SUMMARY

The morphological form of South African cities is deemed inefficient and fragmented. Much of the current structure has been shaped by i) the political history of the country, with major influences from the colonial and apartheid eras; and ii) suburban sprawl influenced by the use of private vehicles. This presents obstacles to the sustainable and equitable development of our cities.

Since the 1990s, efforts have been made to change the development of the country in order to accommodate previously disenfranchised communities through processes of reconstruction and development. Among these efforts are policies and frameworks aimed at guiding the development and growth of cities. Among the many approaches that have been identified are land use strategies, with the central focus of promoting densification and intensification of urban development. Emphasis on densification in certain public transport corridors and decentralised nodes are in general regarded as urban restructuring elements necessary to transform South African cities into efficient and sustainable areas. However, analytical tools that can explore the possibilities and limits of public transport-orientated development are scarce at present.

The University of Utrecht in the Netherlands has developed an analytical model referred to as the node-place model, which can be used to profile nodes and to determine their (re)development potential. This study makes a contribution towards efforts to support the densification concept in general and nodal intensification in particular by applying the node-place model to a selection of railway stations in the Cape Town metropolitan area in order to identify appropriate land use developments to enhance their potential. The model was found to be a useful mechanism for comparing nodes within a transport system for purposes of informing decisions regarding how the nodes should be developed. However, the model requires more accurate and disaggregated data than is generally available for the Cape Town area.

Keywords: urban structure, restructuring, compact development, mixed-use development, node-place model
OPSOMMING

Die morfologiese vorm van Suid-Afrikaanse stede word as ondoeltreffend en gefragmenteer beskou. Hierdie struktuur is grotendeels die gevolg van i) die politieke geskiedenis van die land wat sterk beïnvloed is deur die koloniale en apartheidseras; ii) asook snelle voorstedelike spreiding deur die gebruik van private motorvoertuie. Dit gee aanleiding tot struikelblokke ten opsigte van volhoubare en regverdige ontwikkeling van ons stede.

Sedert die 1990’s word pogings aangewend om die ontwikkeling van die land te verander ten einde deur rekonstruksie- en ontwikkelingsprosesse voorsiening te maak vir voorheen ontkieserde gemeenskappe. Onder hierdie pogings val beleide en raamwerke wat daarop gemik is om die ontwikkeling en groei van stede te lei. Grondgebruikstrateëgieë, wat die bevordering van verdigting en intensifisering van stedelike ontwikkeling ten doel het, ressorteer onder die vele benaderings wat geïdentifiseer is. Klem op die verdigting in sekere openbare vervoerkorridors en gedesentraliseerde nodusse word allereerst beskou as stedelike herstruktureringselemente wat noodsaaklik is vir die transformering van Suid-Afrikaanse stede tot doeltreffende en volhoubare gebiede. Nietemin is analitiese hulpmiddel wat die moontlikhede en beperkinge van openbare vervoergerigte ontwikkeling kan ondersoek, tans nog skaars.

Die Universiteit van Utrecht in Nederland het 'n analitiese model ontwerp, bekend as die nodus-plekmodel, wat gebruik kan word om nodusse te profileer en hulle potensiaal tot (her)ontwikkeling te bepaal. Hierdie studie lever 'n bydrae tot die pogings om steun te verleen aan verdigting in die algemeen en nodale intensifisering in die besonder deur gebruikmaking van die nodus-plekmodel met betrekking tot 'n seleksie spoorwegstations in die Kaapstadse metropolitaanse gebied om geskikte grondgebruiksentwikkelings te identifiseer ten einde hulle potensiaal te verhoog. Daar is bevind dat die model 'n bruikbare werktuig is vir die vergelyking van nodusse binne 'n vervoerstelsel ten einde besluite te kan lei ten opsigte van hoe die nodusse ontwikkel behoort te word. Die model vereis egter akkurater en meer gedetailleerde data as wat oor die algemeen vir die Kaapstad-omgewing beskikbaar is.

