent and temporary employees per business

	Employment				**Sample**
	Perm	**Temp**	**Total**	**Range (min – max)**	
CBD	8.6	2.2	10.8	2 – 100	40
Sub High	6.2	2.0	8.2	2 – 100	40
Sub Low	8.4	2.5	10.9	1- 73	40
Total	7.7	2.2	9.9	1 - 100	120

The average gross leasible area (GLA) is another measure of the size of the businesses, and is given in Table 5.5. The average GLA is approximately 380 m^2, while the range is quite large, i.e. 24 to 4000 m^2. The average size of high-income suburb shops in the sample is the smallest, followed by CBD shops, while low-income suburb shops have the highest average size. This difference could be explained by the higher representation of FMCG businesses in the low-income suburb sample, compared to the higher representation of typical smaller speciality and clothing shops in the high-income suburb sample.

Similar to the number of employees, the range in GLA is large, varying from 24 to 4000 m^2. The maximum size of CBD and high-income suburb shops is the same, and it is twice the maximum size of low-income suburb shops.

The following average employment densities were derived from the employment and GLA results:

CBD: 28 employees per 1000 m^2
Sub High: 23 employees per 1000 m^2
Sub Low: 27 employees per 1000 m^2

Table 5.5: Average gross leasable area (GLA) per business

	GLA (m^2)	Range (min – max)	Sample
CBD	386	26 – 4000	40
Sub High	352	25 – 4000	40
Sub Low	405	24 - 2000	29
Total	379	24 - 4000	109

The average employment densities of CBD and low-income suburb shops are similar and denser than that of high-income suburb shops.

A number of respondents of the low-income suburb shops could not provide the GLA, while they could provide employment numbers. Regression analysis was used to impute the GLA values for these cases based on the employment values for the purposes of the choice modelling. A reasonable relationship was found between GLA and employment with an R square value of 0.63.

5.5.3 Ownership and rent

Table 5.6 indicates that the majority of shops is rented (95 %) and not owned. In the CBD, all shops are rented, a small percentage of shops in high-income suburbs is owned, while a significant percentage of shops in low-income suburbs is owned. Renting floor space makes it easier for a retailer to move to another location, but this will of course depend on the period of the lease.

Table 5.7 gives the average rent per m^2 and the range. The average rent was R85 per m^2 per month, but rent varied considerably between R9 and R190 indicating the large variation in the quality and age of buildings and the quality of the micro location of the shops.

Table 5.6: Ownership of business premises

	Rent (%)	Own (%)
CBD	100	0
Sub High	97.5	2.5
Sub Low	87.5	12.5
Total	95	100

Table 5.7: Average rent per m^2 per month

	Rent (R per m^2 per month)	Range (min – max)	Sample
CBD	65	9 – 190	31
Sub High	93	11 – 160	36
Sub Low	38	11 – 100	27
Total	85	9 - 190	94

There are significant differences between the different locations, with high-income suburbs indicating an average rent of approximately 40 per cent higher than the CBD, while the average rent in the CBD is 70 per cent higher than in the low-income suburbs. The highest individual rent was reported by a CBD retail manager. These significant differences in average rent reflect the general higher quality of buildings and higher income potential of the high-income suburbs, compared to the other locations.

5.5.4 Locational mobility of businesses and causal factors

Table 5.8 indicates the average number of years that retail managers have traded at their current premises. Interestingly, the average number of years varies little between locations, with an average of approximately 6.6 years. However, the period individual retail managers have been at their current premises varies between less than 1 year and more than 20 years.

Table 5.8: Average number of years at current premises

	Years	**Range (min – max)**	**Sample**
CBD	6.2	<1 to >20	35
Sub High	6.7	<1 to >20	34
Sub Low	6.8	<1 to >20	36
Total	6.6	<1 to >20	105

Examination of the frequency distributions indicate that the highest proportion occurs at less than 2 years for CBD and low-income suburb businesses, while it occurs between 2 and 4 years for high-income suburb businesses. Surprisingly, more suburban businesses remained at the current premises for more than 20 years (12 to 17 %) compared to CBD businesses (3 %). This indicates a higher turnover of CBD businesses.

Table 5.9 shows that most retail managers (84 %) had remained at the same premises since the start of their business, while 11 per cent relocated from other suburbs, and 5 percent from the CBD. CBD shops which relocated, all came from other CBD locations (7.5%). No business therefore moved from the suburbs to the CBD.

High-income suburb businesses which relocated, mostly came from other suburb locations (18 %), and only 5 per cent from the CBD. Shops in the low-income suburbs show a similar trend to the high-income suburbs, with 15 per cent coming from other suburbs and only 3 per cent from the CBD. Suburban shops are therefore much more mobile (between 17 and 23 %) than CBD shops.

An important conclusion is that there is not a major relocation of shops from the CBD to the suburbs, but rather that the higher growth of retail activities in the suburbs compared to the CBD, comes mainly from new businesses. This also confirms the findings of the Pretoria mobility study (Cameron, Van Zyl, Naude and Loubser, 1991).

In general, businesses are fairly immobile and prefer to stay at the same location, but if they relocate, they would mostly stay within their current area whether it is the CBD or the suburbs. This is consistent with the notion that retail managers cater for specific markets in either the CBD or the suburbs.

Table 5.9: Previous location

	Always here (%)	**CBD (%)**	**Other suburb (%)**	**Total (%)**
CBD	92.5	7.5	0	100
Sub High	77.5	5.0	17.5	100
Sub Low	82.5	2.5	15	100
Total	84	5	11	100

When retail managers were asked whether they would choose the same location again if they had the choice, most (77 %) indicated "yes", as indicated in Table 5.10. However, significantly less CBD businesses indicated that they would choose the same location again (65 %), while low-income suburb businesses were the most positive about their current location. This implies that the potential demand for relocation is quite high among CBD businesses (35 %), while it is in the order of 12 to 22 per cent among suburban businesses. Various constraints, such as lease, the cost of relocation and the uncertainty of change, prevent businesses that are unsatisfied with their current location from relocating.

To explore the interaction between the age of the firm at the current premises and the mobility of the firm as indicated by those who previously relocated, businesses were categorised as *Young* or *Old*, with 5 years at the current premises as cut-off point, and also as *Movers* (those who previously relocated) or *Stayers* (those who have always been at the current premises).

Table 5.10: Preference for current location

	Prefer current location (%)	**Sample**
CBD	65	40
Sub High	78	40
Sub Low	88	40
Total	77	120

No significant differences between these groups were found. Of the *Young* businesses, 17 per cent were *Movers*, which is only slightly more than for *Old* firms.

For the *Movers,* the split between *Young* and *Old* was similar (50 %), while the same split was indicated for the *Stayers*. The average number of years at the current location was also similar for both *Stayers* and *Movers,* i.e. 6.6 years.

Mobile businesses are therefore not younger, neither are young firms more mobile.

Other factors, such as practical constraints or market conditions, therefore play a predominant role.

Reasons for relocating and for choosing current location

The respondents who indicated that they had moved from another location, gave the following reasons for their relocation:

- Market potential higher here compared to previous location (48 %):
    - More customers.
    - Improved business in low-income market.
- Centre or building better than previous location (26 %):
    - Moved from street front to centre.
    - Luxury centre, bigger centre.
- Location better, closer to customers (26 %):
    - Conveniently situated.
    - Closer to home, better position in town.
    - Most customers here.

Approximately 50 per cent of the reasons related to the market potential, while the nature of the retail accommodation (building or centre) and the location relative to customers, accounted for the other 50 per cent. If one interprets the move to better market potential as better access to a larger market, then accessibility played a predominant role in the decision of retail managers to relocate.

Respondents were also asked for reasons for their responses, summarised in Table 5.13, when they indicated that they would either choose, or not choose, their current location again.

In total 39 reasons were coded for respondents who gave a positive response, and 17 for those who gave a negative response. These reasons were subsequently recoded into a few main categories, and are summarised below.

Reasons in support of the current location in rank order of frequency for total sample were:

- Most respondents (45 %) indicated that business was good at the current location. This was also the reason most frequently reported by CBD and suburban businesses (42 to 47 %).

  Typical reasons were:

  ✓ Have enough clients; High turnover; Steady growth.

- The second most frequent reason was that the business was well established and that the area was familiar (19 %). This was also the second most frequent reason mentioned by CBD and low-income suburb businesses (19 – 24 %), and the third most frequent reason mentioned by high-income suburb businesses (16 %).

  Typical reasons were:

  ✓ Happy here; Well established; Will always have a branch in town.

  ✓ Established under Afrikaans clients; I know the area.

  ✓ Always been here.

- The third most frequent reason was that the shopping centre or location had good characteristics (18 %). This reason was also ranked third by low-income suburb businesses (13 %), but was ranked second by high-income suburb businesses (26 %). However, CBD businesses ranked this reason fourth (13 %).

  Typical reasons were:

  ✓ Upmarket centre; Benefits from advertising by specialist chain shops.

  ✓ Popular centre; Location safe; Shopping mix attracts customers.

  ✓ Water Front good for business; Big centre; Offices nearby.

  ✓ Centre well positioned; Only shop of its kind.

- The fourth most frequent reason was good access to clients and passers by (7 %). This reason was more prominent in the CBD (16 %), ranking third highest, while only a small percentage of suburban businesses mentioned this (3 %).

Typical reasons were:

✓ Central position in the centre; Close proximity to clients.

✓ Good passing-by trade.

- Access to transport was ranked fifth (5 %). The basis of this reason was that transport termini generated passing trade. This was surprisingly mentioned more frequently by high-income suburb businesses (8 %), than by CBD and low-income suburb businesses (3 %).

  Typical reasons were:

  ✓ Good location – close to station (mentioned by CBD and high-income suburb businesses).

  ✓ Close to taxi terminal (mentioned by low-income suburb business).

- A few low-income suburb businesses (5 %) mentioned that the cost of relocation was too high, or that the rent at the current location was more affordable than elsewhere.

- A few businesses said that they were not sure or that it depended on a lot of issues. One mentioned that he would stay provided the centre was upgraded.

Reasons against current location in rank order of frequency for total sample were:

- Most respondents indicated that business was poor at the current location (45 %). This was the predominant reason for the CBD businesses (57 %), while considerably less suburban businesses gave this reason (33 %).

  Typical reasons were:

  X Not enough clients; Business decreased; Bad centre - very quiet.

  X Too far from main centre – not enough traffic.

- The second most frequent reason was that business was better elsewhere (21%). This was only mentioned by CBD (21%) and high-income suburb businesses (33%). Low-income suburb businesses did not mention this at all, possibly due to the fact that they felt captive to the current location.

  Typical reasons were:

  X Move to Tyger Valley – clients have higher income.

  X Prefer to be more in centre of town; Prefer to be in Water Front.

  X Clients are from Tygerberg area; Market shifted to big centres.

- Problems with the centre was the third most frequently mentioned reason (14 %). Again, this was only mentioned by CBD (14 %) and high-income suburb businesses (22 %).

  Typical reasons were:

  X Escalator removed at front of centre; Manager not interested in tenants.

  X Area became third world; Flea markets and hawkers uncontrolled.

- High rentals ranked fourth (10 %). This was the second most frequent reason mentioned by low-income suburb businesses (33 %), and the fourth most frequent reason mentioned by CBD businesses (7 %).

- Strong competition from too many similar shops (7 %) was only mentioned by high and low-income suburb businesses.

- Finally, one low-income suburb business mentioned that he would like to open another shop.

5.5.5 Accessibility and parking

Table 5.11 gives the percentage of businesses where customers have to pay for parking. The customers of the majority of CBD businesses (78 %) have to pay for parking, while only a small percentage of the customers of high-income suburb businesses (13 %) has to pay for parking. Customers of low-income suburb businesses do not pay for parking.

Table 5.11: Percentage of businesses where customers pay for parking

	Pay for parking (%)	Sample
CBD	78	40
Sub High	13	40
Sub Low	0	40
Total	31	120

Table 5.12 indicates the parking fees charged for the first hour for those businesses where parking is payable. Most respondents did not know the parking fees. It may be difficult for retail managers to report on parking fees in the CBD, but it may also indicate a lack of concern for their customers, or that parking fees are not regarded as very important. Of the reported parking fees, most customers pay between R2 and R3 per hour in the CBD, while customers of low-income suburb businesses pay R1 less i.e. between R1 and R2 per hour.

Table 5.12: Distribution of parking fees for first hour

	Don't know (%)	R1-R2 (%)	R2-R3 (%)	R5-R6 (%)	Sample
CBD	48	13	36	3	31 (100 %)
Sub High	60	40	0	0	5 (100 %)
Sub Low	0	0	0	0	0 (100 %)
Total	50	17	30	3	36 (100 %)

According to Table 5.13, more than 50 percent of customers search more than 5 minutes for parking in the CBD and high-income suburbs, compared to only a small percentage of customers in low-income suburbs searching for parking. Availability of parking in the CBD and high-income suburbs is therefore perceived to be a problem.

Most of the parking in the CBD is in covered parking garages, while most of the suburban parking is in open lots. On-street parking is also significant and more predominant in the suburbs.

Table 5.14 gives the percentage of businesses within 5 minutes of various transport facilities. Businesses in low-income suburbs have the best access to main roads (85%), followed by the CBD (58 %), while high-income suburb businesses have the least access to main roads (45 %). Access to train stations is fairly similar in all the areas, with between 30 and 38 per cent being close to a station. The suburb businesses have much better access to bus stops (83 – 90 %), compared to those in the CBD (40 %). This trend is the same for mini-bus taxis.

Table 5.13: Search time for parking and availability of different types of parking

	Parking search time More than 5 min. (%)	**Types of parking (%)**			**Sample**
		On street	**Open lot**	**Covered**	
CBD	55	17	36	47	40
Sub High	60	32	68	0	40
Sub Low	2	36	59	5	40
Total	73	27	54	19	120

Although the accessibility profile of this sample may be different to that of the full population, it is surprising that the accessibility of CBD businesses by road-based public transport is less than that of the suburban businesses. Businesses in the high-income suburbs are mostly dependent on car access, yet they also have very good access to all modes of public transport.

Low-income suburb businesses have the best access to all transport, although access to public transport is more important to them.

Table 5.14: Proportion of businesses close to transport facilities (less than 5 minutes)

	Close to main road (%)	Close to station (%)	Close to bus stop (%)	Close to taxi stop (%)	Sample
CBD	58	38	40	43	40
Sub High	45	30	90	93	40
Sub Low	85	33	83	90	40
Total	63	33	71	75	120

5.5.6 Importance ratings of locational factors

Introduction

This section describes the attitudinal section of the questionnaire and the analysis of the importance ratings of locational choice factors. The theory of multi-dimensional scaling techiniques was presented in Chapter 2.11.7. Market research among commuters in South Africa often made use of these attitudinal techniques and a successful methodology was developed over the years (Falk, 1978; Van der Reis and Lombard, 2001). The standardised technique was therefore adopted for this research.

The attitudinal section of the questionnaire requested importance ratings of factors that retail managers would consider when choosing the best location for their shop. The fifteen factors described in Table 5.15 were specified and respondents were requested to rate each factor on a 5-point scale from "Not important" to "Extremely important". The importance scale is also given in Table 5.15. The keywords in the Table are used as labels in the description of the results.

Table 5.15 Description and keywords of locational factors and importance ratings

FACTORS	KEYWORDS
Degree of traffic congestion on surrounding road network	*TRAFFIC CONGESTION*
Monthly rental for premises	*RENT*
Parking fees for customers	*PARKING FEE*
Size of shopping ccentre where shop is located	*SIZE OF CENTRE*
Distance of shop from freeway	*FREEWAY*
Distance of shop from major road arterial	*MAIN ROAD*
Availability of parking close to shop	*PARKING AVAILABILITY*
Proximity of shop to train station	*TRAIN*
Proximity of shop to suppliers	*SUPPLIERS*
Proximity of shop to other businesses	*OTHER BUSINESSES*
Degree of safety from crime in the area	*CRIME*
Aesthetical appeal of natural and built environment	*AESTHETICS*
Number and variety of shops and businesses in area	*SHOPPING MIX*
Proximity of shop to residential areas	*RESIDENTIAL AREAS*
Proximity of shop to large employment centres	*EMPLOYMENT CENTRES*
IMPORTANCE RATING SCALE	**KEYWORD**
Not important at all	*NOT*
Of little importance	*LITTLE*
Important	*IMPORTANT*
Very important	*VERY*
Extremely important	*EXTREMELY*

In order to obtain a zero reference point for the importance weights that are calculated, respondents were also asked to rate two of the factors on a scale from 1 to 10 in such a way that the sum of these ratings would equal 10. The two factors were chosen to represent the extremes of the importance scale. From the pilot survey and the Pretoria mobility survey (Cameron, Van Zyl, Naude and Loubser, 1991), it was decided that *SUPPLIERS* would be regarded as the least important, while *RENT* would be regarded as the most important. It was explained to respondents that should a person rate *RENT* as a 9 and *SUPPLIERS* as a 1, it would mean that *RENT* was nine times more important than *SUPPLIERS*.

Basic results

A Categorical Judgement Analysis (CJA) program was used to analyse the data. The program was developed locally by TRC Africa (1989) and it is based on the theory reviewed in Chapter 2.1.7. The program fits a normal distribution through the reported ratings and estimates the average importance intervals as well as the average importance weight of each factor relative to the intervals on a scale from 0 to 1 (Torgerson, 1958).

Figure 5.4 (graphs a to d) gives the importance weights of each factor on an importance scale, sorted from most important to least important, for four sample groups, i.e. the total sample, the CBD sample, the high-income suburb sample and the low-income suburb sample. The results typically indicate that the importance intervals are perceived to be unequal. The program provided output without any error messages, indicating that the ratings had sufficient variation and that the two pre-selected factors were indeed perceived to be at the low and high ends of the scale.

The sample as a whole did not regard one of the factors as unimportant. Two factors were regarded as extremely important, namely *CRIME* and *PARKING AVAILABILITY*. The weight of *CRIME* is, however, much higher than that of *PARKING*. Five factors were regarded as very important, i.e. *RENT, SIZE OF CENTRE, SHOPPING MIX, OTHER BUSINESSES* and *MAIN ROAD.* The three least important factors were *FREEWAY, TRAIN* and *SUPPLIERS.*

The CBD sample shows some similarity to the total sample, but also some differences. Again, none of the factors were unimportant. Three factors were regarded as extremely important, *i.e. CRIME, PARKING AVAILABILITY* and *SIZE OF CENTRE*, while three factors were very important, i.e. *RENT, AESTHETICS* and *SHOPPING MIX.* The three least important factors were *RESIDENTIAL, TRAIN* and *SUPPLIERS.*The high-income suburb sample regarded three factors as extremely important, i.e. *PARKING AVAILABILITY, RENT* and *CRIME*, while only one factor was regarded as very important namely, *SHOPPING MIX.*

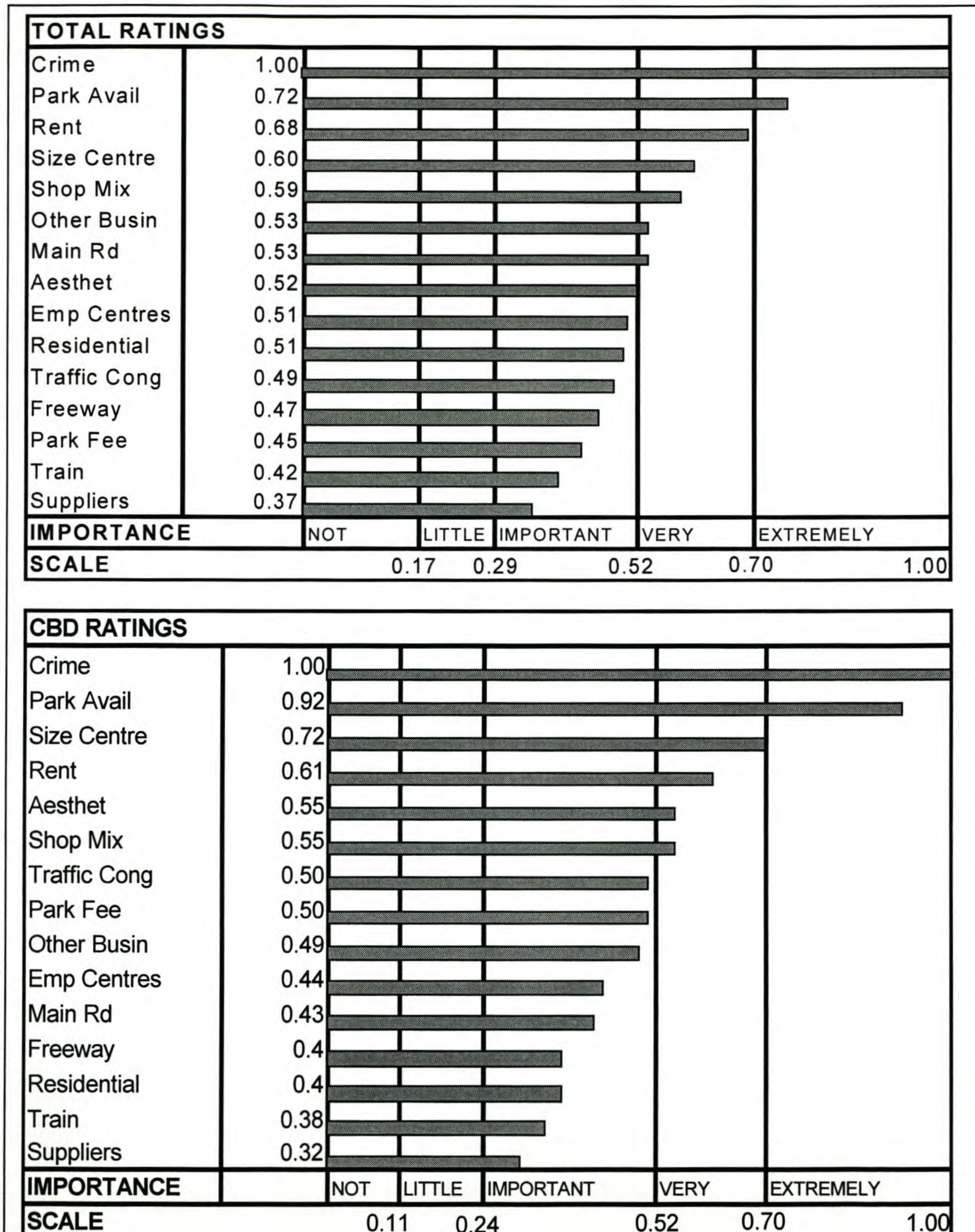


Figure 5.4a and b: Importance weights and ratings of locational factors for the total sample and the CBD sample.

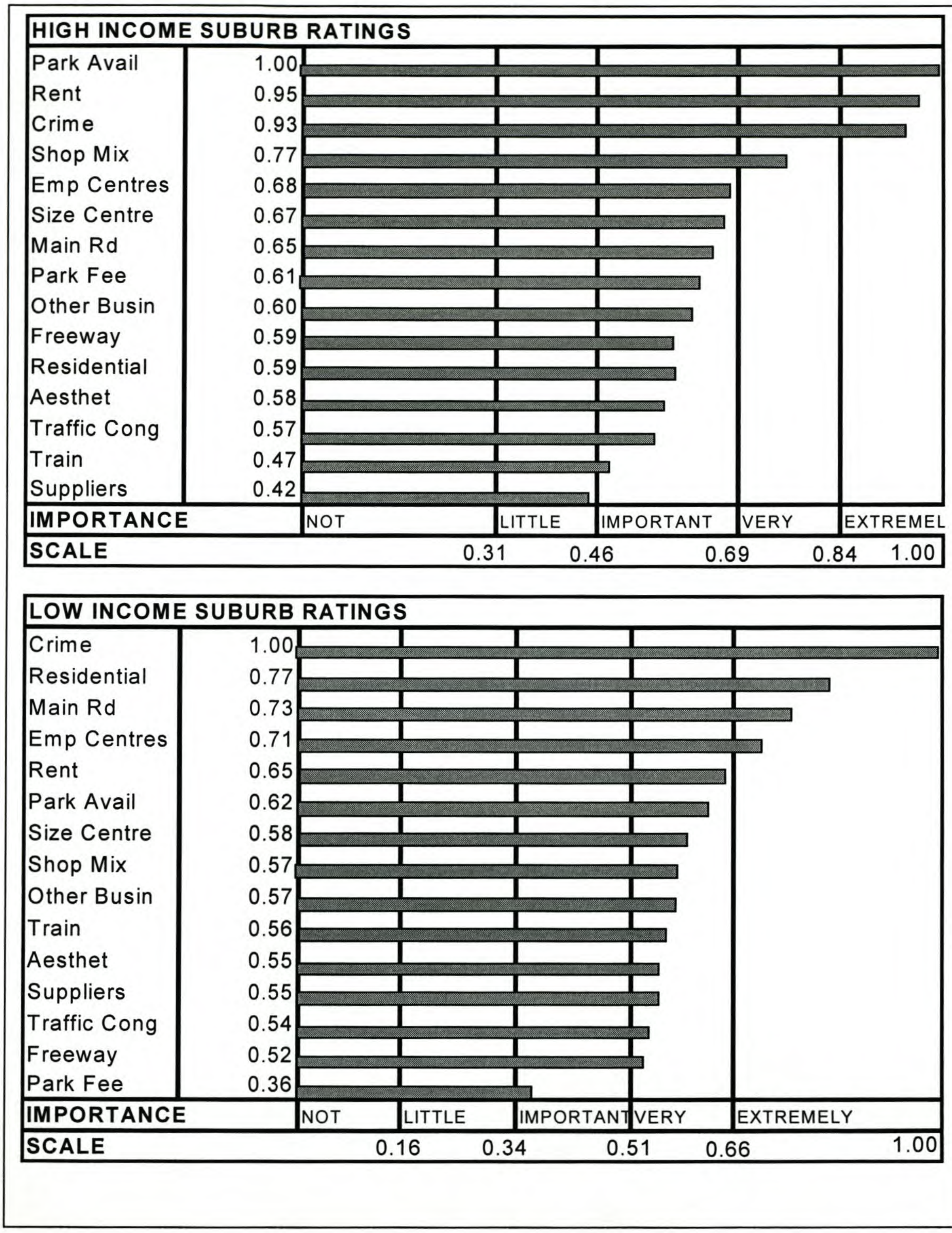


Figure 5.4 c and d: Importance weights and ratings of locational factors for the high-income suburb and low-income suburb sample.

The three factors at the top of the "important" interval were *EMPLOYMENT CENTRES, SIZE OF CENTRE* and *MAIN ROAD*. For this sample, one factor was regarded as of little importance, i.e. *SUPPLIERS*. The other two factors that were at the bottom of the scale were *TRAFFIC CONGESTION* and *TRAIN*.

The low-income suburb sample again indicated different ratings to the CBD and the high-income suburb sample. Four factors were regarded as extremely important, i.e. *CRIME, RESIDENTIAL, MAIN ROAD* and *EMPLOYMENT CENTRES*. Interestingly, all the other factors, except one, were regarded as very important. *RENT, PARKING AVAILABILITY* and *SIZE OF CENTRE* were at the top of the "very important" scale. *PARKING FEE* was the least important factor but was still regarded as important, while *TRAFFIC CONGESTION* and *FREEWAY* were also at the bottom of the scale, but were regarded as significantly more important than *PARKING FEE*.

Comparison of ratings between locations

In order to make comparisons between the CBD and the suburban samples, one needs to compare the rank order and importance intervals and not the weights. For example, a weight of 0.7 means "very important" on the high-income suburb scale, while it is "extremely important" on the low-income suburb scale.

Table 5.16 compares the rank order and importance rating of each factor for the three areas. The factors are given in terms of the rank order of the CBD as the reference case.

Table 5.16: Comparison of rank order and importance ratings of locational factors of three areas

	CBD		HIGH SUBURB		LOW SUBURB	
FACTORS	**RANK**	**RATING**	**RANK**	**RATING**	**RANK**	**RATING**
Crime	1	EXT	3	EXT	1	EXT
Park avail	2	EXT	1	EXT	6	VERY
Size centre	3	VERY	6	IMP	7	VERY
Rent	4	VERY	2	EXT	5	VERY
Aesthet	5	VERY	12	IMP	11	VERY
Shop mix	6	VERY	4	VERY	8	VERY
Traffic cong	7	IMP	13	IMP	13	VERY
Park fee	8	IMP	8	IMP	15	IMP
Other busin	9	IMP	9	IMP	9	VERY
Emp centres	10	IMP	5	IMP	4	EXT
Main rd	11	IMP	7	IMP	3	EXT
Freeway	12	IMP	10	IMP	14	VERY
Residential	13	IMP	11	IMP	2	EXT
Train	14	IMP	14	IMP	10	VERY
Suppliers	15	IMP	15	LIT	12	VERY

CRIME was rated extremely important in all the areas, and it was ranked first in the CBD and the low-income suburbs, and third in the high-income suburbs. The perception that crime is more of a problem in the CBD than in the suburbs is not supported by these attitudes. Crime is often reported in the media as one of the main reasons for decentralization, but these attitudes suggest that it is a serious problem in the suburbs as well. Its high rating indicates that perceived safety from crime is indeed one of the main factors for locational choice.

PARKING AVAILABILITY was also rated extremely important in the CBD and high-income suburbs, where businesses are obviously dependent on customers travelling by car. Parking was not regarded as important in the low-income suburbs where it was ranked sixth and rated very important, as customers in these areas are dependent on public transport.