Kernwoorde: stedelike struktuur, herstrukturering, kompakte ontwikkeling, gemengdegebruikontwikkeling, nodus-plekmodel
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LIST OF ACRONYMS

CBD – Central Business District
CPTR – Current Public Transport Record
CSIR – Council for Scientific and Industrial Research
DFA – Development Facilitation Act
GIS – Geographic Information System
IDP – Integrated Development Planning
LED – Local Economic Development
MCA – Multi-Criteria Assessment
MOSS – Metropolitan Open Space System
MSDF – Metropolitan Spatial Development Framework
NLTTA – National Land Transport Transition Act
OD – Origin-Destination
RSC – Regional Services Council
SDF – Spatial Development Framework
SIC – Standard Industrial Classification
TOD – Transit-Orientated Development
UDF – Urban Development Framework
1. URBAN STRUCTURE AND DEVELOPMENT IN SOUTH AFRICA

1.1 Introduction

In general, cities play an important role both as economic engines of countries and as areas that are attracting a larger share of the population. It is thus very important that they are planned and developed in a manner that supports and enhances their role as economic hubs and population centres. In the Western Cape Province alone, 2.9 million or 64 per cent of the province’s population lives in the Cape metropolitan area (Provincial Government Western Cape, 2004).

The possibility of employment and the hope for a better life are some of the attractions that lure immigrants to cities. Many of the rural immigrants find themselves settling in informal settlements and townships on the peripheries of towns and cities. These settlements, already struggling from infrastructure backlogs and overcrowding, are further put under severe strain. A daily reality for many of the inhabitants in these settlements are long trips to other parts of the cities where they can access jobs and other services such as education and health. The fundamental problem lies in the inherent spatial configuration of the South African urban landscape, where settlements for the urban poor were planned away from the city centres that were traditional economic hubs. Suburbanisation of the middle- and high-income activities has also encouraged long commutes and the use of the motor-car. The effect of suburbanisation has in turn further marginalised the poor who rely mainly on public transport to access services in the suburbs where public transport services are inadequate or expensive.

Thus, the effective functioning of a city and its ability to support its socio-economic development are influenced to some extent by its built form and the location of activities across its landscape. Equally important is an efficient transport system that links the various parts of the city and thereby determines the ease with which goods and people can move between places. Spatial and transport planning outcomes have an influence on each other and need to be aligned in pursuit of sustainable urban development.

This report highlights some aspects of the relationship between spatial and transport planning. More specifically, the discussion centres on the influence of densification on travel behaviour and some of the concepts and tools that are available for exploring this relationship.
1.2 The built form of South African cities

The spatial development of South African cities has largely been influenced by past planning practices from the colonial and apartheid eras. The outcome of these practices is an uncoordinated and fragmented urban fabric, characterised to a large extent by racial segregation. According to Dewar (1995), Lemon (1997) and Van der Merwe (1993) the form of South African cities developed over a few phases, namely:

- the settler-colonial phase (pre-1910) which was characterised mainly by class segregation;
- the segregation phase (1910 – 1950) marked by the introduction of controls on rural-urban movement and segregation embodied in the Natives (Urban Areas) Act of 1923;
- the apartheid phase (1950 – 1985) which was based on racial segregation policies symbolised above all by the Group Areas Act; and
- the post-apartheid phase (1985 to present) which commenced with the abolition of influx control and recently, the inquiry for new urban planning strategies focussing on reconstruction and development.

Currently, urban settlements still reflect to a large extent the influence of apartheid policies. Characteristic results of such policies are well-developed and serviced areas closer to central business districts (CBDs) and other major economic nodes which are occupied by the affluent, mainly white population while the poor, mainly black townships are located in under-developed settlements at the urban periphery. Figure 1 provides a simplified illustration of the outcome of apartheid spatial planning in Cape Town.

While most urban problems in South Africa are not unique, South African cities are unusual because of the direct relationship between law and urban development and the influence this has had on their formation (Berrisford, 1998). To further illustrate this point, Berrisford (1998: 225) writes that “in the urban sphere, despite popular opposition, law succeeded in establishing a physical pattern of urban growth and development that reflected the racist ideology of the apartheid state.” Past planning practices have also influenced urban development patterns in South Africa.
The planning of line departments such as health, education, housing and transport tended to be sectorally focused and work in isolation, without regard for or consideration of the planning and needs of other sectors. This lack of coherent planning has contributed to a dispersed service delivery outcome and a high degree of physical mobility.