It is surprising that *SIZE OF CENTRE* was rated so highly by CBD retail managers. It was ranked third and rated very important, as many shops in the CBD are street-front shops. However, the CBD sample included the Water Front and Golden Acre centres and these centres are also attracting many customers in the CBD. Size of shopping centre is also very important in the low-income suburbs, but less important in the high-income suburbs where it was only rated as important.

RENT is not the most important factor as expected, although rated among the top two to five factors. It was rated very important in both the CBD and low-income suburbs, but rated extremely important in high-income suburbs. The reported rents were much higher in the high-income suburbs, which may explain its higher rating by these retail managers.

AESTHETICS was rated very important in both the CBD and low-income suburbs, but only as important in high-income suburbs. In terms of rank order though, both suburban areas rated *AESTHETICS* fairly low, while it was rated much higher in the CBD. It seems that the CBD retail managers regard this as a problem, while the retail managers in the suburbs are satisfied with their environment and therefore do not regard this as important.

SHOPPING MIX was rated very important in all areas, although it was ranked higher in the high-income suburbs, and rated higher than the size of the centre.

TRAFFIC CONGESTION was rated more important in the low-income suburbs than in the CBD and high-income suburbs. This may be due to less road capacity and poorer infrastructure. However, congestion was ranked much higher in the CBD compared to the suburbs where it was ranked fairly low. Congestion is obviously more of a problem in the CBD.

Although *PARKING FEE* was rated similarly in all areas, it was ranked much higher in the CBD and the high-income suburbs where customers are dependent on car. In fact, *PARKING FEE* was ranked lowest in low-income suburbs. The fact that the latter reported zero parking fees, explains this.

OTHER BUSINESSES, which is an inherent characteristic of the CBD, was ranked the same in all areas, but was rated more important in low-income suburbs. Low-income suburbs have very limited business areas and the need for more business activity is therefore greater.

EMPLOYMENT CENTRES shows a similar trend, i.e. it was rated extremely important in low-income suburbs and only as important in the other areas. However, it was ranked much higher in both suburban areas compared to the CBD. Again, this seems to be expressing a need under suburban retail managers, while CBD retail managers is central to the largest employment area.

MAIN ROAD was rated the same in the CBD and high-income suburbs, but was rated extremely important in low-income suburbs. However, both suburban areas ranked this factor much higher than the CBD. The CBD is well served by a dense network of highly trafficked roads, and proximity to a main road is therefore not a problem in the CBD. Access to a main road is obviously a greater need in the suburban areas.

FREEWAY was ranked low in all areas, although it was rated higher in low-income suburbs. Historically, townships in South Africa were not given good access to passing freeways, and this seems to be a perceived problem in Cape Town as well. In general, local authorities have recently made a concerted effort to provide interchanges to serve low-income areas.

One of the major differences between the responses in low-income suburbs and the other areas, was the rating of *RESIDENTIAL AREAS*. It was rated extremely important and ranked second in low-income suburbs, while it was ranked very low in the CBD and high-income suburbs. It is plausible that this factor was ranked low by the CBD retail managers as their main market is office workers and visitors. Unexpectedly, retail managers in high-income suburbs ranked proximity to employment centres much higher than proximity to residential areas. The reason is probably that they did not perceive proximity to residential areas as a problem, as they were already central to residential areas. Retail managers in the low-income suburbs apparently did not base their ratings on problems experienced, but on the need to be in close proximity to their market. This is plausible as their customers are not very mobile and often need to walk to the shops. Being within walking distance from residential areas, is therefore crucial to their very existence.

TRAIN was ranked low in all areas, although it was rated higher in low-income areas. The CBD is well served by train, and according to reported results, even the suburbs are served by train, while high-income suburb businesses are not dependent on train transport.

SUPPLIERS was ranked very low in all areas, although it was rated more important in the low-income suburbs and the CBD. Retail managers in high-income suburbs rated this as of little importance.

To summarise:

- Fourteen of the fifteen factors were rated as important to varying degrees, from important to extremely important, while only *SUPPLIERS was* rated as of little importance in high-income suburbs;
- Four factors were rated in all areas as either very or extremely important, namely *CRIME*, *PARKING AVAILABILITY*, *RENT* and *SHOPPING MIX*. These factors should therefore be given special attention in any spatial policy regardless of whether it relates to the CBD or the suburbs;
- Actions against crime should be the top priority in all areas, as neglect in one area will lead to shifts from high crime to low crime areas, and these shifts may jeopardize any desirable spatial policy. In addition, high crime rates also impact negatively on the economic growth of the city as a whole.
- In view of the top seven most important factors, the factors that need most attention in spatial policies for each area, are the following:
  - ✓ CBD: *AESTHETICS*, *SIZE OF CENTRE*, *TRAFFIC CONGESTION* and *PARKING FEE*.
  - ✓ High-income suburbs: *EMPLOYMENT CENTRES*, *SIZE OF CENTRE* and *MAIN ROAD*.

- ✓ Low-income suburbs: *MAIN ROAD*, *RESIDENTIAL AREAS*, *EMPLOYMENT CENTRE* and *SIZE OF CENTRE*.

- Low-income suburbs have an overall lack of infrastructure and economic base, and all aspects need special attention to meet the needs of retail managers and their customers, who have limited mobility.
- In terms of the role of transport, provision of parking plays the dominant role for understandable reasons, while traffic congestion and parking fees in the CBD, and access to main roads in the suburbs, also play a significant role.

The practical implications of these results in terms of land-use transport policy are discussed in Chapter 7.

5.5.7 Profile of retail in Cape Town from empirical evidence

Introduction

Information on the retail sector in Cape Town from secondary data sources was useful for the following purposes:

- To relate the profile of the retail survey sample to the profile of the full population of the retail industry in Cape Town.
- To establish the level of decentralization of retail in Cape Town in order to apply the locational choice model to a realistic distribution of retail activities.
- To confirm the values for the independent variables impacting on locational choice for use in the application of the locational model.

The level of decentralization in Cape Town, the distribution of new shopping centres, the average rent of retail space, and parking supply in the CBD, will be discussed in this section.

Level of decentralization in Cape Town

The following data sources provided information on floor area, from which a rough estimate of the actual level of retail decentralization in Cape Town could be made:

- SA Property Owners Association Data Base (SAPOA,2000)

- Cape Town CBD Retail Study (City Council of Cape Town,1987)
- Retail sample survey (1995)

The SAPOA data base provided only information on 25 large shopping centres, while the City Council's CBD survey provided a comprehensive record of all retail outlets in the city bowl. Assumptions were made on small shopping centres in the suburbs, and street-front shops. The assumptions were:

- GLA of small shopping centres (< 10 000 m^2 GLA) is 10 per cent of that of large centres.
- Some 23 activity nodes were identified and it was assumed that street-front GLA varied between 25 000 and 50 000 m^2 per node.

Table 5.17 gives the distribution of floor area in the CBD and the suburbs. If the CBD is defined as the city bowl only, the level of decentralization is 76 per cent. If a broader definition (such as the one used in this study) that includes the Water Front, Sea Point and Green Point as part of the central area is used, the decentralization is 71 per cent. The assumption about street-front shops has a substantial impact on the results, and a current study by the CMC to estimate the land area of activity nodes, will provide a more accurate estimate. At the time of producing this dissertation, these results were not yet available.

Table 5.17: Distribution of retail floor area in the CBD and the suburbs

Retail type and area	**GLA (m^2)**	**Proportion (%)**
CBD city bowl (Retail study, 1987)	492 000	24.3
Water Front	45 000	2.2
Sea Point/ Green Point (estimate)	50 000	2.5
CBD Sub-total	**587 267**	**29.0**
Suburbs:		
Large recorded centres (> 10 00 m^2)	719 326	35.5
Small unknown centres (estimate 10 % of recorded)	71 933	3.5
Street-front shops (estimate)	650 000	32.0
Suburb Sub-total	1 441 259	**71.0**
TOTAL	**2 028 526**	**100**

The Cape Town Metropolitan Council's transport model data base provided another rough estimate of decentralization (Naude, 1991). According to the estimated commercial employment in 2000 by traffic zone, the following distribution of employment was obtained:

- Central area (including Sea Point): 21 per cent
- High-income suburbs: 73 per cent
- Low-income suburbs: 6 per cent

Based on the broader definition of the CBD, the Emme/2 model's data base gave a somewhat higher estimate of decentralization of 79 per cent, compared to 71 per cent based on floor area. Both methods indicate, however, that decentralization has reached a high level in Cape Town.

Distribution of new shopping centres in Cape Town

Information on the distribution of shopping centres and rent was obtained from the following Rode's data sources:

- Rode's quarterly retail survey (Rode's Retail Report,1998-2001).
- Rode's report on the property market (1998).

Rode classifies shopping centres into the following three classes and the same classification was adopted for this study:

- Regional: larger than 30 000 m^2 (more than 40 shops)
- Community: 10 000 to 30 000 m^2 (30 to 60 shops)
- Neighbourhood: 5 000 to 10 000 m^2 (15 to 40 shops)

Table 5.18 gives the distribution of new and refurbished shopping centres in Cape Town according to type of centre and location in 1994. There was a total of 208 546 m^2 of retail floor area under construction, being planned, or being refurbished. Forty three per cent of this was in new centres. The majority of the centres was medium to large, either community or neighbourhood. Most of the centres were in the suburbs. The 13 per cent new centres in the CBD included the Water Front Centre. This increased the share of the CBD above the normal trend. In terms of the modern trend of building centres, the level of decentralization of 87 per cent for new centres is much higher than the existing total level of decentralization of 71 to 79 per cent. The trend is therefore clearly towards increased decentralization.

Table 5.18: Distribution of new and refurbished shopping centres in 1994

Type / Location	GLA (m^2)	%
Neighbourhood	9546	4.6
Community	96400	46.2
Regional	102600	49.2
New/Planned	90146	43.2
Refurbished	118400	56.8
CBD	28000	13.4
Sub	180546	86.6
TOTAL	**208546**	**100**

Average rent of retail space

Rode publishes the rents reported by property owners according to the main criteria affecting the rent. The criteria are:

- Area
- Size of shop (50, 100, 500 m^2)
- Floor in centre (basement, ground, etc)
- Centre or street-front

The rent varies considerably according to the above criteria. Unfortunately, it is not possible to calculate a weighted average rent according to the actual supply of floor area according to the different rent classes, as these are not reported.

The average rent in 1994 across all classes for various locations per month per m^2 GLA was as follows:

Centres:

- CBD: R47
- Suburbs: R47

Street-front:

- CBD: R41
- Suburbs: R37

Assuming an equal supply across all rent classes, there is no difference between the CBD and the suburbs for centres, and only a slight difference between these areas for street-front shops. The greater popularity of centres is reflected in the somewhat higher rents of centres. These rents reflect best location, while other factors such as the specific location, age and condition of building, as well as the distribution of supply amongst these, are not reflected in the above-mentioned average rents.

When the average rent obtained in the sample survey is compared with the distribution of listed rents from Rode, it is evident that:

- The CBD sample rent was on the high side of the listed CBD rents (80 to 90 percentile).
- The rent in high-income suburbs was even higher, compared to the listed suburb rents (> 90 percentile).
- The rent in low-income suburbs was on the low side of the listed suburb rents (30 to 40 percentile).

The lack of information on the supply of floor space by rent class, makes it very difficult to make a reliable conclusion about the distribution of rent from the sample, compared to the actual population. Rode's listed rents gave very few rents in low-income suburbs and it was therefore also not possible to compare low and high-income suburbs.

<u>Parking supply in the CBD</u>

The former Cape Town City Council conducted an extensive parking study in the CBD in 1994 (Cape Town City Council, 1994). The following information relates to short and medium-stay parking typically used by shoppers and visitors. Table 5.19

gives the supply and parking fees of various types of short-term parking. There is a good balance of formal parking, but on-street unmarked parking constitutes the largest proportion. The parking fees correlate very well with those reported by the CBD retail managers.

Table 5.19: Supply and cost of CBD parking (1994)

Type of parking	No of bays	%	Fee (R/hr)
Public covered	1450	17.2	
Pay and display	1670	19.8	R2.60
On-street metered	1619	19.2	R0.90-R1.50
On-street marked	969	11.5	
On-street unmarked, unmetered	2745	32.5	
TOTAL	8453	100	

More than 70 per cent of the parking users indicated that they parked within 5 minutes walking time from their destination, while 22 per cent had to walk for 5 to 10 minutes, and 6 per cent for more than 10 minutes.

Between 40 and 60 per cent of the parking users occupied the parking space for two hours or less, while 8 to 23 per cent stayed for more than 3 hours. The 85-percentile duration of parking of four popular off-street parking lots varied between 3 to 4 hours and 6 to 7 hours.

Although 80 per cent of the on-street parking users stayed for less than the one hour legal limit, those staying longer than the legal limit accounted for the 57 per cent of the total bay-hours. For most of the average working day, 90 per cent of on-street parking was occupied. This is much higher than the international norm of 85 per cent. Meter-feeding of on-street parking was also frequently observed.

The report identified the long duration and high occupancy of short-term parking by workers to the detriment of short-term parking users, as a severe problem. The report formulated various supply and pricing policies to reduce all-day parking in the

CBD, to encourage the use of public transport by means of levies and higher fees for long-term parking, and to provide adequate short-term parking.

The high occupancy and long duration of short-term parking supports the perceptions of the sample of CBD retail managers that a significant proportion of shoppers search for more than 5 minutes for parking. The parking problems also explain the high importance that CBD retail managers attached to parking.

5.6 CONCLUSIONS AND RECOMMENDATIONS

In this chapter market research involving personal interviews with a stratified sample of 120 retail managers that was conducted to characterise CBD and suburban retail businesses, was discussed. The survey quantified the factors that influenced locational choice and determined retail managers' attitudes towards the importance of the factors. A stated preference experiment was also conducted to calibrate a discrete locational choice model. Empirical evidence from secondary data sources was summarised to contextualise the sample survey.

The following conclusions are drawn from the sample survey and secondary data sources:

- *The results indicated significant differences in the profile and attitudes of retail businesses in the CBD, low-income and high-income suburbs.*
- *Although the sample was too small to be statistically representative of the total retail population, the profile of the sample helped to interpret the attitudinal and stated preference results.*
- *The CBD sample displayed a higher proportion of appliance and clothing businesses, the high-income suburb sample displayed a higher proportion of speciality goods shops, while the low-income suburb sample displayed a higher proportion of grocery and FMCG businesses. The size of the businesses in terms of retail area and number of employees ranged widely, with the low-income suburb businesses being somewhat larger, on average, than the CBD and high-income suburb businesses, due to the different types of retail activity.*

- *The vast majority of retail accommodation was rented rather than owned, although a significant proportion of low-income suburb accommodation was owned. The average rent differed widely between the locations, with the high-income suburb businesses paying much higher rent than the CBD retail managers, who in turn paid higher rent than the low-income suburb businesses did.*
- *Retail businesses were found to be fairly immobile with only a small proportion that relocated. CBD businesses indicated a higher turnover than suburban businesses. The different locations displayed the same average age, with no significant interaction between the age of the business at the current location and the level of mobility of the business. Businesses relocated mostly within CBD locations or within suburb locations, with a small proportion relocating from the CBD to the suburbs. These results indicated that decentralization was mostly driven by new businesses locating in the suburbs rather than existing businesses relocating to the suburbs.*
- *The reasons for relocating were mostly related to improved market potential, characteristics of the location and access to customers. Accessibility to the market, therefore, played a major role.*
- *Reasons in support of, or against retail managers' current locations, related to business conditions, established customers and familiarity with the location, the nature of the location, access to clients and to transport, rent and cost of relocation and competition from other businesses. Poor business conditions and access to customers and passers-by featured more prominently amongt CBD retail managers, while rent and cost factors featured more prominently among low-income suburb businesses.*
- *Most customers of CBD businesses paid for parking while most customers of suburban businesses did not have to pay, and parking in the low-income suburbs was free. Parking in the CBD was also more expensive than in the suburbs. CBD parking was mostly covered and open lot, while suburb parking was mostly street-front and open lot.*
- *Access to the main road network was regarded as better by low-income suburb retail managers, followed by the CBD, with high-income suburb retail managers*

reporting the poorest access. Access to train was good and similar in all locations. Access to bus and taxi stops was regarded as better by suburban retail managers than by CBD retail managers.

- *Four factors were rated by retail managers in all areas as either very or extremely important, i.e. CRIME, PARKING AVAILABILITY, RENT and SHOPPING MIX. These factors should therefore receive special attention in any spatial policy regardless of whether it relates to the CBD or the suburbs.*
- *Actions against crime should be the top priority in all areas, as neglect in one area will lead to shifts from high crime to low crime areas, and these shifts may jeopardize any desirable spatial policy. In addition, high crime rates also impact negatively on the economic growth of the city as a whole.*
- *In view of the top seven most important factors, the following factors need most attention in spatial policies for each area:*
    - *CBD: AESTHETICS, SIZE OF CENTRE, TRAFFIC CONGESTION and PARKING FEE.*
    - *High-income suburbs: EMPLOYMENT CENTRES, SIZE OF CENTRE and MAIN ROAD.*
    - *Low-income suburbs: MAIN ROAD, RESIDENTIAL AREAS, EMPLOYMENT CENTRES and SIZE OF CENTRE.*
- *Low-income suburbs have an overall lack of infrastructure and economic base and all aspects need special attention to meet the needs of retail managers and their customers, who had limited mobility.*
- *In terms of the role of transport in locational choices, provision of parking plays the dominant role for understandable reasons, while traffic congestion and parking fees in the CBD, and access to main roads in the suburbs, also play a significant role.*
- *The low importance of rail access implies that rail development as a policy to attract businesses will not be successful. This confirms the international experience that rail projects are generally not successful to promote densification, unless coupled with strong land-use control.*
- *An investigation of secondary data sources found that spatial retail data were virtually non-existent showing the little attention that attractors of transport receive as opposed to the generators of transport. The integrated business data*

base that Statistics SA is busy developing is an important step in addressing a proper sampling frame for surveys of economic activity.

- *The actual level of decentralization in Cape Town was estimated to be in the order of 71 to 79 per cent. According to the size of the retail area that was under construction or planned, decentralization in terms of supply was increasing at a high rate with 87 per cent located in the suburbs.*
- *The higher quality and market potential of shopping centres, as opposed to street-front shops, are evident from the prevailing higher average rent in centres. Average rent differed little between the CBD and the suburbs for each type of retail area, but the higher proportion of street-front shops in the CBD implied lower average rents in the CBD.*
- *The high utilisation and incidence of illegal occupation of short-term parking space by long-term parking users in Cape Town motivated the CMC to formulate a parking supply and pricing policy that will make more parking space available for shoppers and other short-term parking users.*

The following recommendations are made:

- *The most crucial issue that authorities at all spheres must address is to provide a proper data base of spatial economic activities and locational patterns similar to that of the residential component. Economic activities play an equally important role in the shaping of the urban structure and travel patterns. A five-year random sample survey coinciding with the population census and the home interview surveys, and annual monitoring of key parameters, are recommended. Monitoring the supply of and demand for retail space, as well as the main locational factors driving demand, is important.*
- *The retail sample survey and other empirical evidence provide a wealth of information for authorities and other stake holders to start formulating strategies to revitalise CBD's and to manage decentralization pro-actively.*
- *The highest priority of metropolitan authorities to address suburbanisation should be to address crime, manage hawkers and clean the environment in the CBD. This can only be done in partnership by public and private stakeholders. Unless authorities can come to grips with these factors, any attention to the normal suburbanisation forces will be fruitless.*

6. CALIBRATION OF LOCATIONAL CHOICE MODELS AND ELASTICITIES OF CHOICE FACTORS

6.1 INTRODUCTION

In this chapter all aspects of the SP survey and model calibration are described, including:

- strategic SP design considerations relating to spatial choices;
- the design and testing of the SP experiment;
- data processing to prepare the input data format for the SP model calibration;
- calibration of the SP models including the calibration process and the various models calibrated;
- evaluation of the performance of the locational choice models in terms of statistical criteria;
- evaluation of the contribution of respondents' attitudes in terms of importance ratings of their SP choices;
- elasticities of demand for CBD and suburban locations with respect to various choice factors; and
- conclusions regarding the performance of the locational choice model and its use for policy testing.

6.2 STRATEGIC SP DESIGN CONSIDERATIONS RELATING TO SPATIAL CHOICES

The international review of issues to be considered in the design of spatial choice models indicated that such models are more complex than conventional travel choice models. Local and international trends in SP design recommend more simple designs as a general principle. The testing of the initial SP design for the Cape Town retail locational choice model confirmed the need for a more simple design. As the main objective was to obtain a feasible model and not to test various hypotheses regarding alternative designs, it was decided to keep the design as simple as possible subject to meeting the objectives set for the model. The main strategic design considerations are discussed below, while the detailed design specifications are discussed in the subsequent section.

Number of alternatives and feasible choice sets

Spatial choice sets or the number of alternatives to be modelled can be potentially large. Within the total choice set, the number of feasible alternatives that is available to any individual decision-maker can also be potentially large. However, the spatial choice context of the research to simulate the strategic choice of retail managers between the CBD and the suburb limited the number of alternatives to two (CBD versus suburb) or three (CBD, low-income suburb and high-income suburb). The size of the choice set was therefore not a problem.

The IAA problem also needs to be considered in large choice sets. This would be a consideration in the three alternative choice set. Possible solutions are the calibration of probit models instead of logit models, or the use of nested logit models. The literature review indicated mixed results in this regard. One residential location study reported similar results between a nested and a one level MNL model, while a retail choice model reported improved performance of the probit compared to the logit model. However, the logit model also performed well, and the calibration of the probit model indicated some instability in the calibration algorithm. A three alternative design was initially tested for the Cape Town retail research, but the two alternative design was finally selected for the main survey, which resolved the IIA problem.

Modelling of retail mobility

Studies of spatial choices in the residential location market distinguished between mobility choices and locational choices and the need to model both types of choices (see Chapter 2.12). The market research among Cape Town retail managers indicated that only a small percentage of retail managers relocated (11 per cent). The majority of locational choices therefore resulted from new retail outlets which were opened. These could have been either existing retail chain businesses that opened a new outlet, or a new business that was started. In view of the complexity of developing a retail mobility choice model and in view of the fact that it would only address a small proportion of the retail market, such an exercise would not be worthwhile.

The literature review in Chapter 2.10 indicated the choice processes of retail managers to expand and open new outlets. At a strategic level for metropolitan planning purposes it would be very difficult to develop a model that addresses the commercial factors of existing retail businesses to expand or new businesses to start up. The conventional approach of developing an economic growth model of the retail industry or a multi-sectoral input-output model, would be the best method of addressing retail mobility choices.

<u>The use of RP and SP data</u>

SP is the ideal survey method to overcome the problems related to the collection of reliable RP data from retail managers regarding their spatial choices, as a result of the infrequent nature of such choices. The market research among Cape Town retail managers indicated that the average length of stay of a business at a specific location was between 6 and 7 years. Locational choices by retail managers, which in the majority of cases are the result of the opening of new outlets, are therefore made only every 6 to 7 years. Retail managers would find it very difficult to remember details of choices made such a long time ago.

The literature review indicated the need for SP models to be scaled on RP data for forecasting purposes (see Chapter 2.11.3). A few spatial choice studies indicated good correlations between RP and SP models (see Chapter 2.12.2). The scaling methodology estimates a single factor, which is used to scale the SP coefficients. The scaling, therefore, does not affect the relative ratios between the elasticities of different factors.

Due to the problems associated with collecting RP data in the format required to calibrate a discrete choice model, this was not attempted during the Cape Town retail survey. However, information was obtained from retail managers on their actual locational choices, which included frequency of relocation, previous location, reasons for relocation, preference for current location, and importance ratings of locational choice factors. In view of these results, recommendations are made regarding further research needs relating to RP surveys for model calibration purposes.

Number of attributes

Trends in SP studies indicated an increasing emphasis on the importance of keeping SP designs simple by limiting the number of alternatives and the number of attributes. Local experience also regards this as a critical factor, especially among less-literate market segments (see Chapter 2.11 and Chapter 4). This was also an important consideration in the SP design for the Cape Town Retail survey. Important locational factors were therefore identified from previous studies as well as the pilot survey in order to limit the SP variables to the most important ones. In addition, the SP survey was supplemented by the importance ratings in order to determine the relative importance of a comprehensive list of factors.

Utility maximisation and constraint-based techniques

The question among urban planners on whether utility maximisation (compensatory) or constraint-based (non-compensatory) techniques best fit human choice-making behaviour, was investigated by a number of studies (see Chapter 2.12). The most comprehensive study compared these techniques as part of the development of an Activity Based Model (ABM) of short-term activity choices. The study indicated that the constraint-based model gave a somewhat better fit to the observed choices compared to the utility maximisation model. In terms of the more complex spatial choices, planners argued that decision-makers would resort to constraint-based choices, such as Elimination-by-Aspects (EBA), to simplify the decision-making task. However, one study on the location of freight facilities found only a marginal, insignificant improvement of the EBA model compared to the utility maximisation model.

The review of retail managers' spatial choice processes indicated the importance of maximising profit and market share, which would favour the utility maximisation approach. A comprehensive research study on the locational choices of retail managers in the Boston clothing sector found that a utility maximisation model gave a good fit to the observed choice data. Although SP surveys allow various model formats to be tested on the same data set, the calibration of the standard utility maximisation logit model was regarded as an adequate method to satisfy the main objective of the research, i.e to determine the elasticities of the locational choice factors. In the process, the performance of the utility maximisation model to simulate retail managers' spatial choices was tested. Further research on the best modelling technique would, however, be worthwhile to pursue and recommendations are made in this regard in view of the logit models' performance.

6.3 SP DESIGN SPECIFICATIONS

6.3.1 SP design process

In view of the complex choice environment in which the SP experiment had to be conducted, it was considered important to keep the experiment as simple as possible. This meant that the choice context and variables had to be formulated in simple and understandable terms.

To design the experiment it was important to have a clear picture of the objectives of the study, the choices that had to be modelled, and the target population of decision-makers whose choice behaviour had to be captured.

The design of the SP experiment consisted of the specification of the following parameters according to standard procedures, reviewed in literature.

- The choice context was derived from the main objective of the study: Various formats of presenting choices between CBD and suburban locations were considered and one format was tested in the pilot survey. As the choice context was quite different from the normal short-term travel choices found in literature, the pilot survey of the conventional part of the questionnaire was used to test the basic concept among retail managers. One design was tested based on factors reported in the NDOT mobility study (Cameron, Van Zyl, Naude and Loubser, 1991). The pilot test was only the starting point for the detailed design that followed.
- The number and type of variables describing each of the alternative locations are the most important consideration as these directly impact on the complexity of the experiment and number of choices. The initial set of variables was derived from the results of the NDOT mobility study in Pretoria (Cameron, Van Zyl,

Naude and Loubser, 1991). A comprehensive list of variables was compiled and importance ratings of these variables were obtained in the pilot survey. During the pilot test the respondents were also solicited to explain their most important criteria when evaluating alternative locations.

- The number and range of the levels of each variable also influence the number of total choices and it was therefore decided to opt for only two levels of each variable.
- The experimental design is generated by specifying independent combinations of the various levels of the variables. Orthogonal designs yielding between 8 and 16 choice scenarios or cards were considered. An orthogonal design combines the levels of the different attributes in such a way that there is no correlation between attributes.
- Testing the design: The pilot survey tested the initial design and important lessons were learned which changed the final design significantly. The final design was tested again during the initial stage of the main survey.

6.3.2 Testing the SP concept

The purpose of the pilot test among ten respondents in terms of the SP design was more qualitative than quantitative to get a feeling of how retail managers would respond to the SP experiment, and whether they would switch their choices between choice scenarios.

For the pilot test the experiment requested respondents to give a percentage probability, between 0 and 100 per cent, of choosing between the CBD, Belville and Nyanga. The respondents were recruited specifically in these areas. Respondents were briefed that the percentages allocated to each alternative for a specific choice scenario had to add up to 100 per cent.

The following variables were tested, each with two levels:

- Rent (R10 more or less than current rent).
- Size of suburban centre (community or regional).
- Time to find parking (2 or 10 minutes).

- Suburban centre on major or minor road.
- Time to public transport stop or station (2 or 10 minutes).

The fractional design yielded 16 choices per respondent, i.e. a sub-set of SP choice scenarios drawn from the total number of possible scenarios.

The results were disappointing as only four of the ten respondents varied their choices according to the changing levels in the variables. Another problem was that the percentages allocated to the different alternatives for a specific choice scenario did not add up to 100 per cent in a few cases. The concept of choice probability was therefore not always well understood.

The main reason for the inertia to change among the respondents was that the businesses served a dedicated market in either the suburbs or the CBD, i.e. the higher-income residents in Bellville or the lower-income residents in Nyanga. The Nyanga businesses, which were generally small, also felt that they would not be able to compete with larger high-income businesses in Bellville or the CBD. One of these businesses aspired to expand and then to move to the CBD.

The perception of the Bellville businesses was that the CBD was dying, overtraded, and unsafe. One person blamed the Water Front development for the decline in business in the CBD. They also felt that the Nyanga area was unsafe and that they would never consider moving there.

In view of the quality of the responses, it was clear that the number of choice scenarios was too many and that respondents found it difficult to allocate percentages.