1.3 The post-apartheid development trends

The post-apartheid phase has introduced a new trend of development characterised by the growth and development in affluent suburbs, both in terms of residential and employment land uses, and as a result the decline and decay of the historical city centres. Young & Froneman (2000) point out that the central city areas, or CBDs, are no longer the only major employment nodes, but instead employment can also be found in office parks and retail complexes outside the inner core of the cities. For many people living in the black townships, this only increases the distances and travel costs to access job opportunities.

Turok (2000) summarises these post-apartheid development trends in Cape Town in terms of four categories as follows:

- decentralisation – a net shift in economic activity away from the CBD and into higher-income areas of the city. Although in principle decentralisation may support urban integration by rebalancing the structure of the city, in its current form it fails to support the integration as the shift in employment favours high-income areas.
- deconcentration – a net shift in economic activities away from established centres. This phenomenon is inconsistent with the principles of urban integration as it results in a spatially fragmented, low-density, car-orientated development.
northern drift – a shift in property and economic development to the north of the city, thereby reinforcing the spatial inequalities and imbalances in Cape Town.

differentiation – the specialisation of economic centres in different market segments. This trend contradicts urban integration as it reinforces social segregation and spatial separation.

 Concurrently, the townships are experiencing growth in size, largely due to rural-urban migration and unauthorised land occupations by squatters. Despite efforts to address some of the historical inequalities by extending public services to the previously disadvantaged communities, current trends appear not to benefit the historically disadvantaged communities and instead reinforce past patterns of segregation (Turok, 2000). Thus, poor services and unemployment still characterise black townships and remain a challenge even in the present-day post-apartheid cities.

 It would appear that, despite good intentions and concerted efforts to restructure the urban landscape and integrate racially segmented settlements, the outcomes of these plans have not made a marked difference in poor communities. It is thus still important to investigate sustainable models of urban development that can change the legacy of apartheid planning still evident in South African cities today.

1.4 Implication of urban form for travel

The high physical mobility, high costs to individuals and negative impacts to the environment experienced in South African cities are attributed to the urban form. The following concerns have been raised regarding the effects that the segregated urban landscape typical of South African cities have on transport:

- a tendency towards low-occupancy vehicles;
- long trip lengths;
- congestion;
- huge public transport subsidies;
- high commuting costs; and
- inadequate agglomerations to support public transport (Behrens, 1998; Nel, 1998; Schnakenberg, MirriIees & Coovadia, 1998; Spence, 1998).
Of particular concern to the poor communities are the long commutes to access economic opportunities and the associated transport costs.

The spatial separation of residential, employment and social activities not only encourages travel but it does not support multi-purpose or short trips. Access to scattered services requires good public transport services and connections between various parts of the city. Absence of such services not only marginalises poor households that depend on public transport but also encourages the use of private cars, which contributes to negative environmental impacts such as air pollution and depletion of natural resource fossil fuels.

The poor communities at the urban fringes have to endure long journeys to access social and economic services. Although these areas are generally densely populated, overcrowding on trains and other public transport modes is a common problem mainly during peak hours. During off-peak hours there is inadequate demand for services, and many public transport services do not operate optimally during these hours. In addition, there is a uni-directional movement away from the townships to major employment centres during the morning peak and the reverse during the afternoon peak. Therefore, a need exists for alternative development strategies that will benefit especially the poor by improving their access to urban services during peak and off-peak hours.

1.5 Towards a sustainable urban development model for South Africa

The inefficiencies of the spatial configuration of South African cities highlighted above point to a need to identify and investigate alternative urban development strategies that will benefit all residents and produce more efficiently functioning cities. The main focus of such strategies is to improve accessibility to economic and social activities of all citizens in a sustainable manner.

The recognition of the negative impacts of the current form of our cities, especially in the previously disadvantaged communities, has given rise to seeking a developmental solution that aims to uplift the poor. Thus, much of the discussion that follows is inclined towards solutions that will first and foremost be of benefit to the poorer segment of the South African urban population.
The present-day phase of urban development is marked by developmental and reconstruction efforts. In order to overcome the problems that result from isolated sectoral planning, there have also been undertakings to promote integrated development planning (IDP), whereby the needs and plans of the different service sectors are co-ordinated and aligned. The underlying premise of IDP is the delivery of an integrated and widely inclusive package of services which will improve the living conditions of the poor communities. Integrated planning should also address to some extent the problems associated with the spatial distribution of service provision.

However, effective action towards improving the current urban spatial form is unlikely if there is a policy vacuum or if policies are not backed by effective institutional structures and legislation (Nel, 1998). In order to facilitate the integration of land use and transport planning, significant changes in local policy and the legislative environment in South Africa had to be undertaken (Marrian & Freeman, 2001; Vanderschuren & Van Maarsseveen, 2001). The following is a brief description of a selection of strategies and policies that have an impact on land use restructuring and transportation.

1.5.1 The Urban Development Framework (UDF)

The UDF acknowledges cities and towns as engines of growth and therefore the need for their well-being as vital for the economy and for meeting the basic needs of the poor. The purpose of the UDF is to provide an outline of the urban initiatives that are vital in the promotion of sustainable urban development. Four key programmes provide a focus for the implementation of the UDF, namely:

- integrating the city, which aims at negating the influences of apartheid planning;
- improving housing and infrastructure, which involves building habitable and safe communities;
- promoting economic development in order to alleviate urban poverty; and
- creating institutions for delivery so as to meet the stated urban vision (Republic of South Africa, 1997).

Of particular relevance to this study is the need for integrating the city and eliminating the problems that have come about due to the fragmented urban landscape.
1.5.2 *The Development Facilitation Act 67 of 1995 (DFA)*

The DFA was introduced in order to facilitate and speed up the implementation of reconstruction and development programmes in relation to land, to lay down general principles governing land development in the country, and to provide for the establishment of a development commission which would advise government on various aspects concerning land development.

The guiding principles in the Act relevant to spatial and transport planning espouse the overarching intent to correct the historically distorted spatial patterns of settlement and to encourage the development of environmentally sustainable land development principles. These principles include:

- integration of land use types;
- integration of residential and employment land uses;
- diversification of land uses;
- limitation of urban sprawl; and
- creation of compact settlement patterns (Republic of South Africa, 1995).

The DFA highlights the unsustainable urban form and the need for mixed-use compact developments.

1.5.3 *White Paper on Spatial Planning and Land Use Management*

The main objective of this document is to rationalise the numerous planning laws that were found to be in existence in different provinces and local authorities. The intended outcome of the white paper is a legislative and policy framework whose ultimate goal is to enable government, and especially local government, to formulate policies, plans and strategies for land use and land development that address, confront and resolve the spatial, economic, social and environmental problems of the country.

Among the planning outcomes envisioned by the white paper is the need to restructure spatially inefficient settlements (Republic of South Africa, 2001). Of particular interest to this study, is the recognition of the need for a legislative and policy framework for land use and management that will address the inequitable development and problems associated with inefficient spatial arrangements.
1.5.4 The White Paper on National Transport Policy

This policy document states the government’s commitment to the provision of transport services that support government strategies for economic and social development whilst being economically sustainable. Moreover it promotes the use of public transport over private car travel. The national white paper has also set a goal of reducing travel distances and times to a limit of 40 km or one hour in each direction. Furthermore, it stipulates that transport planning should support appropriate strategies such as corridor development and land use densification (Republic of South Africa, 1996).

1.5.5 White Paper on Western Cape Provincial Transport Policy

The overall intention of the provincial transport policy is to bring about a more effective and efficient urban system, primarily through changes in urban structure (Spence, 1998). In the white paper the following is stated:

“Strategic consideration of the relative roles of transport and land use is required to establish efficient, effective and equitable urban systems. The relationship must be firmly described and defined in sufficient detail to guide and control both the spatial distribution of land use activities and transport decision-making. To produce a transport system that is truly efficient, viable and affordable, and is sustainable into the future, it will be necessary to adopt policies such as containment, densification and mixed land use, leading to a fundamental restructuring of the land use system to reduce the demand for movement. In addition, appropriate legislation will be established at the national and provincial levels to ensure that transport and spatial development are integrated and that land use development proposals are subject to an approved land use/transport policy framework.” (Western Cape Department of Transport and Public Works, 1997: 9)

The provincial white paper also “pursue[s] a ‘Public Transport First’ policy” (Western Cape Department of Transport and Public Works, 1997: 14) and it stipulates a 20 per cent reduction in trip lengths exceeding 10 km by the year 2010.
1.5.6 Moving South Africa

The *Moving South Africa* policy document recognises that spatial planning is an effective and important strategy in transport planning. According to the document, commuter rail becomes viable in corridors of more than 30 000 passengers per direction per day, while numbers of passengers between 10 000 and 30 000 per direction per day are suited for road-based transport. The document identifies key strategic actions based on a need to focus investment and resources into high-density corridors and nodes, and by so doing, provide the necessary thresholds for public transport (Republic of South Africa, 1998).