Based on these results it was decided to reduce the number of choice scenarios, to request only discrete choices, and to reduce the alternatives to a binary choice between the CBD and the suburbs. Requesting respondents to indicate a specific choice instead of indicating a degree of preference for one or other alternative is a closer simulation of real life choices and it avoids the problems of the rating techniques (see Chapter 2.11). Experience indicated that simple binary choices (two alternatives) provided the best results (see Chapter 4). This also limited the number of choices and enabled more variables to be tested.

6.3.3 Specification of variables and levels, and choice context

Thirteen variables were identified in the NDOT mobility study (Cameron, Van Zyl, Naude and Loubser, 1991) as being important factors that determine locational choice. In the pilot survey, importance ratings were obtained on each factor in order to define the most important factors for the SP experiment. Table 6.1 lists these factors as well as other factors impacting on locational choice mentioned by the respondents in the pilot survey.

Categorical Judgement Analysis (CJA) was used to determine the average importance weight and semantic importance interval for each variable. The weights are given in Table 6.1. The variables that were rated as very to extremely important, were considered for inclusion in the SP experiment.

Apart from the importance weights of the various factors provided by the retail managers, the important factors identified in the literature review relating to suburbanisation were also considered in the selection of the factors. A balance between land-use and transport factors was also desirable in the experiment.

In view of the fact that only two of the ten respondents were from low-income suburbs, it was decided to weight the responses of the low-income suburbs to be equal to the high-income suburb sample. The rank order was surprisingly very similar with the top three and bottom five factors having the same rank order. Proximity of parking and environment were regarded as less important in the weighted sample compared to the original sample, while access to the main road and the number and variety of shops were regarded as more important.

Proximity to the market is an obvious factor that will always be very important and is therefore not a good policy variable to include in the SP experiment. Safety from crime is difficult to measure and needs to be addressed by authorities in any way. Safety was therefore also not useful to include.

Table 6.1: Variables tested in pilot survey and their importance weights (Sample size=10)

VARIABLE	Importance weight	Importance interval
Rent of shop	1.00	Extremely
Safety from crime	0.99	Extremely
Proximity to residential areas	0.88	Very
Parking available close to shop	0.87	Very
Appeal of built / natural environment	0.84	Very
Distance from freeway/main road	0.83	Very
Traffic congestion	0.83	Very
Number and variety of shops in area	0.82	Very
Proximity to other businesses	0.67	Important
Proximity to public transport facilities	0.63	Important
Parking fees	0.62	Important
Size of shopping centre	0.61	Important
Proximity to suppliers	0.45	Little
OTHER FACTORS		
Need to be close to customers in suburbs		
Need to be on main traffic routes/ on main road		
Suburb more safe, central to customers		
Need to be close to passing pedestrians – at work place		

The following five variables were subsequently selected for inclusion in the SP experiment. These variables were also identified in the literature review as important spatial choice factors in retail planning:

- Rent, rated as the most important factor, was an obvious choice in order to express other factors in terms of monetary values. This was measured in "Rent per month per square metre". Typical rents reported by respondents in the pilot survey as well as statistics published by Rode (1994) were used to obtain realistic rent levels.

- The size of shopping centres, rated as important, is a critical planning and design parameter of shopping centres and has major land, infrastructure and cost implications. Information on the size of shopping centres in Cape Town was used to determine the levels in terms of the "Number of shops in the centre". This variable was only specified for the suburb alternative.
- Availability of parking close to the shop, rated as very important, is also a critical factor in the planning of shopping centres and the supply of parking is also costly in terms of land and infrastructure. Access to parking would also serve as a measure of traffic congestion, which is an important policy factor to include. Although proximity to public transport facilities was regarded as of average importance, it was decided to combine this factor with access to parking in terms of walking time from parking space or from public transport. Access to the main road, rated as very important, is also a critical factor in transport and land-use planning and inclusion of this factor would allow quantification of the role of road in commercial development. This factor was formulated as "shop located on major road or minor road". In view of the fact that most shops in the CBD have good road access, this variable was only specified for the suburb alternative.
- Low- versus high-income suburbs was selected as the fifth SP variable in order to contrast various suburban locations. In terms of the examples of typical low- and high-income suburbs given to respondents, income was not the only dimension, but typical characteristics of low-income suburbs in the South African context such as a population consisting mostly of low-income residents, poor infrastructure, poor access, limited commercial development, and higher densities were also included.

The SP variables were specified in simple and understandable terms. The lower and upper limits of variables were also chosen to present a significant range to force respondents to make trade-offs.

Table 6.2 gives the levels of each of the five SP variables.

Table 6.2: SP Variables and Levels

SP Variable	CBD levels	Suburb levels
1. Rent per m^2 month	R10 less or R10 more than now	R10 less or R10 more than now
2. Walking time from parking or public transport	2 to 7 minutes	2 to 7 minutes
3. Number of shops in shopping centre	Not applicable	40 to 120
4. Shop on major or minor road	Not applicable	Minor or major road
5. Low or high-income suburb	Not applicable	Low or high-income

6.3.4 Experimental design

An experimental design software package, DESIGN-EASE, was used to generate orthogonal designs. (Software supplied by Stat-Ease Corporation, USA.) The experiment was designed to enable the estimation of separate coefficients for each variable related to each alternative as follows (keywords are given in brackets for reference purposes):

- Rent in the CBD (RENT CBD)
- Rent in the suburbs (RENT SUB)
- Walking time from parking or public transport in CBD (WALK CBD)
- Walking time from parking or public transport in suburbs (WALK SUB)
- Size of shopping centre in suburbs (SIZE OF CENTRE SUB)
- Road access: shop on major or minor road in suburbs (ROAD SUB)
- Low or high-income suburb (INCOME SUB)

The above seven variables, each with 2 levels, yielded 128 choices for a full factorial design, i.e. all possible combinations. (Number of choices = 2^7). The pilot test indicated that a partial factorial design of 16 choices per person introduces fatigue, and it was therefore decided to opt for a two-block design with 8 choices per respondent. This is a Resolution IV design which means that only main effects can be estimated, but independently from two-way interactions. All interactions are assumed to be negligible. Louviere (1988) found that main effects explain more than 80 per cent of the variance in the data. This result was also confirmed by the Soweto rail commuter SP study (SARCC, 1999)

A more complicated design, in which the low- and high-income suburbs would be presented as two alternatives, was also considered. This was discarded because it was not considered a viable option as the design yielded too many choices per person.

Table 6.3 gives the final design in random order. Two questionnaires were produced for the survey of which one contained the design of the first block and the other one the design of the second block. The questionnaires were labelled and mixed so that the designs were used in a random way.

Respondents were offered a simple binary choice between locating their business in the CBD or in the suburbs. A plausible reason for such a choice context was provided, i.e. the respondent had to assume that he needed to expand his business and therefore had to look for alternative premises. Specific examples of possible CBD and suburban locations were given.

The final SP design, as presented to respondents in the main survey, is included in Appendix A as part of the questionnaire.

The layout of the SP questions was simplified in comparison with the layout used in the pilot questionnaire. Only two choice scenarios were presented on an A4 page in the form of two show cards presenting each choice situation.

Table 6.3: Final experimental design of SP variables and levels

Choice	Block	Rent CBD	Rent sub	Walk CBD	Walk sub	Size centre sub	Road sub	Income sub
1	1	-10	10	2	7	40	Main	Low
2	1	10	10	2	2	120	Minor	Low
3	1	-10	-10	7	2	40	Minor	Low
4	1	10	-10	2	7	40	Minor	High
5	1	10	-10	7	7	120	Main	Low
6	1	-10	10	7	7	120	Minor	High
7	1	10	10	7	2	40	Main	High
8	1	-10	-10	2	2	120	Main	High
9	2	10	-10	2	2	40	Main	Low
10	2	-10	10	2	2	40	Minor	High
11	2	10	10	7	7	40	Minor	Low
12	2	10	-10	7	2	120	Minor	High
13	2	-10	-10	7	7	40	Main	High
14	2	10	10	2	7	120	Main	High
15	2	-10	-10	2	7	120	Minor	Low
16	2	-10	10	7	2	120	Main	Low

6.3.5 SP sample size

The financial resources rather than theoretical considerations restricted the sample size. The sample size did seem adequate in view of international experience that suggested sizes of 30 to 75 for each market segment.

The total sample of 120 was divided equally between the market segments of interest, i.e. CBD, low-income and high-income suburb retail managers, yielding a sample of 40 each. The sample size per segment was therefore adequate, although on the low side, while the sample was more than adequate if the retail sector in general was regarded as a single segment.

6.3.6 SP pilot survey

To make the most of the available budget it was decided to monitor the first 15 to 20 responses in the main survey carefully and to provide for a possible holding point if it was necessary to make any refinements. The responses were much better than in the pilot test and no further refinements were deemed necessary.

6.4 DATA PROCESSING FOR SP MODELS

Data format

The survey data in STATISTICA format had to be translated into a format acceptable to the ALOGIT calibration software. ALOGIT is a popular package used internationally for calibrating multinomial choice models and is supplied by the Hague Consulting Group in the Netherlands (HCG, 1995).

In order to prepare the data for input into ALOGIT, use was made of an EXCEL spreadsheet. The data was exported from STATISTICA into EXCEL format, and then manipulated in the spreadsheet into the required format. The ALOGIT package only reads data in ASCI format and therefore an ASCI text file was exported from the EXCEL file.

ALOGIT requires a data record for each choice situation, with each variable contained in a column field. The survey data, however, was captured so that each interview, including all the SP choices, was contained as a complete record in the data file. The relevant data selected for modelling, as well as the SP independent variables and locational choices for each of the 8 choice situations, or games, had to be written out as separate records. Each interview therefore yielded 8 records in the SP data file. The so-called Revealed Preference (RP) variables, describing the background data collected from each respondent, had to be duplicated for each of the 8 records for each respondent.

The values of the seven independent SP variables were not captured by the market research company as part of the raw data - only the SP choices for each game. The values from the design that were presented to the respondents, were therefore inserted afterwards into the spreadsheet data base.

Another complication was the two-block design. The SP values for Blocks 1 and 2 were captured in different fields in the survey data, although they referred to the same set of variables. The values of the SP variables were therefore combined into the same fields for each variable. The survey data contained the 8 SP choices for Block 1 as variables SP1 to SP8, while the 8 choices for Block 2 were contained in variables SP9 to SP16. These 16 variables were therefore all moved into one field, named CHOICE, in the spreadsheet.

The final SP data base consisted of 61 variables or fields, and 976 records. The data base contained two extra sets of SP choices because two respondents completed the choices for both Block 1 and 2. These two respondents therefore provided an additional 16 records for the SP data base. The 976 records therefore consisted of 8 times 122 choices.

<u>Data imputation</u>

Data imputation is not ideal, but it is better than ignoring records due to a few missing values. Data imputation was only necessary in the case of two variables, i.e. monthly rent and GLA. Some 21 per cent of the respondents did not provide the monthly rent, while 9 per cent did not provide the GLA of the shop.

The rent was estimated by assuming that the average rent of the relevant shopping centre, or the street-front shops in the area, would apply.

The GLA was estimated from a regression model relating GLA to the number of employees in the business. There was no missing data for the number of employees and therefore a good estimate could be obtained for the GLA. Equation 6.1 gives the regression model used in the estimation of missing GLA values. A reasonable fit of the model was obtained yielding an R-square value of 0.64.

$GLA = 35.4*(EMPTOT) + 9.1$ ....Eq. 6.1

Where: *GLA= Gross Leasable Area* (m^2)
EMPTOT = Total employment

6.5 CALIBRATION OF LOGIT CHOICE MODELS

Binary logit models were calibrated based on the choice of the CBD versus the suburb location as the dependent variable, and the various SP and RP variables that would potentially explain locational choice, as independent variables. The calibration of the SP models consisted of the following process:

Preparation of the data and model specification file for ALOGIT

The data fields were specified and allocated to variable names. The models were specified by indicating which independent variables should be included in the model, which variable indicated the locational choice, and labelling the coefficients for each variable, including the constants.

The ALOGIT program allows new variables to be calculated based on existing variables, and certain out-of-range values of variables to be excluded. The output indicates the average and the ranges of all input variables. This helps to identify any outliers. These can then be excluded from the calibration, or be corrected if possible.

Once the model specification file was prepared, it was easy to calibrate additional models by editing the model specification and running the program again.

Model calibration

The determination of the best set of models for policy-testing purposes, was very much an iterative process. The first model was specified to include all the possible independent variables. The output was checked for any outliers and for high correlation between variables. In subsequent models insignificant or problematic variables were excluded.

Evaluating the significance of variables and models

The goodness-of-fit criteria of logit models are well established and easy to interpret. There are essentially four standard criteria that need to be considered:

(i) As in the case of regression models, there should not be any high correlation between independent variables. This is typically a potential problem among RP variables, while SP variables should have no correlation as they are designed to be orthogonal.

(ii) The overall fit of the model is indicated by the Rho-square value relative to a model calibrated with only constants. This criterion compares the calibrated model with a model that will yield a split according to the market shares represented by the survey data. A Rho-square value of between 0.1 and 0.2 is acceptable, while a value higher than 0.2 is very good.

(iii) The sign of the coefficient of each independent variable needs to be plausible, i.e. a variable that has a negative impact on the share of an alternative must have a negative sign, such as the cost of the alternative, and *vice versa*. If a variable is significant and it has the wrong sign then there are probably errors in the data.

(iv) The significance of the variables is indicated by the t-statistic of the coefficients. If the t-value is greater than 1.96, it indicates that the probability that the coefficient is different to zero, is 95 per cent. A small t-value therefore indicates that the variable is not significantly different from zero and can be excluded from the model.

In the following section the calibrated models are reported and evaluated in terms of the goodness-of-fit criteria.

6.6 SP CALIBRATION RESULTS

6.6.1 Calibration process

The available variables allowed for the following categories of models to be calibrated:

- Various models were calibrated on the total data set by testing various RP variables to be included with the SP variables;
- Segmentation of the data in various ways allowed models to be calibrated for the CBD sample, the total suburban sample, the low- and high-income suburb samples, as well as for shops in centres and street-front shops;
- Models including the importance ratings of locational factors;

Treatment of inertia to change in the SP data

Analysis of the data indicated that a common phenomenon identified internationally and locally, namely inertia to change, was also present. This phenomenon was identified in the Durban and Cape Town low-income public transport SP surveys, especially among bus and taxi users who did not want to choose any train option (Van Zyl, Lombard and Lamprect, 2001). Research conducted as part of the SANPAD project to determine the performance of SP surveys among low-income commuters of various literacy levels, provided further insight into this problem (Arentze, et al, 2002). Some respondents indicated that they found it difficult to make choices based on hypothetical scenarios, and that they made choices according to their current experience.

When dealing with long-term choices such as business location, respondents may find it even more difficult to switch choices between alternative locations, compared to short-term mode choices.

Most of the non-switchers (respondents who chose either the suburb or the CBD for all scenarios) were from the low-income suburbs (50 per cent), although there was also a significant percentage non-switchers in the CBD (21 per cent) and the high-income suburb (29 per cent) samples. The non-switchers constituted 24 per cent of the total CBD sample, 35 per cent of the high-income sample, and 60 per cent of the low-income sample. Some 15 per cent of the non-switchers actually chose the alternative location in all the games, and not their current location. Unfortunately, this significant occurrence of non-switching reduced the performance of the models as indicated in the next section. Apart from the inertia to change inherent in business location choice, it seems the typical problems experienced in SP surveys among less-literate respondents, reported in the Durban and Cape Town studies, were also present here (van Zyl, Lombard, and Lamprecht, 2001).

The higher proportion of non-switching respondents in the suburban sample may also be an indication of the higher popularity of the suburban location compared to the CBD, which supports the other attitudinal results of the survey.

To deal with the "intertia to change" issue, models were calibrated with and without the non-switchers. Models were also calibrated with the respondents' current location as a variable to isolate the non-switching effect from other variables.

6.6.2 Calibration results of SP models

Presentation of calibration results

Tables 6.4a to c give the calibration statistics of the various models tested. The table gives the coefficient of each variable in the utility function used in the logit model, its t-value and its monetary value. The Rho-square value indicating the overall fit of the model, is also given. Each row in the table gives information for a specific model. The column headings in the table give the variable names, whether the variable was included in the utility function of the CBD or the suburbs, and the measurement unit of the variables. The row headings in the table give the segment of the data sample that was used for each model, as well as the sample size.

Alternative specific coefficients were specified in the model calibration. In other words, separate coefficients were specified for the CBD alternative and the suburb alternative to see whether the coefficients are different between the alternatives.

Some of the variables are indicated as dummy variables in Table 6.4. These variables were all specified as having a value of either one or zero. For example, CBD LOCATION assumes the value of one if the respondent is located in the CBD, and zero if he is not located in the CBD.

RP variables were entered by specifying them in either the CBD's utility function or the suburbs' utility function. As none of the RP variables was a unique feature of either the CBD or the suburbs, this choice was arbitrary, as the sign of the coefficient will merely change if the variable is switched between the utility functions.

The following RP variables were specified:

- CBD LOCATION: location of shop in CBD (dummy variable)
- SIZE OF SHOP: size in terms of GLA or employment
- CENTRE LOCATION: location of shop in shopping centre (dummy variable)
- Various product categories as defined in Table 5.2:
  - FMCG
  - APPLIANCES
  - CONVENIENCE
  - CLOTHES
  - SPECIALITY

Tables 6.4a and b give the results for the models calibrated on the total data set. The models in Table 6.4a all have the same basic specification, including all the SP variables, but they differ according to certain RP variables. Table 6.4b tests the significance of shop characteristics according to merchandise or product categories. Table 6.4c tests the differences between models calibrated for different retail segments according to existing geographic location, as well as location in centres versus free-standing shops.

Main models calibrated on total data set

Models 1 and 2 test the difference in specifying the size of the shop in terms of square metres or in terms of total employment. Both the models yielded acceptable Rho-square values of 0.16 to 0.17, although this is not ideal. All the SP variables are significant except for WALK SUB. The SP variables RENT SUB and INCOME SUB are highly significant with t-values between 7 and 8. SIZE OF SHOP SUB is significant in terms of employment, while it is less significant than 95 per cent in terms of physical size.

The application of the t-test indicated that there is no significant difference between the coefficients of the CBD and suburban walk-times at a level of 5%. However, it was decided to keep the two variables separate for the estimation of elasticities and for policy testing purposes.

The coefficients of models 1 and 2 have plausible signs with RENT, WALK and SIZE OF SHOP regarded as impacting negatively on the share of the location, while ROAD access, SIZE OF CENTRE and INCOME SUB are regarded as positive. CBD LOCATION is positive and highly significant showing the high inertia of retail managers to relocate.

The alternative specific constant (ASC) in models 1 and 2, which was attached to the suburbs' utility function, is not significant, but the small positive value indicates some inherent preference for the suburb.

Table 6.4a: Retail location model calibration results: models calibrated on total sample (significant coefficients are shaded)

User Segment Model No Sample Size (n)		Rent Suburb (R/ m² /mnth)	Walk Time CBD (mins)	Walk Time Suburb (mins)	Road Access Suburb (dummy-major/minor)	Size of Centre Suburb (no of shops)	Income of Area Suburb (dummy-high vs low)	CBD Location CDB (dummy	Size of Shop CBD (GLA- m²)	Size of Shop CBD (no employees)	Centre Location Suburb (dummy)	ASC Suburb	Log Likelihood	Rho-sq (Cons)
Total Sample	Coeff.	-0.0126	-0.062	-0.027	0.314	0.004	1.179	1.099	-0.0002			0.402	-552.00	0.16
Model 1	t-values	-8.1	-2.1	-0.9	2.1	2.1	7.9	7.1	-1.7			1.40		
n= 976	R values		R4.90	R2.14	-R24.92	-R0.29	-R93.57	-R87.22	R0.01					
Total Sample	Coeff.	-0.013	-0.062	-0.027	0.314	0.004	1.183	1.120		-0.011		0.360	-551.00	0.17
Model 2	t-values	-8.2	-2.1	-0.9	2.1	2.2	7.9	7.2		-2.3		1.3		
n = 976	R values		R4.91	R2.16	-R24.92	-R.31	-R93.89	-R88.89		R0.86				
Total Sample	Coeff.	-0.018	-0.064	-0.029	0.329	0.004	1.235	0.665		-0.011	1.28	-0.43	-531	0.20
Model 3	t-values	-9.70	-2.10	-1.00	2.20	2.20	8.00	3.90		-2.40	6.1	-1.40		
n = 976	R values		R3.60	R1.62	-R18.48	-R.23	-R69.38	-R37.36		R0.61	-R71.91			
Switchers only	Coeff.	-0.011	-0.096	-0.045	0.479	0.006	1.794	0.035		-0.006	0.527	-1.405	-337.00	0.18
Model 4	t-values	-5.2	-2.5	-1.2	2.5	2.6	9.3	0.2		-1.1	2.0	-3.5		
n = 592	R values		R8.42	R3.95	-R42.02	-R0.54	-R157.37	-R3.07		R0.48	-R46.23			

Table 6.4b: Retail location model calibration results: model 2 including various product categories

User Segment Model No Sample Size (n)		Rent Suburb (R/ m^2 / month	Walk time CBD (mins)	Walk time Suburb (mins)	Road Access Suburb (dummy-ajor/minor)	Size of Centre Suburb (no of shops)	Income of Area Suburb (dummy-high vs low)	CBD Location CBD (Dummy)	Size of Shop CBD (no employees)	Product Category CBD (dummy)	ASC Suburb	Log likelihood	Rho Sq (Cons)
										FMCG			
Total Sample	Coeff.	-0.014	-0.062	-0.028	0.319	0.004	1.198	1.357	-0.012	-0.963	0.436	-545.00	0.17
Model 5	t-values	-8.7	-2.1	-0.9	2.2	2.2	7.9	7.8	-2.5	-3.3	1.5		
N=976	R values		R4.46	R1.99	-R22.79	-R.29	-R85.57	-R96.93	R0.84	R68.79			
										APPLIANCES			
Total Sample	Coeff.	-0.013	-0.062	-0.027	0.315	0.004	1.184	1.144	-0.011	0.316	0.396	-550.00	0.17
Model 6	t-values	-8.2	-2.1	-0.9	2.1	2.2	7.9	7.2	-2.3	0.9	1.4		
N=976	R values		R4.84	R2.13	R24.61	-R0.31	-R92.50	-R89.38	R0.84	-R24.69			
										CONVENIENCE			
Total Sample	Coeff.	-0.013	-0.062	-0.027	0.316	0.004	1.187	0.691	-0.012	0.515	0.48	-548.00	0.17
Model 7	t-values	-8.30	-2.10	-0.90	2.10	2.20	7.90	2.60	-2.60	2.0	1.60		
N=976	*R values*		R4.63	R2.04	-R23.58	-R0.30	-R88.58	-R51.57	R0.90	-R38.43			
										CLOTHES			
Total Sample	Coeff.	-0.013	-0.062	-0.027	0.314	0.004	1.183	1.165	-0.011	0.066	0.393	-550.00	0.17
Model 8	t-values	-7.6	-2.1	-0.9	2.1	2.2	7.9	5.5	-2.3	0.3	1.300		
N=976	R values		R4.95	R2.17	-R25.12	-R0.32	-R94.64	-R93.20	R0.86	-R5.28			
										SPECIALITY			
Total Sample	Coeff.	-0.012	-0.063	-0.027	0.318	0.004	1.197	1.021	-0.021	-1.288	0.178	-545.00	0.18
Model 9	t-values	-7.7	-2.1	-0.9	2.2	2.2	7.9	6.5	-2.6	-3.2	0.6		
N=976	R values		R5.27	R2.30	-R26.72	-R0.34	-R100.59	-R85.80	R1.00	R108.24			
										COMPARATIVE			
Total Sample	Coeff.	-0.013	-0.062	-0.027	0.316	0.004	1.187	0.691	-0.021	-0.515	-0.039		
Model 10	t-values	-8.3	-2.1	-0.9	2.1	2.2	7.9	2.6	-2.6	-2.0	-0.1	-548.00	0.17
N=976	R values		R4.63	R2.04	-R23.58	-R0.30	-R88.58	-R51.57	R0.91	R38.43			

Table 6.4c: Retail location model calibration results: models calibrated on segmented data

User Segment Model No Sample Size (n)		Rent Suburb (R/ m^2 / mnth)	Walk Time CBD (mins)	Walk Time Suburb (mins)	Road Access Suburb (dummy-major/minor)	Size of Centre Suburb (no of shops)	Income of Area Suburb (dummy-high vs low)	CBD Location CDB (dummy)	Size of Shop CBD (GLA- m^2)	Size of Shop CBD (no employees)	Centre location Suburb (dummy)	ASC Suburb	Log Likelihood	Rho Sq (Cons)
CBD	Coeff.	-0.0094	-0.072	0.030	0.543	0.004	1.617			-0.008	0.877	-1.802	-196.00	0.14
Model 11	t-values	-2.7	-1.5	-0.6	2.2	1.2	6.5			-1.3	2.50	-3.7		
n= 336	R values		R7.69	R3.18	-R57.70	-R0.40	-R171.84			R.81	-R93.20			
Suburb Total	Coeff.	-0.021	-0.060	-0.027	0.206	0.004	1.005			-0.016	1.27	-0.118	-326.00	0.19
Model 12	t-values	-9.4	-1.6	-0.7	1.1	1.8	5.1			-1.8	4.2	-0.3		
n = 640	R values		R2.90	R1.32	-R9.95	-R0.21	-R48.55			R.76	-R61.40			
Low inc Sub	Coeff.	-0.012	-0.038	-0.023	0.040	0.002	0.112			-0.178	0.993	0.38	-163.00	0.02
Model 13	t-values	-2.00	-0.70	-0.40	0.10	0.70	0.40			-1.30	1.50	0.4		
n = 320	R values		R3.05	R1.83	-R3.24	-R0.19	-R9.11			R14.47	-R80.73			
High inc Sub	Coeff.	-0.031	-0.088	-0.409	0.399	0.007	2.011			0.002	2.120	-0.559	-148.00	0.32
Model 14	t-values	-7.7	-1.5	-0.7	1.4	2.0	6.4			0.2	4.5	-0.9		
n = 320	R values		R2.87	R13.32	-R13.00	-R0.23	-R65.50			-R.06	-R69.06			
Shopping Centres	Coeff.	-0.0195	-0.069	-0.038	0.517	0.006	1.469	0.493		-0.004	n.a.	0.673	-377.00	0.23
Model 15	t-values	-9.8	-1.9	-1.1	2.9	2.7	7.8	2.3		-0.7		2.00		
n = 744	R values		R3.53	R1.95	-R26.51	-R0.31	-R75.33	-R25.28		R.21				
Street Front Shops	Coeff.	-0.007	-0.054	-0.008	-0.116	-0.001	0.730	0.838		-0.016	n.a.	0.003	-146.00	0.09
Model 16	t-values	-0.7	-1.0	-0.1	-0.4	-0.1	2.6	2.8		-2.4		0.0		
n = 232	R values		R8.02	R1.13	R17.24	R0.07	-R108.47	-R124.52		R2.42				

All SP variables are therefore significant except for WALK SUB.

The RENT variable did not behave well in the model due to the fact that the SP range (-R10 to +R10) was too small relative to the reported rents. The RENT variable specified in the SP model was set equal to the change in the SP rent plus the reported rent. RENT CBD was therefore highly correlated with RENT SUB. Specification of a generic coefficient for RENT resulted in an insignificant coefficient. By specifying the RENT variable as part of the utility function of either the suburb alternative, or the CBD alternative, a significant and plausible coefficient for RENT was obtained. There is no reason *per se* why the rent of CBD and suburban shops should have different coefficients. It was therefore assumed for policy testing purposes that the coefficient for RENT would be the same for the CBD and the suburbs.

Access to parking and public transport is more of a problem in the CBD and this explains the significance of WALK in the CBD and its insignificance in the suburbs.

The SIZE OF SHOP variable yielded a negative coefficient when specified as part of the CBD utility. It means that the retail managers of larger shops would prefer the suburbs above the CBD probably due to physical constraints playing a role in the CBD, as well as transport problems of employees.

<u>Significance of centre versus street-front shops</u>

In model 3 the better of the previous two models was used and a dummy variable added, indicating whether the shop is located in a shopping centre or whether it is a street-front shop. The CENTRE LOCATION variable is highly significant, and the overall performance of the model is increased - the Rho-square value increased from 0.17 to 0.20. The Chi-square test was applied to the differences in the log likelyhood between models 2 and 3. The test indicated that the addition of the CENTRE LOCATION variable improved the model significantly in terms of its fit to the data.

The sample was not specifically designed to achieve a certain quota of street-front shops in all areas, and the market research company therefore recruited respondents where they typically occur with the aim to cover a range of shops in centres and street-front shops. The data set is therefore not ideal to evaluate the differences in street-front and centre shops thoroughly, except to test its significance in retail managers' choice between the CBD and the suburbs. In the section on segmented models this aspect is further explored.

Effect of inertia to change in SP experiment

To test the effects of the inertia to change factor, model 4 was calibrated on those respondents who switched at least once between the CBD and the suburb in the SP experiment. Although the sample size of model 4 is much smaller, the model's fit was significantly improved with the Rho-square value increasing from 0.14 to 0.18. The significance of five of the variables improved, while that of four variables decreased. CBD LOCATION becomes totally insignificant indicating that this variable captures the inertia to change factor in the total data set. The SIZE OF SHOP variable also becomes insignificant as a result of some correlation with the CBD LOCATION and the inertia to change factor. The SUBURB ASC becomes very significant and has a negative sign indicating the effect of negative perceptions of the suburb among switchers not measured by any of the variables in the model among switchers. Removal of the non-switchers, who are mostly in the suburb sample, therefore reduces the inherent preference for the suburb in model 4.

The significance of five of the six SP variables is improved by including only the switchers in the model. The larger variation in the SP data of the sample of switchers therefore improves the SP model. Measures to increase the number of switchers within realistic limits are therefore advisable and guidance on this aspect is provided in the conclusions to this chapter. However, inclusion of captive respondents (non-switchers) in the survey and understanding the factors motivating their behaviour, is also very important. This can be achieved by an attitudinal survey.

Effects of product category

Table 6.4b tests the inclusion of various product categories in the basic model. The five product categories were defined as dummy variables in the utility function of the CBD. Interaction between the product category variables and the other RP variables caused problems and it was therefore decided to enter each product variable separately to test each one's effect – the results of models 5 to 9 appear in Table 6.4b. Model 2 performed the best as the basic platform for including the product variables.

The overall fit of models 5 to 9 as indicated by the Rho-square value remained similar to that of model 2 and varied between 0.17 and 0.18. Three of the five product category variables are significant namely FMCG, CONVENIENCE and SPECIALITY. The application of the Chi-square test indicated that the addition of these variables to model 2 improved the model fit significantly. The APPLIANCES and CLOTHES variables are insignificant, and they did not improve the model according to the Chi-square test. The significance and coefficients of all the SP variables remained similar to that of model 2 and also remained similar between models with different product variables.

The coefficient sign of the FMCG variable is negative in the CBD utility function indicating that managers of FMCG shops prefer the suburb. Only 17 per cent of FMCG respondents are in the CBD. This is plausible, as supermarkets generally prefer to be in the suburbs close to the residential market. Only 17 per cent of FMCG respondents are in the CBD. For the same reason, the positive sign of CONVENIENCE is not plausible at face value, although tourists and employees do offer a significant market in the Cape Town CBD. Approximately 34 per cent of the respondents selling convenience goods are in the CBD.

The sign of the coefficient of SPECIALITY is also negative indicating a preference for the suburbs by these retail managers. Approximately 49 per cent of the SPECIALITY goods sample are in the CBD. Although the CBD offers a strong market for SPECIALITY goods, especially among tourists in Cape Town, this result indicates a preference for the suburbs.

The insignificance of the APPLIANCES and CLOTHES variables is interesting, as the CBD is the conventional market for comparative shopping. This trend has changed as all these goods can now also be obtained from suburban shops. The sample distribution indicates that 34 and 36 per cent of APPLIANCES and CLOTHES shops are in the CBD, respectively.

As the main difference between the above-mentioned product categories with regard to locational choice is whether they are comparative shopping or convenience goods, a comparative product dummy variable (COMPARATIVE) was created. Convenience goods were defined as FMCG and convenience goods, while comparative goods were defined as appliances, clothes and speciality goods. Model 10 in Table 6.5b indicates that the COMPARATIVE product category is significant and negative, indicating a preference of these retail managers for the suburbs. According to the Chi-square test, the addition of this variable to model 2 improved the model significantly.

It is appreciated that no firm conclusions can be made from the modelling of product categories in view of the typical problems with RP variables. The survey was also not designed to explore all the complicated issues relating to the wide range of retail goods, their markets and locational choices. The data set also does not necessarily reflect the actual geographical distribution of shops according to product category. A much larger random survey would be required to explore the impact of product category on locational choice, in addition to including product category as a SP variable to test its effect in a controlled environment.

The modelling results indicate that certain product categories do seem to affect strategic locational choice and that a broad classification of goods into comparative and non-comparative products indicates that retail managers of comparative products have some measure of preference for the suburb location.

Models calibrated on segmented data

Table 6.4c gives the calibration results of models calibrated on the following segmented data sets:

- CBD sample – model 11;
- Suburban sample (low-income and high-income) – model 12;
- Low-income suburb sample – model 13;
- High-income suburb sample – model 14;
- Shopping centre sample – model 15; and
- Street-front shops sample – model 16.

In view of the models based on the existing geographical location, the high-income suburb model performed the best with a very good Rho-square value of 0.32, the CBD model performed second best with a reasonable Rho-square value of 0.14, while the low-income suburb model performed very poorly. The predominance of the inertia to change factor in the low-income sample, and possibly other problems such as lexicographical choices (considering only one variable in all the choice scenarios), leave very little variation to calibrate a meaningful model. Only RENT was significant in the low-income suburb model indicating a lexicographical problem, which was also experienced in the Durban public transport SP study among less-literate respondents (Van Zyl, Lombard and Lamprecht, 2001). The total suburban model does, however, indicate a reasonable model with a Rho-square value of 0.19.

The following observations are relevant:

- RENT is significant in all the geographical segmented models.
- ROAD is only significant for the CBD sample.
- SIZE OF CENTRE is only significant for the high-income sample.
- The INCOME SUB variable is significant for both the CBD and high-income suburb samples.
- CENTRE LOCATION is significant for the CBD and high-income samples, while it is marginal for the low-income samples.
- The SUBURB ASC is only significant for the CBD sample and its negative sign indicates negative perceptions about suburbs not measured by the other variables in the model.

- WALK (CBD and SUB) and SIZE OF SHOP are not significant in any of the models, although WALK CBD as well as SIZE OF SHOP are marginally significant for the suburb sample.
- The coefficients of the significant variables indicate significant differences in some cases such as the RENT coefficient that is the highest for the high-income sample, the ROAD coefficient that is the highest for the CBD and INCOME SUB and CENTRE LOCATION that are the highest for the high-income suburb sample.

In terms of the centre versus street-front models, the centre model performs very well (Rho-square of 0.23) and much better than model 2 (Rho-square of 0.17) on the total sample, which had the same variable specification. The street-front sample suffered from a too small sample size (Rho-square marginal at 0.09) and differences can be more reliably explained by comparing the centre model with the total sample in model 2.

The following observations are made:

- Among the significant variables, ROAD and INCOME SUB have higher coefficients for the centre sample compared to the total sample, while CBD LOCATION has a much lower coefficient for the centre sample.
- SIZE OF SHOP has a much lower coefficient for the centre sample to the extent that it becomes insignificant.
- RENT and SIZE OF CENTRE are also somewhat higher for the centre sample compared to the total sample.
- The SUBURB ASC has become significant for the centre sample, and its positive sign indicates positive perceptions towards the suburb location not measured by the other factors in the model.
- The three significant variables in the street-front model (INCOME SUB, CBD LOCATION, and SIZE OF SHOP) support the above conclusions.

To conclude, the sample segmentation indicates significant differences in the models for the CBD and suburban locations as well as between the centre and street-front shops. The extent of these differences is best explained by assessing the elasticities of the choice factors and these are discussed in a subsequent section.

<u>Monetary values of choice factors</u>

Tables 6.4a to c also give the monetary value of the independent variables, which were calculated by taking the ratio of the coefficient of the relevant variable, which is expressed in utility per unit of the variable, to the coefficient of the RENT variable, which is expressed in utility per Rand per square metre per month. The monetary values of variables are therefore expressed in terms of Rand per square metre per month for each unit of the variable. They provide a very useful way of interpreting the relative impacts of variables by regarding the values as the equivalent rent per month.

Negative factors have positive monetary values, which means that they must be regarded as equivalent costs, while positive factors have negative monetary values, which means that they must be regarded as equivalent savings.

Table 6.5 summarises the absolute monetary values for the most significant variables for each of the main retail segments.

The value of walk time in the CBD for the total sample is approximately R5 per minute implying that retail managers would be willing to pay R25 more rent per m^2 per month to be located 5 minutes closer to their customers' parking or transport facility. CBD retail managers value walking time the highest at R8 per minute, while the suburban retail managers value walking time much lower at R3 per minute.

Location of the shop on a major road compared to a minor road is valued at R25 for the total sample. It means that retail managers are willing to pay an extra R25 per m^2 per month for the benefit of being on the main road. CBD retail managers value main road access much higher at R58, while retail managers in centres value it roughly the same as for the total sample

Although the value of the centre size is low, R0.31 per additional shop, a large centre of 120 shops would be valued at R25 per month equivalent rent (=R0.31x 80) higher compared to a small centre of 40 shops. This value ranged from R0.21 (R17 for a size increase of 80 shops) among suburban retail managers to R0.31 for the total sample and retail managers in centres.

Table 6.5: Monetary values of choice factors (Rand per m^2 per unit)

Choice Factor	Total Sample	CBD sample	Suburb sample	High-income suburb Sample	Centre Sample
Walking time (minutes)	R5	R8	R3	R3	R4
Major road access (major/minor)	R25	R58			R27
Size of centre (number of shops)	R0.31		R0.21	R0.23	R0.31
Income suburb (High vs low)	R94	R172	R49	R66	R75
CBD Location (dummy)	R89				R25
Size of shop (no employees)	R0.86		R0.76		
Centre location (dummy)	R72	R93	R61	R69	
Comparative Products (dummy)	R38				

Retail managers showed a clear prejudice against low-income suburbs indicated by their willingness to pay an extra R94 per month to locate in a high-income suburb rather than a low-income suburb. This value ranged from R49 among suburban retail managers to a high of R172 among CBD retail managers. Retail managers would also be willing to pay a similar high premium to remain at their current location rather than move (R89 per month). Retail managers in centres value existing location much lower at R25.

The monetary value of the size of the shop ranged from R8 to R9 for a small shop of 10 employees to R80 to R90 for a large shop of 100 employees.

Location in a shopping centre was valued from R61 among the suburban sample of retail managers, to R93 among the CBD retail managers.

6.6.3 Calibration results of models including importance ratings

The SANPAD research as well as the Durban and Cape Town user preference studies indicated that respondents' existing situation and perceptions of the alternatives currently available to them influenced their choices in the SP experiment. It seems that they found it difficult to relate to a hypothetical choice situation, and therefore tended to make choices according to their current perceptions of alternatives, especially if the SP levels seemed unrealistic. This phenomenon prompted the author to investigate the impact of respondents' current attitudes and perceptions in the SP model.

In order to test to what extent respondents' inherent attitudes towards different factors influenced their choices in the SP experiment, the importance ratings of the various choice factors collected in the survey were included as RP variables in the main SP model. The rating of each factor, on the five-point scale, was duplicated for each SP choice for a particular respondent, similar to the process followed for other RP variables. Table 6.6 gives the calibration results of the model that includes the importance ratings.

Table 6.6: Best SP model including importance ratings for total sample (significant variables indicated in bold)

Variable	Coefficient	t-value
Model 1 Variables		
Rent SUB	**-0.0095**	**-4.9**
Walk CBD	**-0.08**	**-2.5**
Walk SUB		
Road CBD	**0.356**	**2.2**
Size centre SUB	**0.005**	**2.5**
Income SUB	**1.419**	**8.4**
CBD location	**1.646**	**7.5**
Size shop CBD	**-0.021**	**-3.6**
ASC suburb	-1.289	-1.4
Importance Ratings		
Traffic congestion	**0.253**	**3.1**
Rent	**-0.297**	**-2.7**
Parking fee	0.047	0.7
Size of centre	**-0.225**	**-2.4**
Freeway	**0.439**	**4.1**
Main road	0.215	1.8
Parking availability	**0.290**	**2.3**
Train	-0.126	-1.2
Suppliers	**0.236**	**2.4**
Other businesses	0.177	1.7
Crime	**-0.486**	**-3.0**
Aesthetics	**-0.453**	**-4.1**
Shopping mix	**0.457**	**3.5**
Residential areas	**-0.399**	**-3.4**
Employment centres	**-0.338**	**-2.7**
Sample Size	904	
Rho-square	0.26	

The model in Table 6.6 includes the same SP and RP variables as Model 2 in Table 6.4a for the total sample, as well as the importance ratings. The ratings were arbitrarily specified as part of the CBD utility function. A positive sign of the coefficient of an importance rating therefore implies a positive impact on the preference for the CBD, and *vice versa*.

The model shows an increase in the goodness-of-fit of 50 per cent in terms of the Rho-square value compared to model 2 in Table 6.4a. The importance ratings therefore explain a significant percentage of the total variance in the SP choices.

The suburb constant changed from marginally positive to marginally negative comparing the model with and without the ratings indicating that the ratings measure some inherent preferences towards either the suburb or the CBD.

The correlation matrix of the coefficient estimates of the importance ratings indicated that none of the estimates was so highly correlated that it could cause problems in the model. All correlation coefficients were below 0.5.

Table 6.7 gives the model coefficients, elasticities, importance weights and ratings for the choice factors used in the attitudinal survey. The elasticities were estimated by means of the ALOGIT program, based on small changes to the importance ratings included as independent variables. The factors are sorted according to importance weight from high to low. There is an almost perfect correlation between the coefficients and the elasticities (correlation coefficient of 0.98). This can be expected, as the measurement unit (rating scale) is the same for all factors.

A short interpretation of the coefficients of each choice factor is given below to see how plausible these results are. The same conclusions would be relevant in terms of the elasticities in view of their high correlation with the coefficients.

- TRAFFIC CONGESTION is significant and is positive for the CBD. This does not correlate with the low ranking and rating of Traffic Congestion overall (rank 11, rating important for total sample). The model results can be interpreted as meaning that respondents who rated this factor as more important, would tend to prefer the CBD. This is not plausible as the CBD experiences more congestion and one may argue that retail managers who regarded congestion more important preferred the suburbs. Another explanation is that the CBD segment that actually ranked TRAFFIC CONGESTION higher than the suburb segments, tended to prefer their current location, yielding this result.

Table 6.7: Model coefficients, elasticities, importance weights and ratings of choice factors used in the attitudinal survey

FACTORS	Coefficients	Elasticities	Importance weights	Ratings
CRIME	0.486	1.180	1.00	Ext imp
PARK AVAIL	0.29	0.665	0.72	Ext imp
RENT	0.297	0.587	0.68	Very imp
SIZE CENTRE	0.225	0.292	0.60	Very imp
SHOP MIX	0.457	0.444	0.59	Very imp
MAIN RD	0.215	0.270	0.53	Very imp
OTHER BUSIN	0.177	0.329	0.53	Very imp
AESTHETIC	0.453	0.553	0.52	Very imp
EMP CENTRES	0.338	0.650	0.51	Important
RESIDENTIAL	0.399	0.34	0.51	Important
TRAFFIC CONG	0.253	0.312	0.49	Important
FREEWAY	0.439	0.670	0.47	Important
PARK FEE	0.047	0.070	0.45	Important
TRAIN	0.126	0.197	0.42	Important
SUPPLIERS	0.236	0.273	0.37	Important

- *RENT* is significant and was also ranked and rated highly (rank 3, rating very important). It was regarded as a negative factor for the CBD, in other words, the higher the importance rating of *RENT*, the lower the preference for CBD for the total sample. Respondents who regarded *RENT* as more important, would therefore be more likely to prefer the suburb location. This may be explained by the influence of the lower income suburb sample that would be more sensitive to cost factors, although the high-income suburb segment ranked and rated *RENT* the highest.
- *PARKING FEE* is not significant, which correlates with its low ranking and rating (rank 13, rating important).
- *SIZE OF CENTRE* is significant, which correlates with its high ranking and rating (rank 4, very important). It is negative for the CBD meaning that respondents

who rated this more important, preferred the suburbs to the CBD. Shopping centres are more predominant in the suburbs and that may explain this trend. The SP variable, SIZE OF CENTRE in the suburbs, is also significant.

- *FREEWAY* is significant and positive. It indicates that people who regarded freeway access as more important, preferred the CBD. This supports the conclusion from the SP variable, ROAD, which was more significant for the CBD sample than for the suburb sample. *FREEWAY* was ranked and rated fairly low by all sample segments (rank 12, important) and this does not correlate with the modelled results. People may perceive the CBD as having good road access and being well served by freeways and main roads and hence this result.
- *MAIN ROAD* is only marginally significant and positive for the CBD. This trend is similar to that of the freeway access variable. People who regarded main road access as more important tended to prefer the CBD to the suburbs. *MAIN ROAD* was rated more important than *FREEWAY* (rank 6, very important), which does not correlate well with the fact that it is less significant than *FREEWAY* in the model.
- *PARKING AVAILABILITY* is significant and positive for the CBD. This variable was rated and ranked very high (rank 2, extremely important) which therefore correlates with the modelled results. Respondents who rated *PARKING AVAILABILITY* more important, tended to prefer the CBD to the suburbs. This is difficult to explain as the CBD is perceived to have poorer access to parking, i.e. walking times from parking is longer. It may be that the CBD was perceived to have a larger supply of parking, which is plausible. Alternatively, it could be that the same effect is prevalent as with traffic congestion, i.e. CBD respondents who regarded parking more important, also tended to prefer their current location.
- *TRAIN* is not significant and is negative for the CBD. It was also ranked and rated very low (rank 14, important) which correlates with the modelled results.
- *SUPPLIERS* is significant and positive for the CBD. This variable was rated and ranked very low and this does not correlate with the modelled results (rank 15, important). The respondents who rated *SUPPLIERS* more important, therefore tended to prefer the CBD. This is plausible as the CBD is centrally located and has the highest access to a large variation of suppliers.

- *OTHER BUSINESSES* is marginally significant and positive for the CBD, similar to the *SUPPLIERS* variable. This factor was ranked in the middle of the range (rank 7) and regarded as very important. It shows the same trend as *SUPPLIERS*, i.e. people who rated it more important tended to prefer the CBD to the suburbs. This seems plausible and the same reasons apply as for *SUPPLIERS*.
- *CRIME* is significant and negative for the CBD, which correlates with the high ranking and rating given to this factor (rank 1, extremely important). The model suggests that respondents who rated *CRIME* more important, also preferred the suburbs to the CBD. This trend supports the general perception that the CBD suffers more from crime.
- *AESTHETICS* is significant and negative for the CBD. It was also ranked in the middle of the range and rated as very important. Respondents who rated it more important, tended to prefer the suburbs to CBD, similar to the trend of safety from crime. Likewise, this seems to be plausible as the suburbs are generally preferred for their better quality of the environment.
- *SHOPPING MIX* is significant and positive. It was also ranked and rated fairly high (rank 5, very important). The model indicates that the respondents who rated this more important, tended to prefer the CBD. This is also plausible as the CBD has the highest mix of different shops.
- *RESIDENTIAL AREAS* is significant and negative for the CBD. Although this variable was ranked and rated low overall (rank 10, important), it was rated extremely important by the low-income suburb sample. Its negative sign for the CBD is plausible as the suburban shops would be regarded as close to residential areas. People who regarded this as more important, therefore preferred the suburb.
- *EMPLOYMENT CENTRES* is significant and negative for the CBD. It was ranked and rated low (rank 9, important). Respondents who rated this factor more important, tended to prefer the suburbs to the CBD. This is not plausible as the CBD has the highest concentration of employment. However, employment was rated and ranked higher by the suburb sample and suburb respondents who rated this factor higher also tended to prefer their own location.

To summarise, the respondents' importance ratings of various choice factors did contribute significantly to the overall explanation of the choices in the SP experiment. The positive or negative impact on the share of the CBD *versus* the suburbs seems to be plausible for most of the significant factors.

For most of the factors that were significant, plausible explanations could be given for the impact of the importance rating on locational preference in the model, except for three factors. The exceptions are *TRAFFIC CONGESTION, PARKING AVAILABILITY* and *EMPLOYMENT CENTRES*. The behaviour of these factors may possibly be explained in terms of the co-incidental occurrence of respondents who rated the factor more important and who also preferred their current location.

Apart from a few outliers, there does seem to be a coarse relationship between the importance ratings of factors and their significance in explaining the SP choices.

Plausible conclusions are that retail managers who regard the following factors as very important, tend to prefer the CBD:

- Access to major road arterial
- Proximity to suppliers
- Conglomeration benefits resulting from close proximity to other businesses and shops

Retail managers who regard the following factors as important, tend to prefer the suburbs:

- Rent of retail space
- Size of shopping centre
- Degree of safety from crime
- Aesthetical environment
- Proximity to residential areas

Most of the factors were significant, i.e. 11 out of the 15 factors. The four factors that were not significant are parking fee, access to train, access to main road, and proximity to other businesses. For two of these factors the low importance ratings correlate with the low significance in the model. The other two factors have average rankings, but were regarded as very important which does not correlates well with the modelled results.

Of the seven factors ranked the lowest and rated as only important, only two are not significant in the model. Of the eight factors rated as very to extremely important, all were significant except two that were marginally significant.

To determine whether there is any significant statistical relationship between the coefficients, or elasticities, and the importance weights, two statistical tests were conducted. The average coefficient value was calculated across all factors within each of the three importance rating categories (extremely important, very important and important). An analysis of variance to test whether the average values of the model coefficients (ignoring the sign) differed between importance categories, indicated that the average coefficient increased with an increase in the importance category, but that there were no significant differences between the averages.

Subsequently a correlation analysis between the model coefficients and the importance weights was conducted, which indicated a low correlation coefficient of 0.4.

The most significant finding of these results is that the importance ratings explain almost as much of the variance in the SP choices as the SP variables themselves. It is therefore concluded that respondents' inherent attitudes, as measured by their importance ratings with regard to various choice factors, and their perceptions of the characteristics of the various business locations, contributed significantly to their choices in the SP experiment. The respondents' importance ratings therefore influenced their SP choices significantly, in addition to the SP variables, which they were supposed to consider. The coefficients of the ratings, which is an aggregate expression of the relationship between the ratings and the SP choices, seem to have a qualitative relationship with the aggregate importance ratings at a coarse level. However, the relationship between the coefficients and the importance weights is not statistically significant.

The fact that respondents' inherent attitudes also affected their SP choices is opposing the main objective of the SP technique, i.e. to conduct a controlled experiment in order to test respondents' preferences in view of the specified SP variables. To resolve this SP problem, more comprehensive pilot attitudinal surveys should be conducted prior to and as part of the SP survey. This will help to fully understand the choice factors of the target market and will assist in the best possible design of the SP experiment focusing on the most important factors. Including the importance ratings as RP variables in the SP model could provide further insight in explaining the SP choices. In addition, including important qualitative factors as part of the set of SP variables will force the respondent to consider such factors objectively and to trade them off against the quantitative factors, rather than considering them in a subjective, *ad hoc* way.

Qualitative factors are often included in RP and SP models, but the main objection to this is that such models cannot be used for policy testing as changes in such factors cannot be quantified or predicted (see Chapter 2.11). However, by including qualitative factors a more reliable estimation on the quantitative factors will be obtained, and the relationship between locational choice behaviour and attitudes will be understood better. Further research on the inclusion of attitudinal data in SP studies may help to resolve the typical problems of SP surveys among less-literate people in South Africa, and possibly other developing countries. The method used by Ogden and Young (1983) to obtain importance and satisfaction ratings on choice factors for alternative locations seems to be a very useful method to explore. These models can be used in conjunction with the SP model to cover both attitudinal and quantitative information.

6.7 ELASTICITIES ESTIMATED WITH CALIBRATED MODELS

To determine the relative sensitivities of the shares of the CBD and the suburb in view of changes in the values of the choice factors, it is necessary to estimate the elasticities. The ALOGIT software calculates average elasticities of selected variables by making small changes to the values of independent variables and applying the calibrated model to the changed values (Hague Consulting Group, 1995). Elasticities had been calculated using the main calibrated models reported in the previous section and these are presented below.

Tables 6.8 a and b give the elasticities for all the variables included in the calibrated models for each of the eight retail market segments discussed in the previous section. Elasticties were calculated regardless of whether the variables were significant or not. The significant variables are therefore highlighted in the tables to indicate which of the elasticities are reliable. If the coefficient of a specific variable (the t-value) decreases from one model to the next, and becomes insignificant, the elasticity will also tend to reduce, and therefore the size of the elasticity can still be used for comparative purposes.

Care should be taken when comparing the elasticities of market segments in Table 6.8 as the market shares of the CBD and the suburb differ in the various retail segments according to the stated preferences of the respondents. The preferred total shares for the CBD and the suburb across the ranges in the SP variables are also indicated in the table as these explain the choice behaviour of the respondents and help to interpret the elasticities.

Table 6.8a: Elasticities of demand for CBD versus suburb with regard to various choice factors for various sample segments (estimated with ALOGIT software on SP sample; shadings indicate significant coefficients)

VARIABLE	*TOTAL SAMPLE*		SWITCHERS		CBD SAMPLE		SUBURB SAMPLE	
	CBD SHARE	SUB SHARE	CBD SHARE	SUB SHARE	CBD SHARE	SUB SHARE	CBD SHARE	SUBSHARE
Rent Sub	0.57	-0.40	0.34	-0.34	0.25	-0.35	0.80	-0.36
Walk Time CBD	-0.13	0.09	-0.17	0.17	-0.11	0.16	-0.14	0.07
Walk Time Sub	0.06	-0.04	0.08	-0.08	0.04	-0.06	0.07	-0.03
Major Road Sub	-0.07	0.05	-0.09	0.09	-0.10	0.13	-0.05	0.02
Size of Centre Sub	-0.15	0.10	-0.19	0.19	-0.10	0.14	-0.18	0.08
Income of Area Sub	-0.25	0.18	-0.35	0.35	-0.31	0.43	-0.24	0.11
Inertia to Change CBD	0.11	-0.08	0.01	-0.01	n.a.	n.a.	n.a.	n.a.
Size of Shop CBD	-0.05	0.03	-0.02	0.02	-0.03	0.05	-0.07	0.03
Centre Location Sub	-0.41	0.29	-0.15	0.15	-0.17	0.23	-0.57	0.27
Comparative Products CBD	-0.12	0.09	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Stated Preference Shares	41%	59%	50%	50%	58%	42%	33%	67%

Table 6.8b: Elasticities of demand for CBD versus suburb with regard to various choice factors for various sample segments (estimated with ALOGIT software on SP sample; shading indicate significant coefficients)

VARIABLE	*LOW INC SUBURB SAMPLE*		HIGH INC SUBURB SAMPLE		SHOPPING CENTRE SAMPLE		STREET FRONT SHOPS	
	CBD SHARE	SUB SHARE	CBD SHARE	SUB SHARE	CBD SHARE	SUB SHARE	CBD SHARE	SUBSHARE
Rent Sub	0.39	-0.11	1.03	-0.76	0.74	-0.44	0.10	-0.11
Walk Time CBD	-0.13	0.03	-0.14	0.10	-0.14	0.08	-0.10	0.11
Walk Time Sub	0.08	-0.02	0.07	-0.05	0.08	-0.05	0.01	-0.02
Major Road Sub	-0.02	0.004	-0.07	0.05	-0.11	0.06	0.02	-0.03
Size of Centre Sub	-0.14	0.04	-0.20	0.15	-0.21	0.13	0.02	-0.02
Income of Area Sub	-0.04	0.01	-0.33	0.25	-0.28	0.17	-0.16	0.17
Inertia to Change CBD	n.a.	n.a.	n.a.	n.a.	0.06	-0.04	0.23	-0.26
Size of Shop CBD	-0.14	0.04	0.005	-0.004	-0.02	0.01	-0.09	0.09
Centre Location Sub	-0.68	0.19	-0.62	0.46	n.a.	n.a.	n.a.	n.a.
Stated Preference Shares	22%	78%	42%	58%	38%	62%	52%	48%

In terms of the total stated preference shares, the CBD has the highest share among the CBD retail managers, as could be expected (58 per cent). The suburb has the highest share among the low-income suburb retail managers (78 per cent), followed by the centre segment (62 per cent). These SP shares differ from the shares of the actual locations in the sample, which is 34 per cent for the CBD and 66 per cent for the suburb. The elasticities of the CBD and suburb are equal for the switcher segment due to the fact that their shares are the same.

The elasticities presented here are most useful for identifying the rank order of choice factors and not so much the actual magnitude of its impact. The reason is that the SP input data refer to hypothetical levels for each respondent, while the aggregate market shares of the alternative locations reflect the way people responded to the hypothetical SP levels. The elasticities, therefore, also reflect these conditions. A more accurate estimate of elasticities is obtained by defining realistic input data for each respondent, for his/her existing and alternative location, and applying the calibrated model to this more realistic data set. In addition, the constant of the model need to be adjusted so that the model's aggregate market shares between the CBD and the suburb reflect the observed market shares. This process is explained and implemented in Chapter 7 describing the development of a spreadsheet model for the purposes of policy testing based on the calibrated logit model. The spreadsheet model was also used to determine elasticities of the choice factors. The use of the elasticties to quantify the relative impact of changes in the choice factors on the level of suburbanisation, is discussed in Chapter 7.

Most of the elasticities in Table 6.9 are below 0.5, except RENT, which indicates the highest overall elasticity, equal to 1, for the CBD's share among the high-income suburb retail managers. In general terms, if the elasticity of a factor is in the order of 1 or higher, the factor is generally regarded as elastic, while values below one is regarded as relatively inelastic. However, in terms of locational choices, changes take place slowly over time as a result of a large number of complex factors that determine natural growth in development and relocation of businesses.

The following guideline has therefore been used to classify choice factors in terms of elasticity:

- elasticities above 0.3 - high;
- between 0.1 and 0.3 - medium; and
- below 0.1 - small.