1.5.7 The National Land Transport Transition Act

Key issues that have an impact on land use restructuring can be found in clause 4(1)(j), which states that:

“land transport functions must be integrated with related functions such as land use and economic planning and development through, among others, development of corridors, densification and infilling, and transport planning” (Republic of South Africa, 2000b: 12).

Sections of clause 18(3) state that transport plans must be developed so as to

- “direct employment opportunities and activities, mixed land uses and high-density residential development into high-utilisation public transport corridors interconnected through development nodes within the corridors, and the discouraging of urban sprawl where public transport services are inadequate;
- give priority to infilling and densification along public transport corridors” (Republic of South Africa, 2000b: 21).

This act also provides for the establishment of Transport Authorities which are mandated to prepare Integrated Transport Plans that include spatial development strategies aimed at minimising travel distances, cost and times, as well as the planning, integration, implementation and legal enforcement of these plans in their areas of jurisdiction (Republic of South Africa, 2000b).
1.5.8  Metropolitan Spatial Development Framework (MSDF)

The MSDF originated from a need for integrated planning and development in the Cape Town region. It is “based on a defined vision of a well-managed, integrated, metropolitan region in which development is intensified, integrated and sprawl-contained” (Cape Metropolitan Council, 1996: ix). A set of evaluation criteria has also been formulated with which the success of the proposed strategies can be measured. The MSDF has also identified structuring elements, namely nodes, corridors, a metropolitan open space system (MOSS) and an urban edge.

The underlying theme among these policies and strategies is the recognition of the inefficiencies of the existing spatial structure of settlements and the need for land use and transport planning that will redress the imbalances of past planning practices. Planners and decision-makers are faced with immense challenges to implement these policies and realise their intended outcomes. The need for new planning practices has also created opportunities for research in spatial restructuring of which this study forms a part. The purpose of the study in this regard is described in the following section.

1.6  Aims and objectives of the study

The current urban spatial structure of Cape Town and of other South African cities is regarded as problematic and unsustainable. Racially based residential areas are still a reality, with the former black townships still in a state of under-development and squalor. These peripheral areas lack basic services and where services exist, they are generally of too poor a quality to provide acceptable service levels to these high-density pockets of population.

While reconstruction and development strategies are acknowledged and supported by the government, there are impediments to achieving the intended outcomes of these strategies, among them budgetary constraints and other priorities, lack of institutional capacities and the difficulty to influence the location of private investment developments. Thus new and innovative development strategies, which will integrate the city and improve access to urban functions for the poor, are required.
As Bertolini (1999) has pointed out, it is important to recognise that both spatial decentralisation and concentration trends are evident in the contemporary city. Suitable development approaches should therefore acknowledge the merits of decentralisation and cope with its challenges of unsustainability. A promising approach in this regard is public transport-orientated development, also known as “transit-oriented urban villages” (Bertolini, 1999; Newman & Kenworthy, 1999). This concept encourages high-density nodes of mixed jobs, houses and services linked to the rest of the city by means of public transit.

Spatial decentralisation and concentration trends are also evident in South African cities. Both employment and residential developments are occurring in new nodes that are not only outside the inner city boundaries but also away from the previously disadvantaged communities, further marginalising them. The challenge is on how to improve linkages to these nodes or how new nodes can be identified and developed for the benefit of the poor.

As yet, analytical tools that can explore the possibilities and limits of public transport-orientated development are scarce (Bertolini, 1999). Most research has tried to understand the link between land use and transport and identify strategies for reducing automobile dependence. However, little effort has gone into developing analytical tools that can be used to profile locations. The purpose of the proposed research is therefore to make a contribution towards efforts to define a new development strategy based on a network of intensified nodes, as part of the transport problem solution. The aim of the study is to evaluate an analytical model developed at Utrecht University in The Netherlands referred to as the node-place model. The model has been developed to support nodal development decisions and to assess the development potential of nodes. Using the Cape Town metropolitan area as a case study area, the three objectives of the study are to:

- assess the data requirements of the node-place model and, in particular, to identify the suitability of existing data sources;
- use available data, apply the node-place model to selected railway stations and thereby develop a methodology for profiling nodes; and
- evaluate the role of the model as an urban restructuring tool and to identify potential challenges which could hamper the effective utilisation of the model.