The choice factors that have high or medium elasticities are listed below for each market segment:

Total sample:

- High elasticity: RENT, CENTRE LOCATION;
- Medium elasticity: INCOME SUB, SIZE OF CENTRE, CBD LOCATION, COMPARATIVE products, WALK CBD;

Total sample - switchers:

- High elasticity: INCOME SUB, RENT;
- Medium elasticity: SIZE OF CENTRE, WALK CBD, CENTRE LOCATION; CBD sample:
- High elasticity: INCOME SUB, RENT;
- Medium elasticity: CENTRE LOCATION, WALK CBD, ROAD SUB, SIZE OF CENTRE;

Suburb sample:

- High elasticity: RENT, CENTRE LOCATION;
- Medium elasticity: INCOME SUB, SIZE OF CENTRE, WALK CBD;

Low-Income suburb:

- High elasticity: RENT, CENTRE LOCATION;
- Medium elasticity: SIZE OF SHOP, WALK CBD;

High-income suburb:

- High elasticity: RENT, CENTRE LOCATION;

- Medium elasticity: INCOME SUB, SIZE OF CENTRE, WALK CBD;

Shopping centres:

- High elasticity: Rent;
- Medium elasticity: INCOME SUB, SIZE OF CENTRE, WALK CBD, ROAD SUB;

Street-front shops:

- Medium elasticity: CBD LOCATION; INCOME SUB, RENT, WALK CBD;

The following similarities and differences in elasticties are useful to note:

- RENT has a high elasticity for all segments. The medium elasticity of RENT for street-front shops are probably due to the poor overall model;
- SIZE OF CENTRE and CENTRE LOCATION have the highest elasticity for high- and low-income suburbs, where shopping centres are dominant;
- ROAD has the highest elasticity for the CBD and Shopping centre samples;
- SIZE OF SHOP has a low elasticity for all segments, but has the highest elasticity for street-front shops that have less flexibility for expanding;
- WALK SUB has a low elasticity for all segments probably due to the fact that parking is generally available and traffic congestion is limited in the suburbs.

6.8 IMPLICATION OF ELASTICITIES AND IMPORTANCE RATINGS OF LOCATIONAL CHOICE FACTORS FOR SUBURBANISATION MANAGEMENT STRATEGIES

The implication of the elasticities to define the most effective policies to manage suburbanisation is briefly discussed here. The elasticities are also compared to the importance ratings of choice factors discussed in Chapter 5, where possible.

The rank order of elasticities presented in Table 6.9 is a useful guideline to planners to identify the most effective policies to manage suburbanisation, while the size of the elasticity also gives an indication of the likely impact to expect.

Rent of retail space has a high to very high elasticity and financial policies affecting rent will be the most effective measure to attract retail managers to the CBD, or limit the suburbanisation trend. High-income suburb and CBD retail managers also rated rent as extremely important, while low-income suburb retail managers rated it as very important. High-income suburb retail managers rated rent higher than the other segments, while they also have a higher elasticity for rent than the other segments.

The ability of retail managers to locate in a shopping centre, as opposed to a street-front shop, has a medium to high elasticity. The high-income suburb retail managers have the highest elasticity, although the CBD and low-income suburb retail managers also indicated significant elasticities in the medium range. Factors related to location in a centre, such as is proximity to other businesses and shopping size/mix, were also rated important to very important by retail managers.

The modern trend is to develop almost exclusively shopping centres, even in the CBD where street-front shops are predominant. An effective policy to attract retail managers to the CBD will be to develop centres in the CBD that can compete with the suburban centres. The preference of developers and retail managers for centres counteracts the ideal design features of the activity street to densify development along transport corridors promoted by some town planners (Naude, 1991). These strategies have to be adapted to achieve the intended benefits of the activity streets.

The size of the shopping centre has an elasticity in the medium range inl the basic retail segments. The size of the centre has been rated important to extremely important, with CBD retail managers indicating the highest rating. The policy responses to this factor also relate to the preference for shopping centres discussed above. Curtailing mega-centres in suburbs, or developing them only at suburban nodes that form part of a managed suburban densification strategy, is an important strategy. Development of large centres in the central area that compete with large suburban centres, will also be appropriate.

The income potential of suburbs and typical differences between high- and low-income suburbs are significant factors attracting retail managers to the high-income suburb environment. Its elasticity is medium to high, and even high among the CBD retail managers. It will be very difficult to attract retail development to low-income suburbs for the benefit of township residents. This factor needs to be considered and its impact managed by planners. One policy response is to attract residential development to central areas, which in turn will attract retail to the CBD. This factor was mentioned as one of the reasons why the Cape Town CBD has declined less than those of other cities in South Africa (Rapport, 17 September 2000).

Access to parking and transport facilities is a significant factor in attracting retail activity to the CBD (medium elasticity) in view of traffic congestion and potential lack of parking space typically experienced in the CBD. This factor has a low impact in the suburbs. Availability of parking has been rated very important to extremely important by retail managers in all areas, with the CBD retail managers indicating the highest rating. Parking and traffic management policies to ensure adequate parking for shoppers during the main shopping periods in the CBD will be effective policies to pursue.

To conclude, the modelled elasticities provide a very useful tool to identify the most effective policies to manage suburbanisation and its likely impact. The importance ratings provided by the respondents generally support the elasticities and using both the attitudinal analysis and the elasticities of the retail location choice model, provides the necessary insight to formulate reliable and effective policies.

6.9 CONCLUSIONS AND RECOMMENDATIONS

In this chapter the calibration of a number of locational choice models that estimate the probability of a retailer choosing the CBD or the suburbs for his business location on the basis of various independent variables, was discussed. The monetary values of the significant choice factors were estimated from the model's coefficients. Elasticities were estimated for all the factors in the locational choice model and for various retail segments. The elasticities were used to identify the most effective policies to manage suburbanisation.

The following conclusions are drawn:

- *The best models, which included the SP variables tested in the survey, as well as a number of RP variables, performed well but not as good as indicated by international norms for short term travel choice models.*
- *Most of the SP variables tested, such as factors describing the physical characteristics of the shop and its location, the cost of renting the business space, and transport and accessibility factors, were significant The models provide the perceived level of trade-off between the various choice factors, including how transport and accessibility are traded off against other locational factors.*
- *The monetary values provide a rule-of-thumb valuation of what retail managers will be prepared to pay for certain levels of the choice factors and this gives a very useful insight into their locational choice behaviour.*
- *Segmentation of the sample data and calibration of separate models for the CBD and suburb segments supported the results of the previous chapter that choice factors and elasticities differ between the segments. Significant differences were also found between the models of retail managers in shopping centres and retail managers in street-front shops.*
- *As in the case of other SP studies, inertia to change was found to be a significant factor for the long-term locational choice of retail managers, especially among the low-income suburb retail managers, but also significantly among retail managers from the other segments. Removal of non-switchers from the data set improved the model significantly and ways to resolve this problem will enhance the success of SP models for locational choice purposes.*
- *Another significant finding was that retail managers' inherent attitudes and current perceptions of various locations influenced their SP choices almost as much as the SP variables. This explains the less ideal performance of the basic SP model. A coarse qualitative relationship was also identified between the coefficients of the choice factors in the logit model and the average importance weights of the factors, although the relationship was not statistically significant. This assessment provided further insight into retai managers' locational choices.*

- *Comparison of the elasticities with the importance ratings of the locational choice factors indicated a coarse similarity, which indicated that the model was reliable.*
- *The policies that will be the most effective to manage suburbanisation, according to the elasticities and importance ratings, should address the following choice factors:*
  - *Rent of retail space*
  - *Location in shopping centre or street-front shop*
  - *Market potential/ income of suburb*
  - *Size of shopping centre*
  - *Walking time in the CBD from parking and public transport facilities*
- *Despite the complexities of designing SP models for long-term locational choice, the calibrated models performed sufficiently well to be applied for policy testing purposes.*
- *It was proved that SP modelling techniques can be applied successfully to retail locational choice. However, a number of complexities were identified and the lessons learned will serve to assist future applications and guide research.*

<u>Recommendations for conducting SP surveys for locational choice purposes</u>

From the lessons learned during the design and execution of the SP survey to estimate a locational choice model for retail managers, the following recommendations are made that will help to limit the problems of inertia to change, insensitivity to SP input variables, and the subjective influence of respondents' attitudes on their SP choices.

- *Extensive focus group discussions should be held prior to the SP survey to obtain a thorough understanding of the choice factors and what changes to the SP levels will prompt people to change their locational preferences within realistic limits.*
- *Due to the fact that locational choices are made infrequently and deal with long-term changes, a pre-interview will be helpful to stimulate respondents' locational choice process and to increase the respondent's awareness of his/her attitude to locational factors. The background and attitudinal survey can fulfil this role and be followed up with the SP survey.*

- *Special attention and effort should be given to explain the SP experiment to the respondent and to make him/her understand the need to consider the variation in the SP levels and not his/her own perceptions of the current situation.*
- *The sample size should be increased from the level used in this research, especially among those segments of the market where inertia to change is expected to occur to a significant extent. A sample size of at least 200 per market segment is recommended.*
- *Computer-aided personal interview techniques (CAPI) should be used to relate the SP levels to the respondent's current situation and to build in validation checks. This should include checking responses for typical "inertia to change" and "lexicographic choices" and reviewing of responses if necessary. Reasons for each choice should also be requested and recorded. This will ensure that respondents understand the experiment and react to the changing levels.*
- *Research should be done on the collection of reliable RP data in order to calibrate RP models. This will assist in the interpretation and scaling of SP models. Evaluation of various contexts and parameters for the RP survey design is necessary as such choices are not frequently made and respondents may have difficulty in recalling the factors and their values. The approach by Ortuzar and Rodriques (2000) to select a sample of respondents that recently made locational choices, will be worthwhile to adopt.*
- *Further research is needed on the inclusion of attitudinal and qualitative factors in the SP model. The inclusion and separate analysis of attitudunal questions, similar to the approach used in this research, is highly recommended as this will provide further insight in the locational choice behaviour of the respondents.*
- *Further research regarding alternative model formats, which best fit businesses' locational choice behaviour, is recommended. Although the utility maximisation SP models performed well enough for policy testing purposes, and while it is believed that their performance could be further improved, other modelling formats might also improve the performance of locational choice models. With regard to utility maximisation, or compensatory models, probit models need to be considered when more than two alternative locations are considered. However, it might be more worthwhile to consider constraint-based, or non-compensatory models in view of the problems associated with the calibration of probit models.*

7. DEVELOPMENT OF RETAIL LOCATION SPREADSHEET MODEL AND TESTING OF SCENARIOS

7.1 INTRODUCTION

In this chapter the development and application of a spreadsheet model based on the calibrated locational choice model presented in the previous chapter, is discussed. The spreadsheet model was used to determine the elasticities of suburbanisation with respect to locational choice factors, as well as to test various suburbanisation scenarios to demonstrate the performance and use of the model.

A spreadsheet is the ideal tool for quick, easy and transparent application of logit choice models. The inputs and outputs can be structured in the form of tables and outputs can be viewed immediately after changes have been made to input assumptions.

The most reliable type of application of the logit model on the input data is the technique of sample enumeration. This means that the model is applied to each record in the data base obtained from the sample survey. The model output in terms of the probability of usage of each alternative is calculated for each respondent and then these are aggregated over the whole sample or segments of the sample. Applying the non-linear logit function on average input values will result in different and erroneous results. The sample enumeration technique is also more sensitive to changes in the input values.

The following aspects of the spreadsheet model are described in this chapter:

- Design of the spreadsheet model including the preparation of the input data, the structure of the spreadsheet, the output format and the assumptions made.
- Sensitivity testing and elasticities of locational choice factors included in the model.

- Formulation of suburbanisation scenarios and testing of the impact of the scenarios.
- Summary of importance ratings and elasticities of locational choice factors from all the analyses conducted during the research.
- Proposal on how business location models can be interfaced with conventional transport models.
- Conclusions on the most elastic choice factors and strategies for the management of decentralisation.

7.2 DEVELOPMENT OF SPREADSHEET MODEL

7.2.1 Development process and structure of spreadsheet

Development process

The spreadsheet model was developed in Excel format. The process to develop the spreadsheet involved the following main steps:

- Define model format: Although the calibrated model contained only a binary choice between the CBD and suburb locations, it was decided to apply the model for three locational choices to improve the policy testing capabilities of the model. The CBD, high-income suburb and low-income suburb were therefore specified as the three alternatives. A utility function for each alternative for each record or respondent interviewed was subsequently calculated. It was assumed that the coefficients of both the suburb alternatives would be the same according to the calibrated model. However, the input data and assumptions were varied between the suburb alternatives.
- Design structure and layout in terms of tables and worksheets: The different components of the model were divided into various work sheets of the spreadsheet. It was decided to provide for a status quo scenario to be specified, as well as three scenarios to be compared with the status quo scenario. Each scenario was inserted into a separate work sheet.

Explanation of calculations

Figure 7.1 gives a flow diagram of the calculations done in the spreadsheet. Simplified eqations are used in the Figure to better explain the calculations. The calculations are briefly described below:

- The base year model is initiated with a table containing the input assumptions and the logit model's coefficients (denoted by the symbol **c** in the Figure). The input assumptions are explained in a subsequent section, but these are basically the average values of the model's variables in order to calculate missing values of certain variables for each record in the data base.
- The input assumptions are used to impute values for missing data, and also to calculate certain new variables. The survey data consist of a full set of values for each variable and for each record. The survey data are collectively denoted by the symbol **X** in Figure 7.1.
- The logit equation of the discrete choice model is subsequently applied to the independent values in each record to estimate the market share for the CBD, as well as the shares of the low- and high-income suburbs for each respondent (shares denoted by the symbol **P**). The share is a function of (denoted by **f[ ]**) the coefficients, the survey data, and a constant (denoted by **C**) as indicated in the equation in Figure 7.1.

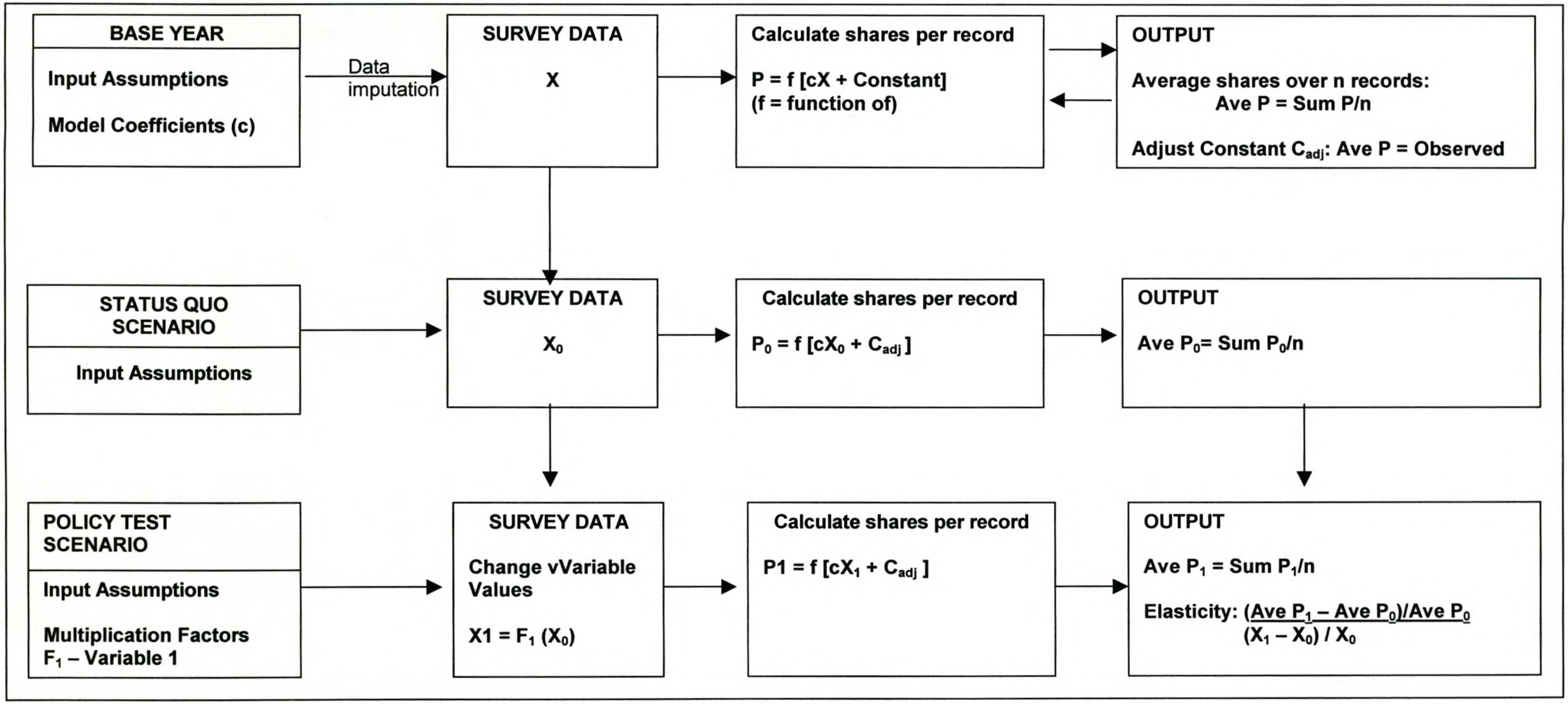


Figure 7.1: Simplified illustration of spreadsheet calculations

- The logit function has the following format, assuming three independent variables X1, X2 and X3, which have the same definition for all three alternatives, CBD, low-income suburb (sublo), and high-income suburb (subhi) :

$P_{cbd} = EXP\ (U_{cbd})\ /\ \{EXP\ (U_{cbd}) + EXP(U_{sublo}) + EXP(U_{subhi})\}$

----------*Equation 7.1*

Where: P_{cbd} = *probability of retailer locating in CBD (range of 0 to 1);*

EXP() = natural logarithm;

U_{cbd} = *utility of CBD* = $c_1X_1 + c_2X_2 + c_3X_3$ + *Constant*

U_{sublo} = *utility of low-income suburb*

U_{subhi} = *utility of the high-income suburb*

Also note that the sum of the probabilities across all three alternatives is equal to one ($P_{cbd} + P_{sublo} + P_{subhi} = 1$).

The share in percentage terms is obtained by multiplying the probability by 100 (share of CBD = P_{cbd} x 100)

- The output consists of the average share of each alternative location, veraging across all records (denoted by **Ave P**). The spreadsheet also adjusts the constant so that the modelled market shares are equal to the observed market shares. The user enters the observed shares in the input assumptions table. The adjusted constant is denoted by $\mathbf{C_{adj}}$.
- The same set of basic calculations is done for each scenario. A status quo scenario defines the scenario with which all the policy test scenarios are compared. The user can change the input assumptions for the status quo scenario if neccessary, but in general the status quo scenario is the same as the base year scenario.
- In order to test a policy, the user increases or decreases the values of the status quo survey data set ($\mathbf{X_0}$) by multiplying with a specified set of multiplication factors (**F**). A factor can be specified for each independent

spreadsheet updates the market shares for each alternative location.

- Another output that is provided for each policy test is the elasticity for each independent variable that is given by the equation under "Output" in Figure 7.1.

Description of worksheets

The information in the spreadsheet was structured into seven worksheets as follows:

- *CAL INPUTS:* Input assumptions, model parameters and model calibration outputs.
- *CAL DATA:* Survey data and modelled shares for calibration purposes.
- *POLICY TESTS:* Input assumptions for *status quo* scenario, multiplication factors for each variable and each scenario, modelled shares for each scenario, elasticities for each scenario, and a graph illustrating changes in locational shares.
- *SQ SCEN DATA:* Similar to *CAL DATA* worksheet but containing transformed data based on status *quo scenario* assumptions, and resulting modelled shares.
- *SCEN 1 DATA:* Same as *SQ SCEN DATA* but containing the transformed data for scenario 1and resulting locational shares.
- *SCEN 2 DATA:* As above for scenario 2.
- *SCEN 3 DATA:* As above for scenario 3.

Spreadsheet development process

The spreadsheet development involved the following activities:

- Import survey data consisting of a row for each interview and a column for each variable (worksheet *CAL DATA*).
- Estimate data for alternatives that were not surveyed: The survey data contained information for the urban area where the respondent's business was located. To apply the model, data are also needed for the alternative area so that the model can calculate the probability of locating the specific business of the respondent in each alternative area based on the

characteristics of each area. This data imputation process is described in more detail below.

- Create table with input assumptions: This allows input assumptions to be changed and sensitivity tests to be conducted on the assumptions (worksheet *CAL INPUTS*).
- Create table with model parameters and output table with shares calculated by the model. These tables are used for calibration purposes in order to adjust the suburb constants so that the modelled shares for the three alternative locations match observed shares for the whole study area (worksheet *CAL INPUT*).
- Create work sheet for status quo scenario, which contains a copy of the survey data, the transformed data based on the input assumptions for the status quo scenario, and the application of the model to the transformed survey data (worksheet SQ SCEN DATA).
- Create table with multiplication factors for each variable and each scenario: This table allows the user to specify a multiplication factor for one or more variables for each of the three scenarios. The specific variables in the survey data are then multiplied with this factor, and the changed locational shares are calculated (worksheet *POLICY TESTS*).
- Create worksheets for each of the three scenarios similar to that *of SQ SCEN DATA,* containing the transformed data for the scenario and the resulting locational shares (worksheets *SCEN 1 DATA, SCEN 2 DATA, SCEN 3 DATA*).

Figure 7.2 illustrates the spreadsheet structure in terms of the main components contained in each worksheet. Examples of the tables in each worksheet are provided in section 7.2.3.

7.2.2 Data imputation for alternative locations

For each of the three alternative locations, the model requires a value for each variable in the model and for each business where an interview was conducted. The values of the SP variables used during the survey represent hypothetical situations in order to determine how the respondents' choices would vary between different levels. These values can obviously not be used in the application of the model. The background survey data provided the information for each respondent's current location. For example, if the current location was the CBD, values for each variable in

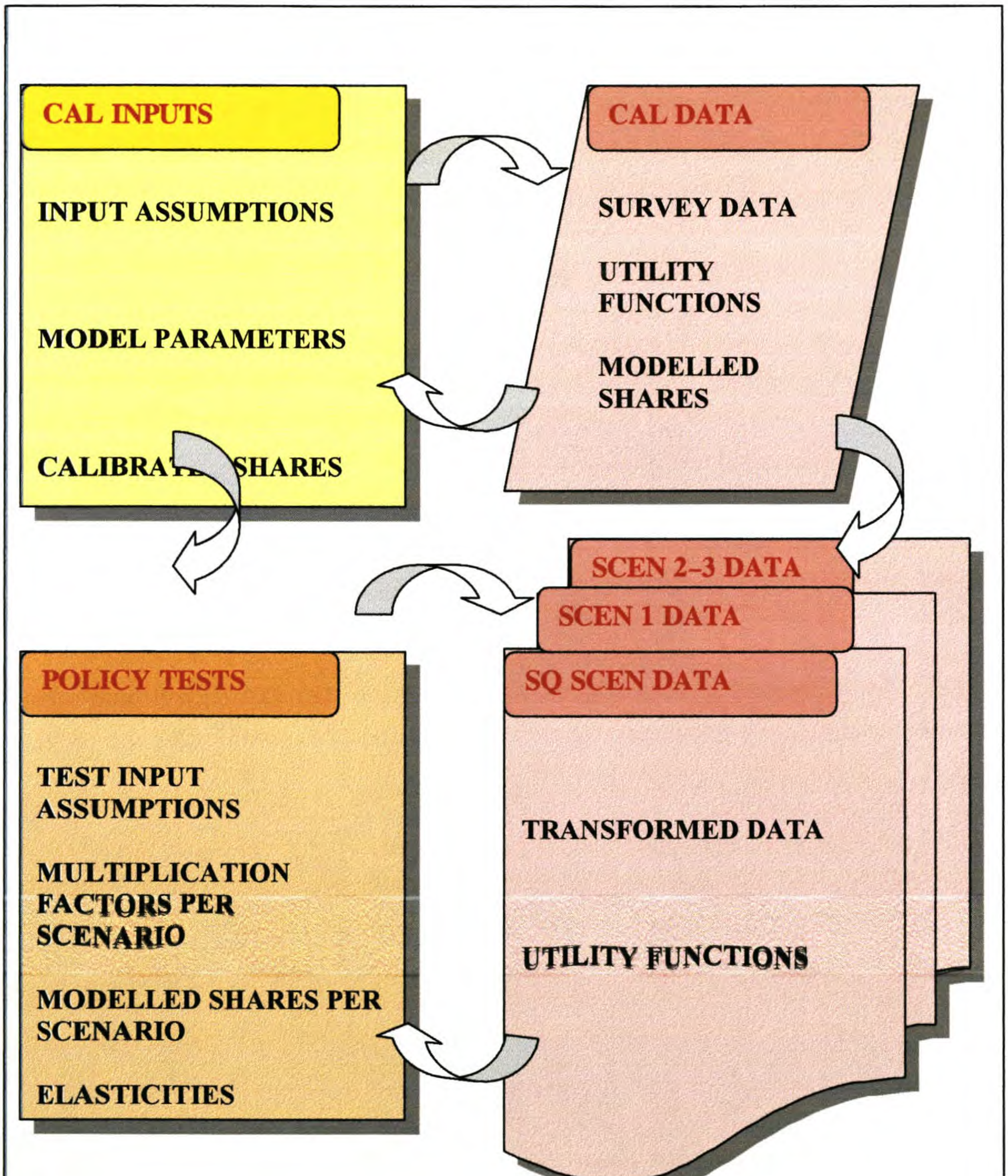


Figure 7.2: The structure of the spreadsheet model

the model need to be estimated for the low and high-income suburbs. The reported value for the respondent's current location was used, and the values for the alternative locations were estimated from average values according to type of business and shopping centre from the rest of the survey data. In this process various assumptions had to be made and these were entered in a table. The spreadsheet was designed in such a way that the imputed values are linked to the assumptions so that the impact of changed assumptions can be determined.

Model 1 in Table 6.4a was included in the spreadsheet. Although this was not the best model that was calibrated in terms of statistical fit, it was selected for two reasons:

- The model was calibrated on the full data set, which avoids possible biases resulting from the smaller datasets of the segmented models.
- It contains the size of the shop, in square metres, which is often more readily available from local council records, rather than employment.

The following seven variables were used in the spreadsheet (abbreviations used in tables are given in brackets):

(i) Rent of retail space (**Rent**) (Rand per square metre per month).

(ii) Generalised access time from transport to shop (minutes) based on walking time (**Walk time**, **Wk time**), parking fee (**Park fee**) and value of time (**VOT**).

(iii) Road access for suburb (**Rd access**) (major or minor road dummy).

(iv) Size of shopping centre in suburb (**Size centre**) (number of shops).

(v) Floor space of shop in CBD (**Size shop**) (GLA in square metres).

(vi) Income of suburb (**Income**) (low vs high-income dummy).

(vii) Current location of shop (**CBD location**) (dummy indicating CBD or not).

Variables were defined for each location, i.e. the CBD, low-income suburbs (**low sub** or **lo sub**) and high-income suburbs (**high sub** or **hi sub**). In subsequent tables and graphs the location to which each variable relates to is indicated by means of the relevant abbreviation eg. **CBD, low sub** or **high sub.**

The data imputation for each variable is discussed below:

Rent

The values for the RENT variable were generated from a normal distribution with average and standard deviation estimated from the survey data for the three locational market segments. A spreadsheet function generating a distribution from specified parameters was used for this purpose. Each time the model is applied by changing any input value, a new set of values is generated for the alternative locations to the current locations. The actual distributions of rent from the survey data were found to be skewed and the parameters specified could yield negative rents based on the normal distribution. A minimum rent was therefore also specified to overcome this problem.

Generalised access time

In order to provide greater policy testing capability it was decided to enter a generalised transport access time instead of the walking time used in the calibrated model. The generalised time function is similar to the generalised cost function concept used in transport modelling. The parking fee together with assumed values of time (VOT) were used to estimate the equivalent time of the parking fee. This was added to the reported walking time to obtain the generalised access time. The coefficient for walking time was assumed to apply to the generalised access time as well.

Weighted average walking times calculated using reported walking times by mode (car, bus, mini-bus taxi and train) and typical modal splits reported by Crous and Clark for Cape Town (2000). Values of time from SP and RP studies conducted by Clark in Cape Town were also used (Crous and Clark, 2000).

Reported parking fees from the survey were averaged for the different locations. It was further assumed that the walking time intervals used in the survey would be translated into absolute times as follows:

- Less than 5 minutes = 2 minutes
- More than 5 minutes = 7 minutes

Road access

The road access variable took the form of a dummy variable for suburban shops located on a major road (1) or on a minor road (0). For the alternative location, a weighted average value was calculated according to the percentage of shops reported to be on a major or a minor road. These weighted values therefore vary between 0 and 1.

Size of centre

The size of the shopping centre in the suburb was specified in terms of the number of shops. For the alternative location, the average number of shops per centre for small, medium and large shops and for low and high-income suburbs was used. This variable was set to zero for street-front shops.

Size of shop

The floor space of the shop was entered into the CBD utility function. It was assumed that the retailer's current reported floor space in terms of GLA would apply whether he/she located in the suburb or the CBD. It was therefore not necessary to impute any GLA values.