By developing a method for nodal profiling, it is hoped that the development potential of nodes can be enhanced and exploited by applying appropriate development instruments. In
particular, an emphasis will be placed on transforming areas around transport nodes into transit-friendly communities by taking advantage of opportunities for infill residential development, pedestrian access improvements and mixed-use developments, as well as the potential for these areas to maximise interaction between different parts of the city and thus improve accessibility.

1.7 Report structure

The rest of the report is structured as follows. Chapter 2 discusses the concept of transit-orientated development (TOD), including both international and local interpretations. The main aim of the case study is to assess the data requirements and usefulness of the model to spatial restructuring in the South African context. Chapter 3 provides an overview of data requirements for the node-place model, while the application of the model to railway stations in Cape Town will be dealt with in Chapter 4. Concluding comments pertaining to the assessment of the model in achieving the stated objectives of this study and avenues for further research are dealt with in Chapter 5.
2. **PUBLIC TRANSIT-ORIENTATED DEVELOPMENT (TOD)**

2.1 **Definition of transit-orientated development**

Public transit-orientated development, also referred to as ‘transit villages’, is a way of locating people near transit services so as to encourage the use of public transport. Such developments comprise a centre with a mix of high-density land use developments and a transit station at the centre of the core. A transit-friendly community therefore encourages public transit use, decreases automobile dependency and offers a variety of activities by incorporating commercial, residential and civic uses within reasonable walking distance to a rail station or bus stop in a well-designed pedestrian-orientated environment (Puget Sound Regional Council, 1999). In the South African context, transit villages incorporating low-income housing will improve accessibility of the poor to economic and social activities.

Transit-orientated development is one of several planning models found within a planning movement known as neo-traditionalism or new urbanism. It refers to compact developments with a mix of housing, retail and offices centred on a transit station, whose purpose is to encourage walking and to provide easy regional access by public transport, of individual communities (Puget Sound Regional Council, 1999). In the United States, TOD at railway station areas has emerged as a strategy for increasing transit ridership and managing growth. The benefit of TOD for transit agencies is increased ridership and, in turn, increased revenues from operations. For local governments and regional planning agencies, TODs represent opportunities for intensive developments to control sprawl and to manage growth (Puget Sound Regional Council, 1999).

In South Africa, transit ridership among the poorer communities is not an issue as the majority cannot afford to own private motor vehicles. Therefore, the benefits of TODs may be found in improving access to both local and other urban functions and to accommodate some of the housing backlogs in locations that are accessible. Public transport planning in South Africa is orientated to peak-period commuter trips, while non-work trips have not received much attention. The opportunities for TODs in South Africa are many and consider both the work trips and non-work trips, and encourage infill as well as urban revitalisation. The essence of transit-orientated development is to create a vision of a compact and walkable
neighbourhood, with most basic needs accessible on foot or by bicycle, and improved regional connectivity via public transport (Puget Sound Regional Council, 1999).

There are three dimensions which are thought to significantly increase transit ridership and to distinguish transit villages from other urban settings (Bernick & Cervero, 1997). These are density, diversity and design, which are described as follows:

- **density** – enough residents and workers within a reasonable walking distance to the transit station in order to generate high ridership;
- **diversity** – the mixture of land uses; and
- **design** – physical features and site layouts that are conducive to walking, cycling and transit riding.

A further distinction is also made between two types of transit-orientated developments, namely urban and neighbourhood, whose differences depend on their articulation with the transit system and the intensity of their development (Gilbert & Ginn, 2001). Urban transit-orientated developments are generally located on a regional transport system and have high commercial intensities, employment clusters and moderate to high residential densities. Neighbourhood transit-orientated developments, on the other hand, are located on local or feeder transport systems and tend to have moderate residential densities, retail, service, entertainment, recreation and civic uses. Niles & Nelson (1999) have identified the factors that determine the success of each type of development, which they refer to as local and regional-scale TODs (see Appendix A). In this context, local and regional-scale TODs are synonymous with neighbourhood and urban TODs respectively.