Suburb income

Suburb income is a dummy variable entered according to whether the shop is located in a high-income area such as Bellville or Durbanville (=1), or in a low-income suburb such as Langa or Nyanga (=0). For a shop located in the CBD, a weighted average value according to the assumed percentage of retail GLA in low-income and high-income suburbs was used.

This variable captures not only the income of the suburban markets but also the social and infrastructure characteristics of the suburbs. Any change in this variable can be interpreted as a change in the market potential of the high-income suburbs relative to that of low-income suburbs representing changes in the distribution of population and income.

Current location

The current location variable measures the retailer's inertia to change and is entered as a dummy variable into the CBD utility function. If the respondent's current location is in the CBD, the value is equal to 1, otherwise it is 0. This variable therefore increases the utility of the CBD relative to the suburb with a constant value, while the attraction of the suburbs due to any improvement to the utility of the suburb relative to the CBD, is reduced to a certain extent.

Calibration of suburb constant

The constant is entered into the utility function of each alternative and it controls the relative shares of the various alternatives. The constants are normally adjusted so that the model will yield the observed shares of the alternatives at the current levels of the independent variables. A simple equation (equation 7.2) is used to adjust the constant from the calibrated value to yield any specified distribution of shares.

Adj. Constant of Alt_i =

(Cal Constant of Alt_i*) + Ln (Obs Share* Alt_i */ Mod share* Alt_i*) --------- Equation 7.2*

where:

Adj Constant of Alt_i *i = Adjusted constant of Alternative i*

Obs Share Alt_i *= Observed Share of Alternative i*

Mod Share Alt_i *= Modelled Share of Alternative i*

The calibrated constant of the CBD was arbitrarily set to zero, and the calibrated constant of the high-income suburb alternative was set to equal the ALOGIT calibrated constant. The initial calibrated constant of the low-income suburb was set to yield modelled shares roughly in proportion to the observed shares. The adjusted constant for each alternative is calculated from equation 7.2 based on the set of calibrated constants, and the modelled and observed shares.

The spreadsheet automatically adjusts the constants to match the observed shares entered by the user.

7.2.3 Main input and output tables

Tables 7.1 to 7.3 illustrate the main input and output tables in the spreadsheet. Table 7.1 gives the input assumptions referred to in the previous section. Table 7.2 gives the model parameters, and the calibrated and observed shares of the various retail locations. Table 7.3 illustrates the input of the multiplication factors for each variable and each scenario, as well as the output in terms of the modelled shares for each scenario. The percentage change in the shares for each scenario relative to the status quo scenario is also given.

From these outputs the elasticities are calculated for any given change in the input value of a choice factor as follows:

Elasticity of Choice Factor i for Alternative A =
% Change in Share of Alternative A / % change in value of Choice Factor i
- - - - - Equation 7.3

Figure 7.3 illustrates the main output which consists of the elasticities and a graph of the percentage change in the share of the CBD, and the shares of the low and high-income suburbs plotted against the values of the selected multiplication factor, CBD Rent, under scenarios 1, 2 and 3. The user can select the factor for which the elasticities and graph must be showed. The scenarios give the results of an increase in the value of CBD rent of 10 %, 20 % and 30 %.

The share of the CBD decreases by between 5 and 15 percent, i.e.from 28 % for the status quo, to 24 % under scenario 3. This resulted in an increase in shares of the suburb locations of between 2 and 8 per cent. The direct elasticity of the CBD's share at a 10 per cent increase in the rent is -0.5, while the cross elasticities for the low and high-income suburbs are 0.3 and 0.2. The elasticities remain very similar for 20 and 30 per cent increases in the rent.

Table 7.1: Input assumptions in spreadsheet model

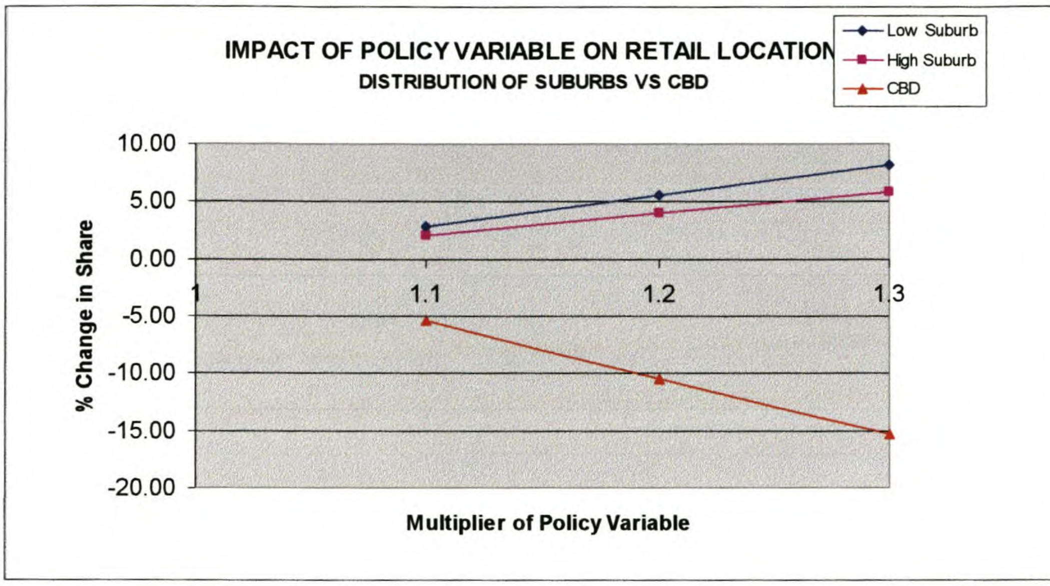
VARIABLE	CBD	LOW SUBURB	HIGH SUBURB	TOTAL
% Split (CBD, Sub)	29	6.8	64.2	**100**
% Split (LoSub, HiSub)		9.6	90.4	**100**
RENT (R per mnth)				
Ave Rent	94	65	93	
Std deviation	170	148	54	
Minimum Rent	40	19	39	
Modal Split				
% Car	44	20	90	
% Bus	8	20	2	
% Taxi	13	36	5	
% Train	35	24	3	
Walk Time (min):				
Wk Time Car	4.8	2.1	5	
Wk Time Bus	5	2.9	2.5	
Wk Time Taxi	4.9	2.5	2.4	
Wk Time Train	5.1	5	5.5	
Ave Wk Time	4.9	3.1	4.8	
Park Fee (R/hr)	1.35	0.05	0.15	
Value of Time (R/hr):				
Car	40	40	40	
PT	10	10	10	
Ave VOT (R/Hr)	23.2	16	37	
% Split Centre Size:				
Small centre %		70	10	
Medium centre %		20	10	
Large centre %		10	80	
Size of Centre				
Small (no. shops)		26	30	
Medium (no. shops)		70	100	
Large (no. shops)		200	230	
Ave Size (no Shops)		52.2	197	**183**
Major/minor Rd Dummy:				
%On Main Rd		85	45	
Value Main Rd		1	1	
Value Minor Rd		0	0	
Ave Value		0.85	0.45	**0.49**

Table 7.2: Spreadsheet table: model parameters and calibration of constants

VARIABLE	COEFF	LowSub	HighSub	CBD
Rent CBD	-0.0126			
Rent sub	-0.0126			
Wk time CBD	-0.062			
Wk time sub	-0.027			
Rd access sub	0.314			
Size centre sub	0.004			
Income sub	1.179			
Cbd location	1.099			
Size shop CBD	-0.00017			
Constants	0.0402	-2.9	0.02	0
Model Share Iter. 1 (%)		4.60	75.20	20.19
Observed Share (%)		6.80	64.2	29.00
Adjusted constants		-2.519	-0.138	0.362
Final Model Share (%)		**6.65**	**65.94**	**27.41**

Table 7.3: Spreadsheet table: multiplication factors and modelled shares (example of how an increase in the CBD rent is tested)

	VARIABLE	MULTIPLICATION FACTORS		
		SCEN 1	SCEN 2	SCEN 3
1	**CBD Rent**	**1.10**	**1.20**	**1.30**
2	Suburb Rent - Low	1.00	1.00	1.00
3	Suburb Rent - High	1.00	1.00	1.00
4	Parking Fee CBD	1.00	1.00	1.00
5	Parking Fee Low Sub	1.00	1.00	1.00
6	Parking Fee – Hi Sub	1.00	1.00	1.00
7	Walk time – CBD	1.00	1.00	1.00
8	Walk Time – Low Sub	1.00	1.00	1.00
9	Walk Time –Hi Sub	1.00	1.00	1.00
10	Ave VOT CBD	1.00	1.00	1.00
11	Ave VOT LowSub	1.00	1.00	1.00
12	Ave VOT Hi Sub	1.00	1.00	1.00
13	% Major vs Minor road	1.00	1.00	1.00
14	Size Centre Low Sub	1.00	1.00	1.00
15	Size Centre Hi Sub	1.00	1.00	1.00
16	Income Suburb	1.00	1.00	1.00
17	CBDLocation	1.00	1.00	1.00
18	Size of Shop (GLA)	1.00	1.00	1.00
Scen	% LOW SUBURB	6.84	7.03	7.20
Scen	% HI SUBURB	66.30	67.56	68.76
Scen	% CBD	26.86	25.41	24.04
SQ	% LOW SUBURB	6.65	6.65	6.65
SQ	% HI SUBURB	64.97	64.97	64.97
SQ	% CBD	28.37	28.37	28.37
%CHNGE	% LOW SUBURB	2.87	5.61	8.23
%CHNGE	% HI SUBURB	2.04	3.98	5.83
%CHNGE	% CBD	-5.34	-10.43	-15.27



GRAPH SELECTION		MULTIPLIER (M)		
Select Input Variable	Policy Variable	M1	M2	M3
1	CBD Rent	1.1	1.2	1.3
ELASTICITIES	% LOW SUB	0.287	0.281	0.274
	% HI SUB	0.204	0.199	0.194
	% CBD	-0.534	-0.521	-0.509

Figure 7.3 Example of spreadsheet output: graph, giving change in share of various locations and elasticities resulting from increases in CBD rent

7.3 SENSITIVITY TESTING AND ELASTICITIES OF LOCATIONAL CHOICE FACTORS

The spreadsheet model was used to determine the elasticities of locational choice with respect to each of the choice factors. The input values of each factor were increased by 10, 20 and 30 per cent, in turn, keeping the values of all the other factors at their default values. Table 7.4 gives the percentage change in the share of each location relative to the *status quo* share for a 10 and 30 per cent increase in each choice factor. The direct elasticity at a 10 percent increase of each factor is also given. The table also gives elasticities estimated by ALOGIT as reported in Chapter 6 for comparative purposes. A negative elasticity means that an increase in the factor for a particular location results in a reduction in share, and *vice versa*. Due to many zero parking fees in the suburbs, an additive factor between R0.5 and R1.5 was applied to parking fee.

Figure 7.4 illustrates the absolute value of the elasticities arranged from high to low in graphical format.

When interpreting the results of the locational choice model, it must be appreciated that the changes in the shares of alternative locations will only take place over the long term. An annual growth rate of 2.7 per cent per annum in any factor will yield a 30 per cent change over a ten year period, while a 5.4 per cent growth rate per annum will yield a 30 per cent change over 5 years. The model does not predict the time period, but only states that a certain change in the share of the CBD or suburb location will take place if the value of the choice factor changes by a certain amount over a period, assuming everything else stays the same.

The results indicate elasticities in the order of less than 0.1 up to 0.53. The intervals of elasticity defined in Chapter 6 are used here as well, i.e. elasticities between 0.3 and 0.53 are regarded as high, 0.1 to 0.3 as medium, while values less than 0.1 are low or inelastic.

Table 7.4: Change in locational shares and direct elasticities resulting from changes in choice factor values

Factor	% Change in Share (10 to 30 % increase)	Direct Elasticity at 10 % increase	ALOGIT Elasticities Total Sample
Rent CBD	-5.3 to -15.2	-0.53	
Rent Low Sub	-4.0 to –11.5	-0.40	Tot Sub
Rent Hi Sub	-4 to –12.1	-0.41	-0.4
Walk Time CBD	-1.9 to –5.7	-0.19	
Walk Time Low Sub	-0.8 t0 –2.3	-0.08	Tot Sub
Walk Time Hi Sub	-0.4 to –1.2	-0.04	-0.06
VOT Hi Sub	+ 0.02 to + 0.06	0.002	
Rd Access Hi Sub	+0.14 to + 0.43	0.014	Tot Sub
Rd Access Low Sub	+0.08 to + 0.24	0.008	0.05
Size Centre Low Sub	+3.2 to +10.2	0.32	Tot Sub
Size Centre Hi Sub	+1.7 to +4.9	0.17	0.1
Income Hi Sub	+1.7 to +4.8	0.17	0.18
Size Shop CBD	-0.33 to –0.99	-0.033	-0.03
	(R0.50 to R1.50 addition)		
Park fee CBD	-4.9 to –14.4	-0.13	
Park Fee Hi Sub	-0.7 to –2.0	-0.002	

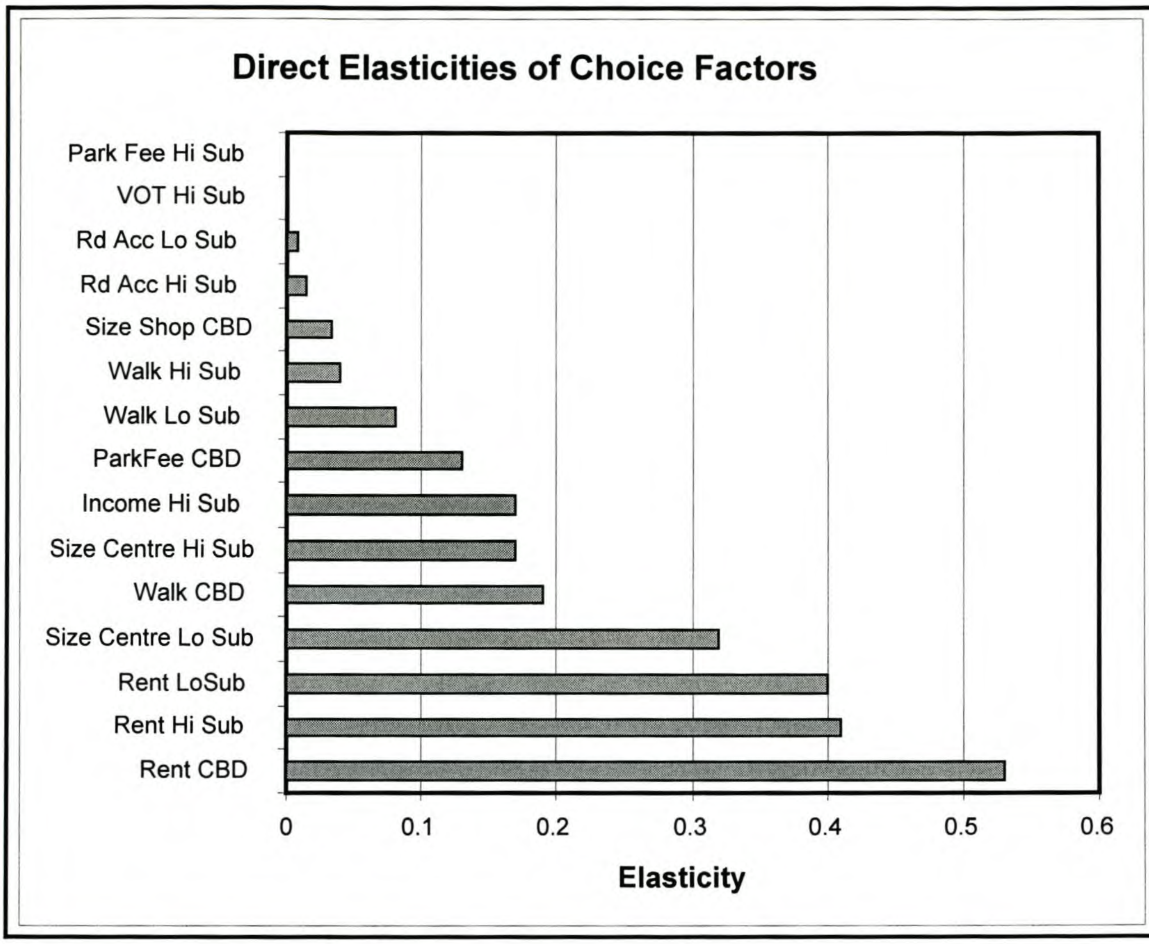


Figure 7.4: Absolute elasticities of locational choice with respect to various choice factors

According to Table 7.4, rent has the highest impact in terms of percentage change in market share, up to 15 per cent, followed by parking fees, up to 14 per cent, and the size of shopping centres, up to 10 per cent. Access to transport (walk time) and market potential (high versus low-income) result in impacts of 5 to 6 per cent.

The most elastic choice factors (elasticity above 0.3) which should be the priority consideration in the formulation of policies to manage urban decentralisation are:

- Rent for all locations; and
- Size of the shopping centre in lower-income suburbs.

This is plausible as cost is one of the main considerations for any business, while the size of shopping centre and the shopping mix could also have a majr impact as is evident from the large influence exerted by regional shopping centres such as Menlyn in Pretoria, Sandton City and East Gate in Johannesburg and the Water Front and Canal Walk in Cape Town. Often smaller centres in the vicinity suffer because of these developments. These results are confirmed by reports of various property analysts concerned about the impact of regional centres on established centres as discussed in Section 5.6.7.

Choice factors with medium elasticities of between 0.1 and 0.3, which should also be considered in policy formulation, are:

- Walk time from transport to shop in the CBD.
- Size of centre in high-income suburbs.
- Income and character of the suburb.
- Parking fee in the CBD.

The transport and accessibility factors are therefore not very elastic, but significant to warrant careful consideration. In combination, these transport factors that are normally considered important in land-use and transport planning, can have a high impact.

Factors that are not elastic and which may receive less attention are:

- Walk time from transport to the shop in the suburbs.
- The size of the shop in the CBD.
- Road access in the suburb, i.e. shop located on major or minor road.
- The value of time.
- Parking fee in the suburbs.

Table 7.4 indicates that the elasticities estimated with the ALOGIT software on the survey data are very similar to those estimated with the spreadsheet model for most of the factors. The largest differences occur with size of centre and road access. However, road access has a small elasticity in both cases, while ALOGIT estimates a lower elasticity for Size of centre compared to the spreadsheet. Although the input data and market shares of the CBD and suburbs differ between the two sets of elasticities, the results do not seem to be sensitive to these differences.

When interpreting the elasticities, it should be borne in mind that the elasticity is not only a function of the sensitivity or weight (coefficient) in the model, but also of the range of values of the input factor in the sample data and the current share of the alternative. As a result of the low share of low-income suburbs in retail, a change of say two percentage points in the share will yield a larger percentage change in share than for high-income suburbs which has a larger current share. For example, the 10 per cent increase in the number of shops in the centre caused the share of high-income suburbs to move up with 1.1 percentage points, while the share of low-income suburbs moved up with only 0.21 percentage points. Applying these absolute increases to the current shares, yields a much larger percentage change in share for low-income suburbs compared to that of high-income suburbs, i.e. 3.2 percent compared to 1.7 percent. This resulted in the higher elasticity of size of centre for low-income suburbs.

It is therefore also useful to look at the absolute impact of changes in choice factors and not only at the relative impact. As the level of input values differs between locations, it is best to assess the impact of various factors separately for the different locations. Figure 7.5 illustrates the absolute differences in shares between scenario 3 (30 % increase in value of factors) and the *status quo* scenario grouped by location.

The factors having the highest absolute impact (2 percentage points) in all areas are rent in the CBD and high-income suburb, size of centre in high-income suburb, and the market potential (high versus low-income) of high-income suburbs. The factors impacting significantly on the CBD are rent, walk time and parking fee. For the high-income suburb the significant factors are rent, size of centre, market potential, and walk time. The impacts on the low-income suburbs are generally low because of the low values of the choice factors. Rent, size of centre and market potential have the highest impact on low-income suburbs.

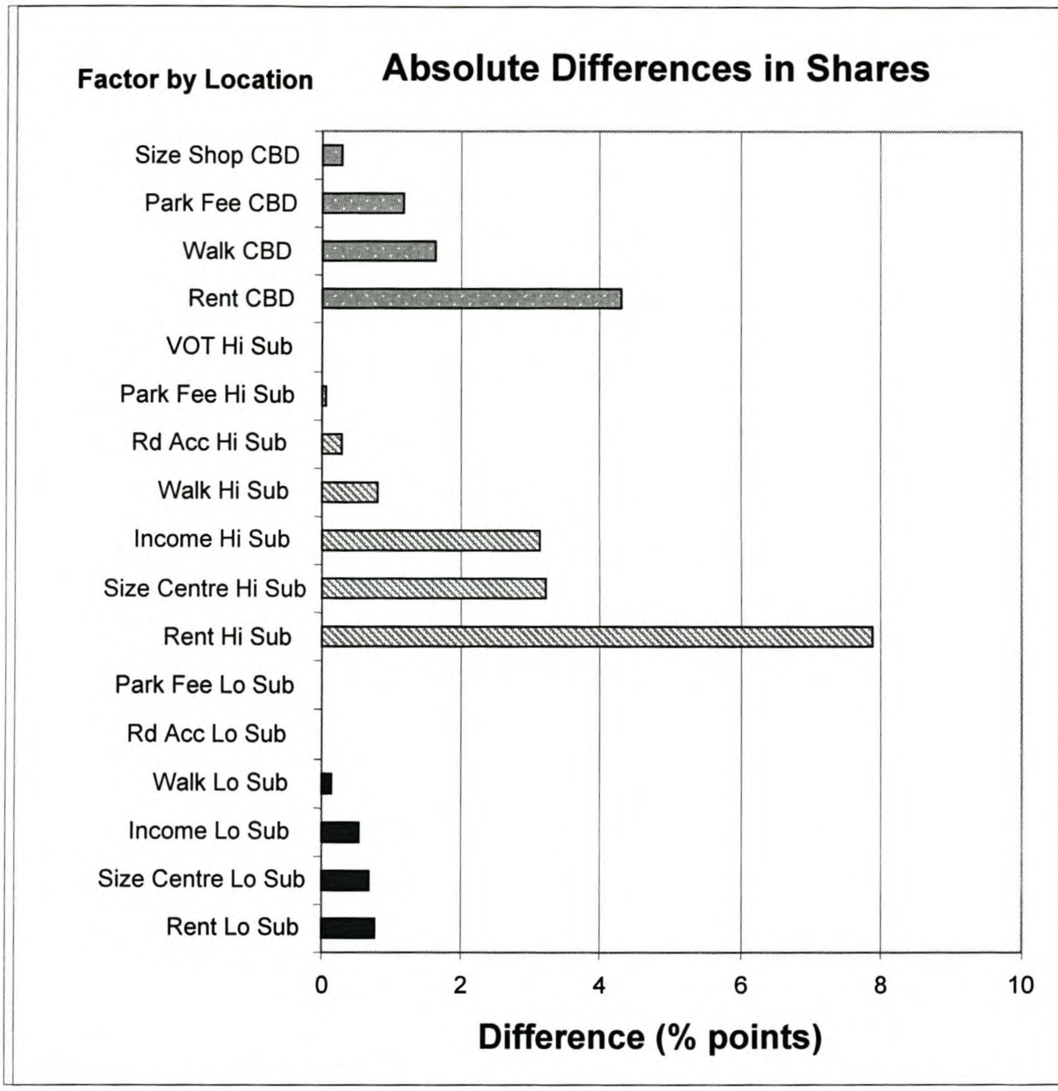


Figure 7.5 Absolute differences in shares based on a 30 per cent increase in choice factor

A final dimension of these results is the cross elasticity. A change in any factor in one location not only impacts on that location, but also on the other locations as a gain in one location means a loss in other locations. The cross elasticities measure these indirect impacts. A rank order of all direct and cross elasticities is useful for assessing all impacts as given in Table 7.5.

Table 7.5: Absolute direct and cross elasticities impacting on each location and sorted by rank for each location

Factor	LOW SUB	Factor	HI SUB	Factor	CBD
RENT HI SUB	0.84	RENT HI SUB	0.41	RENT HI SUB	0.74
RENT LOW SUB	0.40	RENT CBD	0.20	RENT CBD	0.53
SIZE CENTRE LO SUB	0.32	SIZE CENTRE HI SUB	0.17	SIZE CENTRE HI SUB	0.32
RENT CBD	0.31	INCOME SUB	0.17	INCOME SUB	0.32
SIZE CENTRE HI SUB	0.31	WALK CBD	0.07	WALK CBD	0.19
INCOME SUB	0.28	PARK FEE CBD	0.05	PARK FEE CBD	0.14
WALK CBD	0.09	WALK HI SUB	0.04	WALK HI SUB	0.08
WALK LOW SUB	0.08	RENT LOW SUB	0.03	RD ACCESS SUB	0.04
WALK HI SUB	0.08	SIZE CENTRE LO SUB	0.02	RENT LOW SUB	0.03
PARK FEE CBD	0.07	RD ACCESS SUB	0.01	GLA SHOP CBD	0.03
SIZE SHOP CBD	0.02	WALK LOW SUB	0.01	SIZE CENTRE LO SUB	0.02
RD ACCESS SUB	0.01	SIZE SHOP CBD	0.01	WALK LOW SUB	0.01

The share of low-income suburbs will experience the highest impact due to changes in other areas. Rent changes in high-income suburbs have the highest overall impact. Constraints not simulated in the model will, however, limit this impact. Other significant impacts come from size of centre in its own location, rent in the CBD, size of centre in high-income suburbs, and market potential in suburbs.

The impacts on the high-income suburbs are generally lower due to its higher share. High-income suburbs are most affected by changes in rent in the CBD and in its own location, size of centre in its own location, and market potential of suburbs.

The CBD is most affected by rent in its own location and the high-income suburbs, size of centre in the high-income suburbs, income potential in the suburbs, transport access in the CBD and parking fees in the CBD.

7.4 TESTING OF SUBURBANISATION SCENARIOS

7.4.1 Context of scenario testing

In this section the testing of various scenarios in terms of the locational factors included in the spreadsheet model is described. The main application of the locational choice model in urban land-use transport planning is to determine the demand for retail space in the CBD and the suburbs. Similar to normal practice when conducting scenario testing, a trend scenario was formulated to determine the impact on decentralisation if locational forces are allowed to follow past trends. To determine how effective a combination of various interventions would be to reduce the trend in decentralisation, a managed decentralisation scenario was formulated and tested.

The model estimates the aggregate probability of retail managers choosing the CBD and the suburbs for their business location. This can be interpreted as the proportion of businesses that will locate in the CBD and the suburb. The proportions can be applied to the total demand for retail space in the whole metropolitan area from a separate analysis. The number of businesses can subsequently be converted to demand for retail space or employment by applying average ratios of retail area per business or employment per business. This demand for retail space must be distinguished from the actual supply of retail space.

Following the model calibration process, it is normal practice to validate the model on historic trend data to determine how accurate the model will simulate real life trends. Unfortunately it was not possible to validate the locational choice model due to the lack of trend data of some independent variables, and the lack of data of trends in decentralisation, which is the output of the model. A detailed investigation of all the planning data at the disposal of the Cape Town Metropolitan Council (CMC) was also not possible considering the scope of this dissertation. The scenario testing done for the purpose of the dissertation was to demonstrate the application of the model and to determine typical impacts of changes in locational factors on decentralisation.

7.4.2 Formulation of scenarios

Values of the independent variables, or locational factors, were estimated for both the trend scenario and the managed decentralisation scenario using data from various sources. Planning reports of the CMC, bulletins of Statistics S.A., and Rode's Retail Reports were used for this purpose.

A time horizon of ten years was used. The percentage change in the value of each locational factor over a ten-year period was used as the multiplier factor defined in the spreadsheet.

In view of the lack of trend data and the potential significant impact of the large Canal Walk shopping centre recently developed in Cape Town, it was decided to formulate two trend scenarios – with and without the Canal Walk centre. Canal Walk is part of a larger development, Century City, some ten minutes drive from the CBD along the N1 freeway. As such it is a typical suburban shopping centre aimed at the higher income car owner and it is easily accessible from the freeway from a dedicated interchange.

Rent of retail space

The only source of retail rent data is Rode's Retail Report which is published every three months. Publications from 1994 to 2001 were reviewed to obtain growth rates in retail rent. Rents published by Rode are obtained from sample surveys of retail businesses and are given for various floor area sizes and locations, distinguishing between street-front shops and shopping centres.

Table 7.6 gives the growth in rent for street-front shops and shopping centres, and the ratio of street-front shops to centres for both the CBD and the suburbs. Interestingly, the average growth in rent is similar for the CBD and the suburbs. However, the growth in rent of street-front shops is significantly lower than that of shopping centres. Due to the fact that the CBD consists mainly of street-front shops, and the suburbs mainly of shopping centres, the weighted average growth in rent in the CBD is lower than that in the suburbs. The average growth in rent was finally adjusted for inflation.