According to Coovadia & Shaw (1997: 1) “fixed-track public transport facilities, such as rail, serve as ideal facilities for enhanced high-demand corridor movement patterns which will be encouraged by development in close proximity to stations, where appropriate.” These developments will also contribute towards the following developmental aims:

- infilling and integration;
- improving and addressing issues related to local economic development (LED) opportunities;
- increasing transit ridership;
- reducing average trip lengths, time, costs and amount of travel; and
- revitalising urban areas.
While access to good transit should on its own provide economic benefits owing to the interaction possibilities inherent in such locations, public seed monies can be used to leverage private investment in order that TODs become viable (Niles & Nelson, 1999).

2.2 Impacts of a compact urban form on travel

The current form of South African cities has negative travel implications prompting a quest for alternative forms of urban growth that are sustainable (Morojele, 2001). Many strategies have been proposed and researched around the world, with the aim to reduce travel in general and automobile dependency in particular. Among these are land use strategies whose central focus is to promote densification and intensification of urban development. These strategies recognize the importance of co-ordinating land use and transport planning (Cape Metropolitan Council, 1998; Visser, 1993; Western Cape Department of Transport and Public Works, 1997). Theoretical and empirical studies in this regard have indicated that dense, mixed-use developments can be expected to alter travel behaviour in terms of:

- modal choice - by favouring the use of public transit, walking and cycling;
- trip characteristics - shorter commutes due to the proximity of urban activities; and
  - fewer trips made possible by trip chaining.

In general, the proponents of urban compaction assume that residents of dense developments will:

- use public transport or walk more than residents in low-density areas;
- travel less; and
- undertake shorter journeys.

It is realised, however, that “those who can afford to own cars and use cars will be unlikely to voluntarily forgo their comfort in favour of a less comfortable mode of travel. The major emphasis to change the dependence of this group on cars, would be to try and reduce the number and length of trips” (Green, Maré & Naudé, 1992: xii).

To date there is no strong, shared perspective on the nature and magnitude of the relationship between land use patterns and travel behaviour. Some theoretical and empirical research has indicated the existence of a strong relationship between land use patterns in the form of
density and transport (Næss, 1999 & 2000; Newman & Kenworthy, 1991 & 1999). For example, using data on global cities, Newman & Kenworthy (1991 & 1999) have shown that density influences journey distances and hence energy use. Næss (1999 & 2000) has also indicated that land use planning can influence the extent and character of transportation and hence energy use through:

- reducing the movement of people and goods; and
- transferring from energy-demanding (e.g. private cars) to energy-efficient (e.g. public transport) means of transportation.

Other researchers have only found a weak link between urban form and transport, and have concluded that other factors, such as household income and size, have a stronger influence on travel behaviour (Crane & Crepeau, 1998; Krizek, 2000). Regardless of the inconclusive statements pertaining to whether there is a link in the first place, and to the magnitude of this link when it exists, Simmonds & Coombe (1997) found that most studies support the compact city concept as a way of reducing automobile dependence and thereby minimising its social and environmental costs.

2.3 Why TOD for South African cities?

The peripheral location of the majority of poor households in South African cities translates into long journeys to and from work and other urban services on a daily basis. The cost of travel to work is also high, both to the individuals and the state through transport subsidies. Fortunately, there are certain advantages that can be expected to be achieved by the introduction of TOD to South African cities, namely:

- The lack of economic and social opportunities in poor areas results in a need to travel long distances to access jobs and other services. Mixed-use nodal developments can be expected to result in reduced travel distances and times and to encourage walking due to the proximity between residential, social and economic activities. By implication, the following can also be realised:
  - with reduced distances a reduction in travel costs can be expected, as more people will live closer to work and social opportunities;
  - the state can be expected to benefit through a reduction in transport subsidies;
  - increased economic opportunities due to proximity to employment centres; and
  - a better utilised rail infrastructure throughout the day.
• Non-work travel has been neglected in transport planning so far while the focus has been on the transport needs of the commuter. As a result, non-work travel is not adequately served by mass transit. Mini-bus taxi services have largely responded to this demand for off-peak travel. The poor quality or inadequate provision of retail and public services in previously disadvantaged communities encourages travel in order to access these services elsewhere in the city. It is expected that the transit-orientated development concept will provide an alternative development strategy that will also benefit non-work travel by ensuring that facilities and services are accessible by walking or public transport.