Table 7.6: Growth in rent of retail space (Rode's Retail Report)

	CBD	Suburbs
Rental growth – str. front shops (% p.a.)	6	5.9
Rental growth – centres (% p.a.)	9.9	10
Proportion st. front GLA (%)	89	45
Weighted ave. rental growth (% p.a.)	6.4	8.2
Rental growth adjusted for inflation (6 % p.a.)	0.4	2.1

The growth in rent indicated in Table 7.6 was used for the trend scenario. For the managed decentralisation scenario it was assumed that the CMC would charge a levy on suburban centres, or provide an incentive to CBD retailers. The Act on Property Tax makes it possible for local authorities to charge a levy on property owners that can give authorities the necessary income to revive CBD's (Rapport, 17 September, 2000). It was therefore assumed that a 10 per cent levy would be charged on suburban retailers' property tax, and that the property tax would be 10 per cent of the average rent. The rent of CBD retailers was kept the same as for the trend scenario.

Parking fees

Due to the general scarcity of short-term parking space in the CBD, it was assumed for the trend scenario that parking fees in the CBD would grow 5 per cent per annum more than in the suburbs in real terms. For the managed scenario the proposed parking supply and pricing policy of the CMC to increase parking space for short-term parking users will result in a 5 per cent growth per annum of parking fees of suburbs relative to that of the CBD in real terms.

Access to transport

Due to the higher traffic congestion in the CBD compared to the suburbs, and the scarcity of parking in the CBD, it was assumed that accessibility of the CBD would decline relative to that of the suburbs. The Moving Ahead study (Cape Town Metropolitan Council, 1998) reported a growth of 2.8 per cent per annum in commuter traffic yielding an increase of 32 per cent over ten years. In congested conditions, the delays caused by traffic congestion will grow more than the volume. A typical volume delay function used in traffic models suggests that an increase in traffic volume will result in an increase of 48 per cent in delay.

The policy of the CMC to promote public transport and the proposal to increase parking fees for long-term parking users giving a further incentive for car users to switch to public transport, will result in improved accessibility of the CBD. It was therefore assumed that the managed scenario would yield a decrease of 50 per cent in the growth of delays compared to the trend scenario.

Road access in suburbs

As it is difficult to conceive how road access of shopping centres will change over time, it was decided to test the impact of the Canal Walk centre which has good access to the N1 freeway. Two tend scenarios were therefore tested. For the first trend scenario the road access factor was kept constant, while it was increased with 17 per cent for the second trend scenario. The retail area of the Canal Walk centre added some 17 per cent to the total area of suburban shopping centres.

Size of shopping centre in suburbs

Two trends have emerged during the last few years with regard to the size and type of shopping centres that have been developed. Firstly, large regional centres such as Canal Walk in Cape Town, the upgraded Menlyn in Pretoria and Gateway in Umhlanga have become very popular in South Africa. Currently there are ten such centres countrywide varying from 65 000 to 127 000 m^2 in size. (Finansies en Tegniek, 23 February 2001).

The other trend is the development of small convenience centres of less than 5000 m^2 driven mainly by a number of family grocery stores that came on the market (Finansies en Tegniek, 12 January, 2001). The downward effect of new convenience centres on the average size of suburban centres is unlikely to have any impact on the competition between the CBD and the suburbs, and this trend can be ignored.

To illustrate the impact of the large regional centres, the increase in the average size of centres in the suburbs as a result of the development of Canal Walk, was assumed as part of the second trend scenario. The average size of suburban centres increased with 13 per cent with the addition of Canal Walk.

For the managed scenario, it was assumed that the impact of the increasing size of centres in the suburban areas would be kept constant by balancing the supply of centres between the CBD and the suburbs. Development of centres in the CBD such as the Foreshore Conference Centre will also counter the attraction of suburban centres.

Size of shops in the CBD

Lack of trend statistics with respect to the size of shops made any assumptions impossible. It was therefore assumed that size of shops would remain the same for all the scenarios.

Access to market potential of suburbs

Two factors that play a role in the growth of the suburban retail market were considered. The first is the growth in buying power of suburban residents that can be measured in terms of the growth of employed residents and growth in their average income. However, this market potential can only be realised if there is a supply of retail space. The controlling factor is therefore the growth in the supply of retail space, especially in the high-income suburbs as simulated by the locational choice model.

From Rode's Retail Reports it was estimated that the growth in GLA in high-income suburbs from 1994 to 2001 was 8.9 per cent per annum including Canal Walk, and 3.7 per cent excluding Canal Walk. The supply of retail space increased by almost 50 per cent over the last seven years.

From the Moving Ahead report, a growth of 2.5 per cent in employment is expected in the Cape Town Metropolitan area from 1995 to 2015. From surveys of employment and earnings Statistics SA reported an annual growth of 8.4 per cent in income at national level (Statistics SA, September 2001). In real terms this amounts to a growth of 2.3 per cent assuming an inflation rate of 6 per cent. If it is assumed that Cape Town employees have experienced a similar growth in income as the national average, and this income growth is combined with the employment growth in Cape Town, a real growth of approximately 4.9 per cent per annum in the aggregate income of all employees is obtained. The supply of retail space in Cape Town, excluding Canal Walk, is therefore in line with the growth in buying power. However, with the addition of Canal Walk, there seems to be an over-supply of retail space, unless the tourism market can provide the additional demand.

For the first and second trend scenarios, a growth of 3.7 and 8.9 per cent per annum, respectively, in the accessibility of suburban market potential, was assumed. This simulates the impact with and without Canal Walk.

For the managed decentralisation scenario it was assumed that the supply of retail space in high-income areas would be controlled so that the growth in supply would be in line with demand. A growth of 3.7 per cent in accessibility to suburban market potential similar to the first trend scenario was therefore assumed.

External factors

To demonstrate the impact of external factors, of which safety and security are the most significant, the CBD loyalty factor or inertia to relocate from the CBD was used as a measure of the impact of external factors. If the various strategies of the Cape Town Partnership to revitalise the CBD are successful, crime and other negative factors impacting on the CBD can be reduced significantly. It was assumed that crime would be reduced by 30 per cent over the ten year planning horizon. This is a modest decrease of 2.7 per cent per annum. The CBD loyalty factor was therefore assumed to increase by 30 per cent for the managed scenario, while no changes were made for the trend scenarios.

7.4.3 Impact of retail decentralisation trend and management scenarios

The growth rates of the various locational factors defined for each scenario were converted into multiplier factors over a ten year period and entered into the spread sheet model. Table 7.7 gives the multiplier factors for each scenario as well as the impact of each factor separately in terms of the percentage change in the share of the CBD relative to the base year. The total impact of each scenario is also given in terms of the share of the CBD and the suburbs for the three scenarios, the base year shares, and the percentage change between the scenario shares and the base year shares. The elasticity of each factor with respect to the CBD is also given for comparative purposes (from Table 7.5). Figure 7.6 illustrates the results graphically.
The trend scenario excluding the impact of the Canal Walk centre reduces the share of the CBD with 11 per cent over ten years, and increases the share of the suburbs with 4.4 per cent. The Canal Walk centre has a major impact on decentralisation – the share of the CBD reduces with 35 per cent and the share of the suburbs increases with 14 per cent. In contrast, the managed decentralisation scenario indicates that a combination of strategies to attract retailers to the CBD can have a significant positive impact on the share of the CBD, in the order of a 23 per cent increase in share.

In terms of the typical changes in the locational factors over a ten-year period, the accessibility of the suburban market and the relative changes in rent between the CBD and the suburbs have the highest individual impact. The results demonstrate that despite the positive impact of the lower growth in rent in the CBD compared to the suburbs, negative factors impacting on the CBD outweigh this positive impact.

Table 7.7: Impact of decentralisation scenarios on CBD and suburb shares estimated with locational choice model

FACTOR	MULTIPLIERS			ELAS= TICITY	% CHANGE CBD SHARE		
	TREND 1	TREND 2	MAN DEC	TABLE 6.5 CBD	TREND 1	TREND 2	MAN DEC
RENT CBD	1.04	1.04	1.04	0.53	+19.5	+19.5	+34.6
SUB LOW	1.18	1.18	1.18				
SUB HIGH	1.32	1.32	1.53				
PARK CBD	+0.85	+0.85	+0	-0.14	-8.5	-8.5	+0.3
SUB LOW	+0	+0	+0.1				
SUB HIGH	+0	+0	+0.1				
WALK CBD	1.48	1.48	1.24	-0.19	-9.0	-9.0	-4.6
SUB LOW	1	1	1				
SUB HIGH	1	1	1				
RD ACC SUB	1	1.17	1	-0.04	0	-0.6	0
SIZE CENTRE:					0	-4.6	0
SUB LOW	1	1	1	-0.02			
SUB HIGH	1	1.13	1	-0.32			
INCOME SUB	1.44	2.35	1.44	-0.32	-13.3	-34.6	-13.3
CBD LOCATION	1	1	1.3		0	0	+8.0
SIZE SHOP	1	1	1	-0.03	0	0	0
SCEN SUB (%)					**74.9**	**81.7**	**65.3**
SCEN CBD (%)					**25.1**	**18.3**	**34.7**
BASE SUB (%)					**71.7**	**71.7**	**71.7**
BASE CBD (%)					**28.3**	**28.3**	**28.3**
% CHNGE SUB					**4.4**	**13.9**	**-8.9**
% CHNGE CBD					**-11.2**	**-35.3**	**22.6**

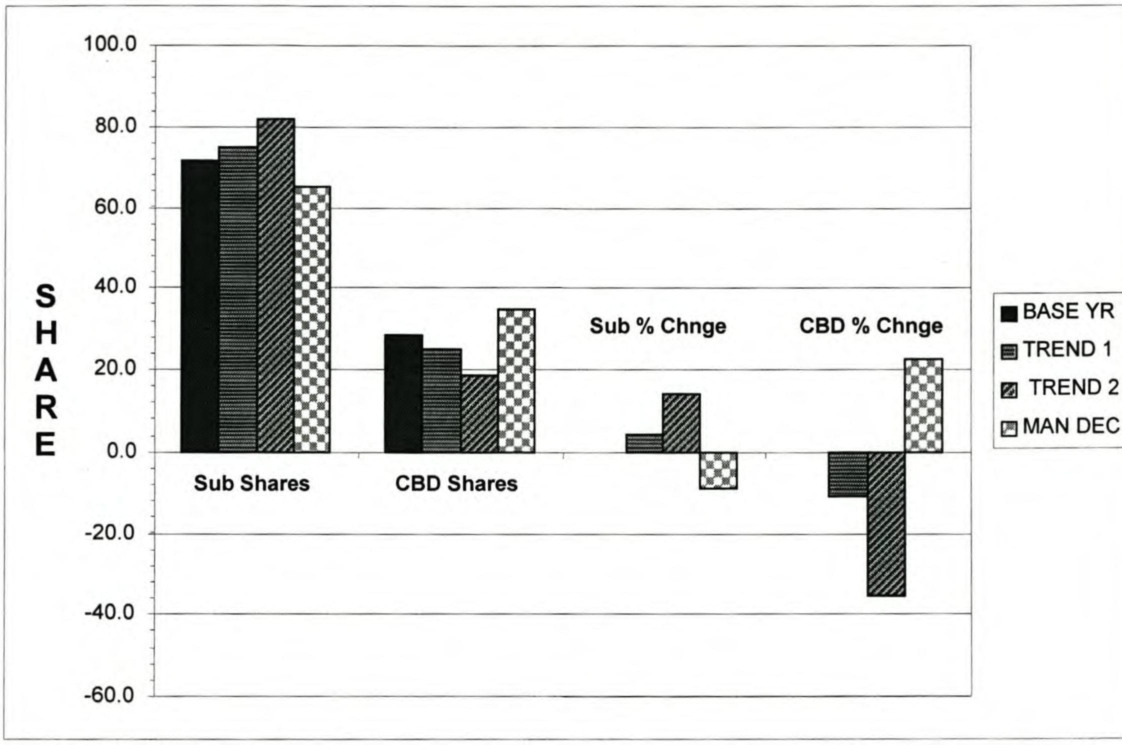


Figure 7.6: Graphical illustration of impact of decentralisation scenarios on CBD and suburb shares

The typical changes in the accessibility and parking fees of the CBD, and external factors such as crime also have significant impacts, followed by the size of shopping centres in the suburbs. The change in road access of suburban centres has a limited impact.

Various policy or "what if" tests can be conducted on the formulated scenarios. For example, if the crime and other negative external factors should increase further for the trend scenario excluding Canal Walk, say with 30 per cent, the share of the CBD will decrease with some 18 per cent, instead of 11 per cent.

To explore the uncertainty about the average size of shopping centres further: If the average size of centres is reduced by 25 per cent excluding Canal Walk, and by 84 per cent including Canal Walk, the share of the CBD will decrease by between 3 and 28 per cent under the trend scenarios, instead of 11 and 35 per cent.

Impact on demand for retail floor space

To facilitate the interpretation of the changes in retail decentralisation, the impact of the scenarios on retail floor area is given in Table 7.8. Assuming that the total base year retail floor area is roughly 2 million m^2, and assuming that the demand for retail area will grow by 2.5 per cent per annum, similar to the employment growth, the total floor area will be 2.56 million m^2 in ten year's time. By applying the estimated splits between the CBD and the suburb from the spreadsheet model, the floor areas in Table 7.8 are obtained for each scenario.

Table 7.8: Demand for retail area in ten year's time for each scenario

	Trend 1 % split	Trend 2 % split	Man Dec % split	Base Yr GLA (million)	Trend 1 GLA (million)	Trend 2 GLA (million)	Man Dec GLA (million)
Sub	74.9	81.7	65.3	1.434	1.917	2.092	1.672
CBD	25.1	18.3	34.7	0.566	0.643	0.468	0.888
Total	**100**	**100**	**100**	**2.000**	**2.560**	**2.56**	**2.56**

By comparing the floor areas of the different scenarios, the following impacts are obtained in terms of:

- equivalent number of regional retail centres of 50 000 m^2; and
- Saturday morning total peak hour vehicle trips, assuming 10 trips per 100 m^2 GLA

- Difference between high-growth and low-growth trend scenarios:
  Increase of 3.5 centres in suburbs, or 17 000 morning peak hour trips.
- Difference between managed decentralisation and low growth trend scenario:
  Increase of 4.9 centres in CBD, or 25 000 morning peak hour trips.
- Difference between managed decentralisation and high growth trend scenario:
  Increase of 8.4 centres in CBD, or 42 000 morning peak hour trips.

The impacts are therefor substantial, even at a conservative growth rate in demand.

Comparison of sensitivity of Cape Town retail model with the USA retail models

The testing of the impact of reducing car accessibility in the CBD provides a direct comparison with the retail models reported by Meyer and Miller (2000) that were applied in Denver. The policy test involved a 2.5 and 5 minute increase in the walking time from the car to the final destination in the CBD. The Cape Town retail location model indicates a 19 per cent decrease in the share of the CBD in retail activity as a result of this policy test. The Denver aggregated retail model predicted a 33 per cent decrease in retail activity in the CBD, while the disaggregated model predicted a much higher decrease of 43 per cent. Meyer and Miller felt that this sensitivity was too high and that it was probably a result of the iterative nature of the models. The Cape Town model indicates a much lower sensitivity of retail activity to changes in the walk time. The Cape Town model provides a direct trade-off between transport accessibility and retail activity, while the Denver models iterate between transport accessibility models and retail activity models.

It is not suggested that the Cape Town model is more reliable, as no post-intervention validation data is available on either of the models as a basis of comparison. However, the comparison gives some indication of the plausibility of the Cape Town model.

7.5 SUMMARY OF ELASTICITIES AND IMPORTANCE WEIGHTS

Table 7.9 gives a summary of the elasticities from the spreadsheet model and those obtained from the ALOGIT software, as well as the importance ratings from the categorical judgement analysis. Priority was given to the spreadsheet elasticities, and these were supplemented by the elasticities from the ALOGIT software for variables not included in the spreadsheet model. The highest value of the direct elasticity and the cross elasticity of a factor was used as the criterion. Empty cells indicate that either the elasticity or the importance rating was not available. The table serves as a guiding framework with regard to the likely impact of the various choice factors on suburbanisation.

The suburbanisation impact matrix in Table 7.9 can be used as a sketch planning tool to get an initial idea of the most effective policy factors to control suburbanisation, re-vitalise the CBD, or attract retailers to a priority corridor or node. A more detailed review of the elasticities is necessary to assess the likely impact in more detail, while the retail location model can be used to test the impact of a specific policy or set of policies.

Table 7.9: Summary of elasticities and importance ratings

	CBD		HIGH SUBURB		LOW SUBURB	
FACTORS	**Elast***	**Import**	**Elast***	**Import**	**Elast***	**Import**
Crime		EXT		EXT		EXT
Parking Availability		EXT		EXT		VERY
Size of Centre	HIGH	VERY	MED	IMP	HIGH	VERY
Rent	HIGH	VERY	HIGH	EXT	HIGH	VERY
Aesthetics		VERY		IMP		VERY
Shopping Mix		VERY		VERY		VERY
Traffic Congestion		IMP		IMP		VERY
Parking Fee	MED	IMP	LOW	IMP	LOW	IMP
Other Businesses		IMP		IMP		VERY
Emp Centres		IMP		IMP		EXT
Main Road access	LOW	IMP	LOW	IMP	LOW	EXT
Freeway access		IMP		IMP		VERY
Residential access		IMP		IMP		EXT
Train access		IMP		IMP		VERY
Suppliers proximity		IMP		LIT		VERY
Income suburb	HIGH		MED		MED	
Walk time – CBD	MED		LOW		LOW	
Walk time – suburb	LOW		LOW		LOW	
Size of shop	LOW		LOW		LOW	
Location in Centre	MED		HIGH		MED	
Product Category	MED		LOW		LOW	

***Note: High elasticity > 0.3; Medium elasticity 0.1 to 0.3; Low elasticity<0.1**

7.6 INTERFACING BUSINESS LOCATION MODELS WITH AGGREGATE NETWORK MODELS

Similar to the development of the retail location model, business location models for the manufacturing and service (office) sectors can be developed. These models can be used on their own to test specific policies relating to the locational choices of businesses between the CBD and the suburbs. However, the power of these models can also be utilised by interfacing them with the existing aggregate land-use and transport models of the metropolitan area.

This section defines a coarse methodology, rather than the detailed mathematical functioning of the modelling system. The author had tested some of the principles of this approach successfully for the East Rand by interfacing the HLFM2 sketch planning model with the conventional EMME/2 transport model (see Chapter 3.4). The modelling process will allow planning authorities to assess the impact of densification strategies on business locational choices, and in turn, the detailed impact of these on the transport system.

Figure 7.7 illustrates how the business location models can be interfaced with the land-use and transport modelling system. No formal land-use model is needed and the existing analytical techniques of the authority to estimate future demographic and economic growth can be used.

<u>Estimate future growth</u>

Assuming that a base model is available, the first step is to estimate the future growth in population and economic activity for the whole metropolitan area. The economic growth then needs to be distributed between the main business sectors of manufacturing, retail, and services. These projections are often done for urban areas as part of the normal planning process, by using growth models applied to each economic sector, or by using input-output models.

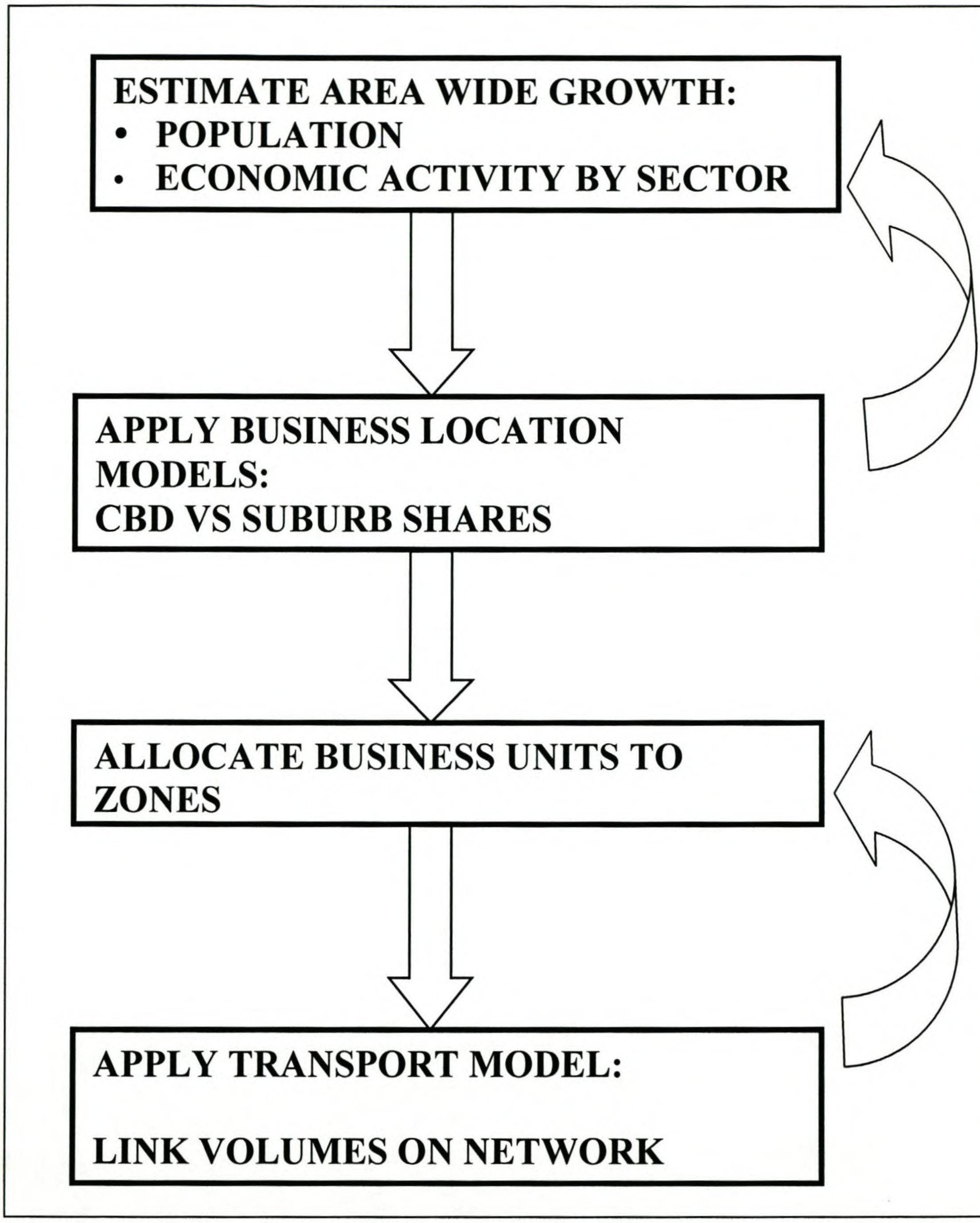


Figure 7.7: Flow diagram showing the interfacing of business location models with an aggregate transport network model

Translate economic activity into business units

Before the business location models can be applied, the economic activity in terms of GDP needs to be translated into number of businesses by means of appropriate factors. The number of businesses can in turn be translated into floor area and employment. For this purpose it will be important to develop a data base and to monitor changes in these key factors over time.

Allocate total business activity to strategic locations – considering mobility and locational choice

Similar to the spatial choice processes involved in the residential market, business choice models also need to consider the interaction between mobility choice and locational choice. Modelling of locational choice should distinguish between the following three market segments:

- Existing businesses remaining at their current location.
- Existing businesses relocating due to various trigger factors.
- New businesses locating in a specific area – this may be an existing business opening a new outlet, or a totally new business.

The business location models are relevant to the existing businesses seeking to relocate as well as the new businesses. Business mobility or the decision to relocate can be triggered by numerous commercial and market factors specific to each business at a micro-level. The retail survey indicated a number of typical trigger factors:

- Decline in business profitabillity due to changing market conditions.
- Growth in demand leading to the need to expand coupled with a lack of space to expand.
- Unaffordability of rent leading to the need to search for cheaper accommodation subject to rental agreements
- Dissatisfaction with building accommodation.

Generally their will be a time lag between a change in circumstances and the decision to relocate, as well as between the decision to relocate and the act of relocation due to various practical constraints. In view of the fact that business mobility is very difficult to model and that only a small percentage of businesses actually relocate, according to the retail survey, this decision process only needs to be addressed in coarse terms compatible to the level of detail of the strategic model.

By calibrating the constants of the alternative locations in the business location model such that the modelled shares match the observed market shares, the model is applicable to the total market. The constants simulate the inherent preferences for the existing location and changing values of the independent variables will only result in marginal changes to the locational shares. The busines location models are therefore applied to the total number of future businesses, consisting of the three market segments defined above.

It is appreciated that the dynamics of the time lags between economic triggers and the manifestation of business activities on the ground in specific locations are ignored by this modelling system. The results of the model should rather be viewed as potential demand at each modelled time period, and it should be kept in mind that that a few years may elapse before this demand changes activities on the ground. However, this does not impact negatively on the policy evaluation capability of the model.

Trend and densification scenarios will typically be formulated in terms of the factors driving the locational choice models, similar to the exercise described in Chapter 7.4.2 for the retail location model.

Allocate business units to transport zones

The CBD and suburban business units are then further allocated to their respective zones by means of existing procedures. If assumptions made during the previous step, such as density standards, are violated during the zonal allocation, the business location models can be applied again with adapted assumptions, and the process repeated. The use of a spreadsheet will automate this process and allow for quick iterations.

Apply transport network model

Finally, the transport network model is applied to determine the impact of the scenarios on the transport system. Again, if certain assumptions regarding transport accessibility made during the application of the business location models are violated, the process can be re-iterated. This will of course be more time consuming and can be made optional. The conventional process in any case does not exercise such consistency checks, as assumptions are often subjective.

7.7 CONCLUSIONS AND RECOMMENDATIONS

In this chapter a locational choice model that was developed in spreadsheet format, using the sample remuneration approach, was discussed. The model provided the impacts of locational factors on the demand for retail space in the CBD and the suburbs.The model's constants were adjusted to simulate a realistic level of decentralisation. The spreadsheet allows adjustment of the model's input parameters so that the base year scenario of the model can easily be updated to changed circumstances. The model provides for the simultaneous testing of three scenarios, and estimates elasticities and cross elasticities of locational factors, the absolute shares of the CBD, low and high-income suburbs, and also illustrates the changes in shares between the scenarios in graphical format.

Direct and cross elasticities, as well as absolute changes in shares, were estimated to determine the locational factors with the highest impact. Three decentralisation scenarios were formulated and tested in terms of changes in the values of locational factors over a ten-year period. A suburbanisation impact matrix that indicates the available elasticity and importance rating of each choice factor analysed for the dissertation, was compiled. Finally, a method was proposed to interface business location models, similar to the retail location model developed during this research, to conventional transport models such as EMME/2.

The main conclusions drawn from the application of the locational choice model were:

- *The model provides plausible impacts of locational choice factors, it is policy sensitive, but also stable by indicating moderate changes in locational shares.*
- *Elasticities of locational choice factors ranged between less than 0.1 to 0.53. Land-use and economic factors such as rent, size of the shopping centre, and market potential of suburbs indicated the highest elasticities and absolute impact on locational choice.*
- *Although the transport and accessibility factors indicated elasticities in the medium range, their combined impact will be high.*
- *The low-income suburbs will experience the highest impact due to changes in other areas. Rent changes in high-income suburbs, size of centre in its own location, rent in the CBD, size of centre in high-income suburbs, and market potential in suburbs, have the highest overall impact.*
- *The impacts on the high-income suburbs are generally lower due to its higher share. It is most affected by changes in rent in the CBD and in its own location, size of centre in its own location, and market potential of suburbs.*
- *The CBD is mostly affected by rent in its own location and the high-income suburbs, size of centre in the high-income suburbs, market potential in the suburbs, tansport access in the CBD and parking fees in the CBD.*
- *The two trend scenarios confirmed increased decentralisation despite a lower real growth in rent in the CBD compared to the suburbs. The huge impact of large regional suburban centres such as Canal Walk was also demonstrated. The share of the CBD may decline between 11 and 35 per cent over a ten-year period without and with the Canal Walk Centre.*
- *In contrast, the managed decentralisation scenario indicated that a combination of strategies to attract retailers to the CBD may have a significant positive impact on the share of the CBD, in the order of a 23 per cent increase in share.*
- *In terms of the typical changes in the locational factors over a ten-year period, the market potential in the suburbs and the relative changes in rent between the CBD and the suburbs had the highest individual impact.*

- *The typical changes in the accessibility and parking fees of the CBD, and external factors such as crime also had significant impacts, followed by the size of shopping centres in the suburbs. The change in road access to suburban centres had a limited impact.*

The following recommendations are made:

- *The locational choice model developed as part of this dissertation can easily be replicated for any economic sector and urban area and it is recommended that metropolitan authorities in South Africa assess and apply the modelling approach for their own areas.*
- *In view of the fact that all planning data could not be analysed, the CMC should refine the trend information presented here, and workshop the results with relevant stakeholders to confirm the trend information, validate the calibrated model, and formulate appropriate trend and managed decentralisation scenarios. This will be a powerful tool for defining and implementing strategies to revitalise the CBD and achieve a balanced development of the total metropolitan area.*
- *A major draw-back of the application of the locational choice model was the lack of trend data on the various locational factors and data for the validation of the model. It is recommended that metropolitan authorities implement a monitoring system to obtain regular information on the important factors defined here as well as the demand and supply of retail, and other economic sectors, at a strategic level. This should be done in co-operation with Statistics SA and private sector specialists who are already monitoring certain statistics.*
- *It is recommended that metropolitan authorities and other stakeholders assess the elasticities and scenario testing results presented here to start a process of interpreting the results for their own areas, and to formulate and implement managed decentralisation strategies to achieve an optimal level of decentralisation for their cities. The retail model for Cape Town can be applied as a sketch planning tool as a point of departure by adjusting the input parameters for their own areas and using the model for scenario testing.*

8. CONCLUSIONS AND RECOMMENDATIONS: THE MANAGEMENT OF SUBURBANISATION

8.1 INTRODUCTION

This chapter provides a synthesis of all the results of the research conducted for the purposes of the dissertation as follows:

- An appropriate modelling approach for South Africa.
- The important locational choice factors of retailers that need to be considered by authorities.
- The impacts of suburbanisation and effective policies to be implemented in order to manage suburbanisation.
- Contributions made by this dissertation, recommendations to authorities to manage suburbanisation, and research needs to be addressed.

8.2 AN APPROPRIATE MODELLING APPROACH FOR S.A.

The international and local review of modelling approaches indicated the disappointment with large-scale interactive land-use transport models. More successful local approaches involved integrated sketch planning models and simplified and transparent land-use spreadsheet techniques. It is a pity that interactive land-use transport models have gone out of favour following the MEPLAN implementation in Cape Town, despite the successful application of the HLFM2 model on the East Rand. However, the ISGLUTI study group was more positive about the interactive models and they indicated the importance of assessing longer-term secondary effects that are currently ignored by authorities in S.A. (Webster, et. al., 1988).

The literature review identified two trends in land-use transport modelling, i.e. the trend towards small-scale, problem-specific models, such as discrete choice RP and SP models, and the trend towards large-scale activity-based models offering a behavioural integration of land-use and transport. In view of the extensive resources required for the ABM approach, the approach of small-scale, problem-specific models is more appropriate and affordable for a developing country such as South Africa. In S.A. even the conventional transport models are going out of favour due to a lack of human and financial resources. The long time intervals of between 10 and 20 years between model recalibrations on new-home interview surveys are also indicative of the resource constraints of authorities.

With the use of simplified models that focus on specific problems and that can even be transferred from other areas, secondary effects of transport on land-use can be evaluated. For example, the retail location model of Cape Town may be updated in a limited way, without new surveys, for other authorities.

International planners expressed the need for more behavioural SP models addressing longer-term effects, including locational choices. Discrete choice SP models can be applied successfully to locational choices as indicated by this dissertation. It was demonstrated that the model is policy sensitive and gives plausible results. The spreadsheet application allows for quick policy testing and addresses the need for small-scale problem-specific models in support of the management approach to planning. It was also indicated how the SP locational choice model can be expanded and interfaced with existing network models.

Guidelines were given regarding the application of SP models to business location choice to overcome certain problems that limited the performance of the SP models in this research. A significant finding was the strong subjective influence of respondents' attitudes on their stated preferences. Increased sample size, more attention to focus groups and the collection of attitudinal information to support the SP modelling, are important considerations. Development of survey techniques to calibrate RP locational models, the investigation of non-compensatory models, and the incorporation of important qualitative variables in the SP experiment, are important research needs.

Finally, the dissertation identified the lack of basic spatial statistics on and trends in non-residential demand and supply. It is important that authorities together with the private sector determine key peformance indicators and collect data to inform basic planning for business activities that is just as important as residential activities in the performance of the urban system. The dissertation provides an indication of typical basic data needs.

8.3 SUMMARY OF LOCATIONAL CHOICE FACTORS AND THE ROLE OF TRANSPORT

From various international and local market research studies, empirical studies and applications of land-use transport models, the important role of transport mobility and accessibility in urban development was identified. The main driving force of suburbanisation is urban growth and subsequent suburban sprawl that causes retail activity to follow its market to the high-income suburbs where retail is easily accessible by car. Various factors such as lack of parking and traffic congestion, increased crime and uncontrolled hawkers also pushed businesses away from the CBD. The CBD market changed to one mainly serving CBD workers, tourists and public transport captive users for whom the suburban retail centres are often difficult to access. The changing distribution of the CBD and suburban markets therefore resulted in different profiles of retail in these areas and differences in locational choice factors.

The market research conducted for this dissertation among retail managers in Cape Town, determined their importance weights of locational choice factors for businesses located in the CBD, low-income and high-income suburbs. The importance of various choice factors was further quantified from a SP survey of the retail managers' locational choices and the calibration of a discrete choice model simulating their locational choices.

The following conclusions are drawn from the analysis of retailer managers' importance ratings of choice factors:

- Four factors were rated as either very or extremely important in all areas, namely crime, availability of parking, rent, and number/variety of shops. These factors should therefore be given special attention in any spatial policies regardless of whether it relates to the CBD or the suburbs.
- Actions against crime should be the top priority in all areas, as neglect in one

area will lead to shifts from high crime to low crime areas, and these shifts may counteract any desirable spatial policies. In addition, high crime rates also impact negatively on the economic growth of the city as a whole.

- The seven most important factors that need the most attention in spatial policies in each area are:
  - CBD: aesthetics, size of centre, traffic congestion and parking fee;
  - High-income suburbs: employment centres, size of centre and main road access;
  - Low-income suburbs: main road access, residential area, employment centres, size of centre;
- Low-income suburbs have an overall lack of infrastructure and economic base and all aspects need special attention to meet the needs of retailers and their customers who have limited mobility.
- In terms of the role of transport in locational choices, provision of parking plays the dominant role for understandable reasons, while traffic congestion and parking fees in the CBD, and access to main roads in the suburbs also play a significant role.

The application of the locational choice model indicated the following elasticities of the various choice factors, supplemented by the elasticities obtained from the application of the ALOGIT software:

- Elasticities ranged between less than 0.1 to 0.53. Land-use and economic factors such as rent, size of the shopping centre, location in a shopping centre, and market potential of suburbs indicated the highest elasticities and absolute impact on locational choice.
- Although the transport and accessibility factors indicated elasticities in the medium range of 0.1 to 0.3, their combined effect will have a high impact.
- The share of low-income suburbs is mostly affected by changes in other areas. Rent changes in high-income suburbs, size of centre in its own location, location in a shopping centre, rent in the CBD, size of centre in high-income suburbs, and market potential in suburbs had the highest overall impact.
- The impact on the high-income suburbs is generally lower due to its higher

share. It is most affected by changes in rent in the CBD and in its own location, size of centre in its own location, location in a shopping centre, and market potential of suburbs.

- The CBD is mostly affected by rent in its own location and the high-income suburbs, size of centre in the high-income suburbs, market potential in the suburbs, location in a shopping centre, transport access in the CBD, main road access, and parking fees in the CBD.
- There are significant differences in the elasticities of retail managers in shopping centres and those in street-front shops. Further research is needed, however, to identify the differences in choice factors between shopping centres and street-front shops.
- Although the product category of the shop was not significant or plausible for some categories, the categorisation of products into comparative and convenience shopping goods indicated that there was a low but significant elasticity of comparative products in favour of suburbs.

8.4 IMPACT OF SUBURBANISATION AND STRATEGIES TO MANAGE SUBURBANISATION

The international and local review of the impact of suburbanisation indicated that this is a world-wide trend typical of growing cities and that it was the result of rapid urbanisation. The impact of suburbanisation is wide-spread and multi-dimensional and it affects the whole urban system in terms of its structure, activity and transport patterns, which in turn affects the social, economic, and the environmental well-being and energy efficiency of the city. The market forces driving suburbanisation are so strong that they can at best only be guided in the right direction, as opposing the forces will be ineffective and very costly. South African cities are still young compared to international norms and by acknowledging the problem now and taking pro-active action, the negative impact of suburbanisation can be minimised and positive aspects can be reinforced. Suburbanisation mainly benefited the high-income car owners through improved accessibility of suburban nodes, while it reduced access for the mostly poor, public transport captive communities. It must be recognised that the benefits enjoyed by both businesses and high-income suburban residents are large and that this provided a huge tax base for city councils to be used in providing services for the whole urban population. It will therefore be wrong to ignore this and care must be taken not to kill the goose that lays the golden eggs. Again, management is the key word.

The increasingly high intensity of media reports on the rapid decay of CBD's in South Africa, some even stating that it may be too late to repair the damage in certain cities such as Johannesburg, indicate that this matter must be treated with the utmost urgency by metropolitan authorities. The big cities have already started with programmes such as business improvement districts to address the basic factors such as crime, hawking and the quality of the environment. The results of the Cape Town study showed that before even trying to address the higher level land-use and transport factors impacting on the CBD's livelihood, the serious impact of rising crime and uncontrolled hawking must first be addressed. This was seen as the most important factor by CBD and suburban retail managers.

A spreadsheet model incorporating the retail model and the retail sample data base was developed to test the elasticities of various choice factors and also to test suburbanisation scenarios:

- Three decentralisation scenarios were formulated and tested in terms of changes in the values of locational factors over a ten-year period. The two trend scenarios confirmed the increased decentralisation of the CBD despite a lower real growth in rent in the CBD compared to the suburbs. The huge impact of large regional suburban centres such as Canal Walk was also demonstrated. The share of the CBD may decline between 11 and 35 per cent over a ten-year period.
- In contrast, the managed decentralisation scenario indicated that a combination of strategies to attract retailers to the CBD could have a significant positive impact on the share of the CBD, in the order of a 23 per cent increase in share.
- In terms of the typical changes in the locational factors over a ten-year period, the proximity to the suburban market and the relative changes in rent between the CBD and the suburbs had the highest individual impact.

- The typical changes in the accessibility and parking fees of the CBD, and external factors such as crime also had significant impacts, followed by the size of shopping centres in the suburbs. The change in road access of suburban centres had a limited impact.

From the identification of the significant choice factors impacting on the locational choices of retailer managers, policies and strategies can be formulated to address these factors. Although the study was done in Cape Town, the problems are in many respects typical of South African cities, and the results can be transferred to other cities by making appropriate adjustments for unique local conditions.

Policies can be classified into those improving the attractiveness of the CBD and those addressing the suburban areas. To have any impact, policies must address both categories comprehensively. A brief summary is given here of the main policies and strategies that should be implemented to manage suburbanisation:

- Authorities must address management and institutional issues at the highest level following the principles advocated by the modern management and decision-oriented approach to planning. If all role players do not support and actively pursue identified strategies the widespread problems cannot be addressed. Metropolitan authorities must also actively pursue the creation of transport authorities that will be responsible for all transport functions in the city. This will at least put all the transport factors under the control of a single authority.
- The active pursuance of the typical corridor, nodal and land infilling policies should be the main overall strategy. Land infilling must, however, also follow densification principles to be beneficial. A lot of work done on the conceptual design of corridors and nodes needs to be considered. A major strategic problem seems to be that the various spatial frameworks defining the location of corridors and nodes to be developed contain too many of these and this dissipates the scarce development resources. Prioritisation of the corridors and nodes to a few priority ones and agreement by all stakeholders to support these, will be important. This in itself would not be sufficient and authorities must also implement various incentives and disincentives, and even

regulations, to promote development in preferred corridors and discourage unwanted development.

- Corridors must be centred on the CBD and link outlying townships with the CBD. This will in some cases by-pass high-income suburban nodes. Such nodes should also be prioritised and if they are defined as priority development areas, densification should also be promoted at these nodes. Special attention will then be required to serve these nodes by appropriate public transport services and to link these nodes to the radial corridors.
- When formulating incentives and disincentives, authorities should consider the importance weights and choice elasticities of business managers. The weights and elasticities identified for Cape Town retailer managers can be used as a point of departure. Dedicated surveys among a sample of businesses are relatively quick and cheap compared to the benefits that can be derived from the surveys. The very useful results obtained for the Cape Town study used very limited resources. The elasticities and weights give a good indication of the likely impact of various incentives and disincentives.
- Financial measures will have the highest impact. Levies charged to businesses and developers in undesirable areas can be used to provide tax incentives to those locating in priority areas. As indicated by the Cape Town experience, businesses are willing to pay an extra levy in return for improved services and increased security. Often developers' fees disappear into the general budget of authorities. These fees and levies must be seen to be used to address the improvement of transport or engineering infrastructure required to support land-use development.
- Creative zoning and transport regulatory measures have been successfully applied overseas to promote mixed land-use and development in priority areas in partnership with property owners and developers. Authorities can be much more creative to promote development in preferred area.
- The characteristics of the shopping node, such as the number and mix of shops, and size of the centre also have a significant impact on the attractiveness of the node. Economic considerations such as the market potential of the suburb also have a significant impact. These factors may also be used by authorities to attract business back to the CBD or areas close to

the CBD as indicated by the Water Front development in Cape Town and the Foreshore Conference Centre. Convenient, high-frequency distribution services between the node and the CBD will ensure that the CBD will also reap the benefits of the development.

Although authorities do not have a direct influence on the nature of a development and the economic market forces, they can use the elasticities of these factors to determine the impact of new developments on the likely shifts in demand from existing to new developments. To protect the CBD and other existing business nodes, some overseas countries such as the Netherlands, require developers to conduct an impact study to show that there is sufficient overall demand and that their development will not impact negatively on established nodes (Van der Schuren and Van Maarseveen, 2001). Business and retail locational choice models, together with retail market forecasting techniques, will also be essential in these impact studies. Such impact studies will also ensure that the market for retail and offices is not oversaturated. Concerns are often expressed by property analysts that some areas have an oversupply of shopping centres and offices. Supply and demand information can be used to determine the level of incentives and disincentives.

- Promoting residential activities in the CBD can have a positive impact on the economic viability of the CBD, but the security situation and management of sectional-title deed properties must first be addressed for banks to be persuaded to withdraw their moratorium on loans in the CBD's of some South African cities.
- Transport access, especially to car in the CBD, also has a significant impact on suburbanisation and this factor is under the direct control of the authorities. Authorities must give new attention to parking supply and pricing policies. Care must be taken not to chase car users away as the attractiveness of the CBD is very sensitive to car access. However, carefully designed policies can make more short-term parking available to shoppers, promote public transport and reduce congestion. Clark quantified the huge parking subsidies paid by employers to their car-owning employees in Cape Town CBD (Crous and

Clark, 2000). An extra levy on long-term parking will be affordable and these funds can be used to promote public transport access to the CBD.

- The testing of urban densification strategies by land-use transport models, both locally and internationally, indicated that corridor development strategies on their own will not be effective to achieve a shift from private to public transport. It is also necessary to address the difference in travel time and costs between private and public transport directly to achieve this objective.
- Large-scale new rail projects are not appropriate solutions for managing suburbanisation as indicated by mostly negative international experience and supported by the low importance ratings of rail access as a locational choice factor by Cape Town retailer managers. Upgrading of existing rail infrastructure and services, together with pro-active land development around stations, will have the best chance of success.
- The user preference studies in Durban and Cape Town indicated the mode choice factors that are important to captive public transport users. These factors should be addressed together with any urban densification strategies to be of any benefit to public transport users. Properly designed integrated rail services can attract significant additional demand from bus and taxi users, but any such rail-based policy should first address the security and image problems of the train mode to be successful.

8.5 Contribution to knowledge and recommendations

The author made the following unique contributions to knowledge in the main focus area of his research:

- The development of a retail SP locational choice model to simulate the locational choice behaviour of retailer managers in terms of their choices of the CBD and the suburbs. This model is in support of the need for small-scale short-term modelling techniques to inform decision-making, as well as the need to quantify choice factors of business managers in order to devise appropriate incentive and disincentive schemes to promote corridor and nodal development.

- In support of the locational choice model, retailer managers' attitudes were analysed and importance weights of choice factors were determined to obtain a more comprehensive quantification of the relative sensitivities of these factors.
- Elasticities and importance weights of locational choice factors that are very useful in identifying effective policies to manage suburbanisation were estimated.
- The impact of various transport accessibility factors relative to typical land-use and economic factors was determined.
- The retail locational choice model was applied to demonstrate the significant impact of suburbanisation trends on the decentralisation of retail in Cape Town, and also how the model can be applied to formulate a decentralisation management strategy that can increase the share of the CBD in the future growth of the retail market.
- The successful application of SP models to longer-term complex locational choices was demonstrated and various guidelines were formulated to improve future applications of SP models.
- A significant finding was that retail managers' attitudes towards the relative importance of various locational choice factors contributed as much to the explanation of their stated preferences in the SP experiment as the variables tested in the SP experiment. More research is needed on how respondents' attitudes impacts on their stated and revealed preferences. This need was also expressed by the international community.
- Finally, the lack of, and need for proper monitoring of basic demand and supply statistics of business activities were highlighted.

The author also made a supporting contribution through active participation in various project teams in the evaluation of strategies to promote urban densification by using land-use transport models and the application of SP and RP models to quantify the mode choice factors of low-income public transport users. The implications of this work for the modelling and evaluation of policies to promote urban densification and manage suburbanisation were synthesised for the purpose of the dissertation:

- An appropriate approach to land-use transport modelling in South Africa was formulated, and the interfacing of business location models with existing transport network models was defined.
- The use of RP and SP models to determine the elasticities of mode choice factors of less-literate public transport captive users provides guidance to improve future applications of these techniques in these communities.
- The relative importance of mode choice factors of public transport users, especially in Durban and Cape Town, was estimated and compared. These results make an important contribution to formulate appropriate public transport policies to serve corridor and nodal developments. Suburbanisation has reduced the accessibility of suburban nodes for public transport users and densification policies need to rectify this situation.

Recommendations

The following recommendations are made including the need for further research:

- Authorities in all spheres of government must provide a proper data base of spatial economic activities and locational patterns similar to that of the residential component. A five-year random sample survey coinciding with the Population Census and home interview surveys, and annual monitoring of key parameters, are recommended.
- The retail sample survey and other empirical evidence provide a wealth of information for authorities and other stakeholders to start formulating strategies to revitalise CBD's and to manage decentralisation pro-actively.
- Various recommendations with respect to SP surveys have been made and only the main issues are summarised.
    - Use of computer-aided personal interview techniques (CAPI) to relate the SP levels to the respondent's current situation and to build in validation checks. This should include checking responses for typical "non-switching" and lexicographic choices and reviewing of responses if necessary. Reasons for each choice should also be requested and recorded. This will ensure that respondents understand the experiment and react to the changing levels.

  - Inclusion of comprehensive revealed choice factors that retail managers considered when choosing their current location, as well as the preference of the current location versus others.
  - Calibration of RP models to assist in the interpretation and scaling of SP models. Further research in this regard relating to locational choice is necessary. Evaluation of various contexts and parameters for the RP survey design is necessary as such choices are not frequently made and respondents may have difficulty in recalling the factors and their values.
  - Inclusion of importance and satisfaction ratings, which are very helpful in understanding respondents' attitudes towards choice factors.
- The elasticities and importance weights of retail locational factors should be used by authorities to devise incentive and disincentive measures to promote corridor and nodal development. Creative zoning and transport regulatory measures are recommended to promote mixed land-use and development in priority areas in partnership with property owners and developers.
- Corridors and nodes must be prioritised and agreement obtained from all stakeholders to direct scarce resources only at these nodes.
- More small-scale and problem-specific modelling techniques, including SP locational choice models, should be used to test urban densification policies. These techniques should be interfaced with the existing transport network models of authorities.
- As a first point of departure, the Retail Locational Choice model can be applied by authorities, with limited updating of input assumptions, and used to test and formulate appropriate policies to manage urban decentralisation.
- Market research of business location choices and SP studies to determine the importance weights and elasticities of choice factors must be conducted by authorities to formulate appropriate suburban management scenarios for their areas.
- The following research needs were identified:
  - The attitudes and decision-making processes of businesses when making locational choices, including the impact of constraints and group decision-making behaviour at boards of directors level.

- The locational choice behaviour of developers that has a major impact on urban structure. The application of decision tables may be useful for exploring the decision-making behaviour of developers.
- The influence of business managers' attitudes on their stated and revealed locational choice preferences. Non-compensatory models seem to have potential and they need to be investigated further.
- The locational choice behaviour of other service sectors, such as the office sector, and community services.
- The choice of retail accommodation, shopping centres versus street-front shops, and the impact of product category on locational choice in terms of more detailed definitions.
- Trends in the key factors relating to the demand for and supply of accommodation for retail and other service sectors. This should include quantifying the dynamics of how changes in economic indicators translate into business activities on the ground. Such a time-series data base will be essential to provide contextual information for the application of SP locational choice models.

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APPENDIX A

COPY OF QUESTIONNAIRE
USED IN CAPE TOWN RETAIL SURVEY

CAPE TOWN: RETAILERS

MARCH 1995

CORPORAT
& SOCIA
RESEARC

RESPONDENT INFORMATION

NAME AND ADDRESS OF COMPANY

NAME: ______________________________

POSTAL ADDRESS: ______________________________

____

STREET ADDRESS OF SHOP TO WHICH QUESTIONNAIRE REFERS/

____

____

TEL. NUMBER ______________________________

NAME OF RESPONDENT: ______________________________

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PART 1: GENERAL INFORMATION

NB

1. Area of shop location and name of shopping centre:

AREA	- 2 -	**CENTRE**	
CBD	1	______________________	- 3 -
Bellville	2	______________________	- 4
Kayelitsha	3	______________________	- 5
Langa	4	______________________	- 6
Nyanga	5	______________________	- 7
Mitchell's Plain	6	______________________	- 8
Other/Ander............................	7	______________________	- 9

2. What type of products are provided/sold by your shop?

		- 10 -
Butchers	62000	1
Grocers and other dealers in foodstuffs	62002	2
Bottle stores	62003	3
Men's outfitters	62004	4
Ladies outfitters	62005	5
General outfitters and dealers in piece goods and textiles	62006	6
Shoe stores	62007	7
Dealers in furniture, household requisites and household appliances	62008	8
Book stores and stationers	62009	9
Jewellers	62010	10
Chemists	62011	11
Bicycle dealers	62013	12
Dealers in sport and entertainment requisites	65015	13
General departmental stores	62016	14
General dealers	62017	15
Dealers in miscellaneous goods	62019	16

3. What is the Gross Leasable Floor Area of your shop?................................square metres. - 11 -

4. How many employees do you have in the shop including management?

Number of employees

	Full time	**Part time**	**Total**	
Permanent	______	______	______	- 12 -
Temporary	______	______	______	- 13 -
		Total	______	- 14 -

5. How long has your business been located here?________________Years - 15 -

6a. Where was your business previously located?

Always been here	1	-16-
Cape Town CBD	2	
Other suburb..	3	
Other city, town...	4	

6b. If you have moved here from another location, why did you move?

Reason ____

____ -17-

6c. If you had a choice, would you choose this shop location again?

	- 18 -	
Yes	1	Why?.. ....-19-
No	2	Why not?.. ....-20-

PART 2: CHARACTERISTICS OF EXISTING LOCATION/

7a. Do you rent or own the property?

Rent	1	- 21 -
Own	2	

7b. If you rent the shop, what is your monthly rent per m^2? (**NB Excluding electricity, parking, service fees etc.**)

_________________________ R per m^2 - 22 -

8a. Do customers pay for parking?

Yes [1] No [2] - 23 -

8b. If 'yes', what is the parking fee for the first hour? R_____________________ - 24 -

9a. How close is your shop to the nearest major road? (e.g. Adderly, Voortrekker)

• Not more than one block away	1	- 25 -
• More than one block away	2	

9b. How close is your shop to the nearest train station, bus stop and taxi rank?

	WALKING DISTANCE		
	Less than 5 mins	More than 5 mins	
Train station	1	2	- 26 -
Bus	1	2	- 27 -
Taxi	1	2	- 28 -

9c. How long does it normally take your customers to search for a parking space close to your shop during peak hours?

Less than 5 minutes	1	- 29 -
More than 5 minutes	2	

10 Is there sufficient parking space available close to your shop? (less than 5 minutes walking distance)

Street (pavement parking)	1	- 30 -
Uncovered parking	2	
Covered parking	3	

PART 3: IMPORTANCE RATING OF FACTORS IMPACTING ON SHOP LOCATION

11. **Suppose you need to expand your shop and as a result you need to move to a new location.** Please evaluate the importance you attach to each of the following factors when considering the best location for your shop.

NB **PLEASE BASE YOUR EVALUATION ON THE CHOICE OF AN ASSUMED NEW LOCATION - NOT ON YOUR CURRENT LOCATION**

Use the following 5 point scale by circling the appropriate number:

SHOWCARD

Not important at all	1
Of little importance	2
Important	3
Very important	4
Extremely important	5

FACTORS	EVALUATION SCALE					
Degree of traffic congestion on surrounding road network	1	2	3	4	5	- 31 -
Monthly rental for premises	1	2	3	4	5	- 32 -
Parking fees for customers	1	2	3	4	5	- 33 -
Size of the total shopping complex where shop is located	1	2	3	4	5	- 34 -
Distance of shop from freeway	1	2	3	4	5	- 35 -
Distance of shop from major road arterial	1	2	3	4	5	- 36 -
Availability of parking close to shop for customers	1	2	3	4	5	- 37 -
Proximity of shop to train station	1	2	3	4	5	- 38 -
Proximity of shop to suppliers	1	2	3	4	5	- 39 -
Proximity of shop to other businesses	1	2	3	4	5	- 40 -
Degree of safety from crime in the area	1	2	3	4	5	- 41 -
Aesthetical appeal of the natural and built environment	1	2	3	4	5	- 42 -
Number and variety of shops and businesses in the area	1	2	3	4	5	- 43 -
Proximity of shop to residential areas	1	2	3	4	5	- 44 -
Proximity of shop to large employment centres	1	2	3	4	5	- 45 -
Other..	1	2	3	4	5	- 46 -

12. If you have 10 points to allocate between the 2 factors "Rent of premises" and "Closeness of shop to suppliers" to indicate their relative importance, how many points will you allocate to each factor? Example: allocating 1 to factor A and 9 to factor B will mean B is nine times as important as A. A value of five to each factor will mean equal importance

		Value (out of 10)	
Closeness to suppliers		______________	
Rent of premises		______________	- 47 -
	Total	**10**	- 48 -

PART 4: PREFERENCE FOR ALTERNATIVE SHOP LOCATIONS

13/14 Now put yourself in the following situation: You would like to expand your shop and you need to decide whether to move to one of two locations: the Cape Town Central Business District (CBD), or to a suburban shopping centre such as Belville, Khayelitsha or Mitchell's Plain. Ignoring the cost of expansion or moving, indicate your preferred location choosing between the CBD and a surburban location.

The characteristics of the shop location used to base your choices on, are varied between two levels as follows:

Monthly Rent = R10 m^2 more per month than you currently pay **OR**

= R10 m^2 less per month than you currently pay.

Walking Distance

Typical time for customer to walk from their parking space, or from nearest public transport terminal (train station, bus or taxi stop) to shop:

- 2 minutes walking distance **OR**
- 7 minutes walking distance

SUBURBAN CENTRES ONLY

Number of shops in suburban shopping centre

120 shops (such as) **OR**

40 shops (such as)

Proximity of suburban centre to a major road

- Major road such as Voortrekker road in Belville **OR**
- Minor road five blocks away from major road

Personal income and housing density of residents in suburb

- Low income = R10 000 p. a. and high density **OR**
- High income = R45 000 p. a. and low density

For each of the following 8 choice situations, compare the specified characteristics of the CBD location and the suburban location, then indicate which one of the two you would prefer.

13a.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 MORE
Walking time from parking space or public transport	2 MINS	7 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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13b

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 MORE
Walking time from parking space or public transport	2 MINS	2 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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13c.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 LESS
Walking time from parking space or public transport	7 MINS	2 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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13d

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 LESS
Walking time from parking space or public transport	2 MINS	7 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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13e.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 LESS
Walking time from parking space or public transport	7 MINS	7 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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13f

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 MORE
Walking time from parking space or public transport	7 MINS	7 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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13g.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 MORE
Walking time from parking space or public transport	7 MINS	2 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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13h

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 LESS
Walking time from parking space or public transport	2 MINS	2 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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14a.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 LESS
Walking time from parking space or public transport	2 MINS	2 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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14b

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 MORE
Walking time from parking space or public transport	2 MINS	2 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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14c.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 MORE
Walking time from parking space or public transport	7 MINS	7 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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14d

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 LESS
Walking time from parking space or public transport	7 MINS	2 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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14e.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 LESS
Walking time from parking space or public transport	7 MINS	7 MINS
Number of shops in shopping centre	N/A	40
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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14f

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 MORE	R10 MORE
Walking time from parking space or public transport	2 MINS	7 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	HIGH
Preference (Circle)	1	2

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14g.

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 LESS
Walking time from parking space or public transport	2 MINS	7 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MINOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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14h

Factors to consider	(i) Cape Town CBD characteristics	(ii) Suburb character-istics
Rent per square metre	R10 LESS	R10 MORE
Walking time from parking space or public transport	7 MINS	2 MINS
Number of shops in shopping centre	N/A	120
On major or minor road	N/A	MAJOR
Low or high income suburb	N/A	LOW
Preference (Circle)	1	2

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NB **INTERVIEWER TO COMPLETE**

PART 5: SHOPPING CENTRE INFORMATION

NB **OBTAIN INFORMATION FROM CENTRE MANAGER**

a. Name of Complex:____ - 65 -

b. Gross Leasable Area:____ - 66 -

c. Number of shops in centre:______________________________________ - 67 -

- 68 -
- 69 -
- 70 -
- 71 -
- 72 -
- 73 -
- 74 -
- 75 -
- 76 -
- 77 -
- 78 -
- 79 -
- 80 -
- 81 -
- 82 -
- 83 -
- 84 -