• Transit-orientated development also offers an opportunity to address the housing shortage through the identification of well located, accessible areas that can accommodate high-density residential developments. However, the success of this notion relies on the availability of both vacant and re-developable land.

Several notions or forms of TOD are already evident in the spatial development plans of the country’s metropolitan councils which have identified transport corridors and nodes as essential spatial restructuring elements.

2.4 The corridor and node concept

The corridor and node concept provides a frame in which a certain desired relationship between land use and transport can be articulated. The Moving South Africa definition of a corridor is: “A high-volume transport route that links major activity centres. Corridors and nodes that they connect are areas of highly concentrated passenger and freight customer demand and therefore require relatively large-scale investment in infrastructure and services. Corridors generally consist of a simple core route structure (which allows for higher speeds and frequencies), supported by an accessing system of feeder routes” (Republic of South Africa, 1998: 84). Marrian & Freeman (2001) describe the generic components of a transport-land use corridor which act as forces of attraction in a corridor, as:

• outer nodes at the ends of the corridor;
• inner nodes between the outer nodes;
• a stretch of land bordering the activity spine; and
• land between the inner and outer nodes and not bordering directly on the spine.
These components are shown diagrammatically in Figure 2.

![Diagram of corridor components](image)

**Figure 2:** Components of a corridor  
(Source: Marrian & Freeman, 2001: 13)

The corridor and node concept has been popularised in South Africa in the land use/transport planning sphere. This concept encourages high-density, mixed-use developments focused around strategic public transport-oriented corridors and nodes. Development corridors and nodes are to serve as structuring elements of a new landscape. In so doing, travel demand can be concentrated and therefore lead to necessary thresholds for public transport and subsequent lower unit costs and accessibility to urban functions can be improved.

### 2.5 Spatial development frameworks

The purpose of a spatial development framework (SDF) is to reflect the strategic and policy framework contained in the IDP and to provide broad spatial guidance for existing and future development and land use. Among SDF objectives is a need to improve accessibility to infrastructure, services and economic opportunities and to guide the location of possible future development projects. SDFs are legislated requirements of the Local Government: Municipal Systems Act, Act No. 32, 2000 and the Local Government: Municipal Planning and Performance Management Regulations, Notice 796, 2001.
The specific requirements of the above-mentioned legislation with regard to the contents of the SDF are to:

- set out objectives that reflect the desired spatial form of the municipality;
- contain strategies and policies regarding the manner in which to achieve the above objectives (especially with regard to desirable land use patterns, spatial reconstruction of the municipality and the location and nature of development within the municipality);
- set out basic guidelines for a land use management system in the municipality;
- set out a capital investment framework;
- contain a strategic assessment of the environmental impact of the spatial development framework;
- identify programmes and projects for the development of land; and
- provide visual representation of the desired spatial form of the municipality, indicating the following:
  - Where public and private development and infrastructure investment should take place;
  - Desired or undesired utilisation of space in particular areas;
  - The urban edge (optional);
  - Areas where strategic intervention is required; and
  - Areas where priority spending is required (Republic of South Africa, 2000a).

Higher densities and the mixing of different land uses are key variables at the urban scale for reducing the physical separation of activities. The Urban Task Force (1999) mentions the key principle of urban design as the optimisation of land uses through intensifying developments and diversifying activities and uses. “Policies which result in residents being more centrally located and substantially better served by public transport and/or policies which achieve a finer mixture of different land uses are more likely to reduce car travel than policies which concentrate particular types of destinations, such as employment” (Simmonds & Coombe, 1997: 664).

Coovadia & Shaw (1997) state the following benefits of dense mixed-use developments:

- increased public transport patronage and the promotion of efficient public transport modes;
- the stimulation of development and investment in low-income areas; and
- restructuring of the urban layout.
The more sprawling the area, the more important it is to concentrate facilities and services in corridors and nodes (Ewing, Haliyur & Page, 1994). This form of urban structure ensures that communities internalise as many facilities and services as possible, by concentrating them in centres and corridors and thereby ensuring efficient automobile trips in sprawling cities because linked accessibility can be maintained. According to Newman (1996), high-density urban development that is integrated around the transit system is central to the success of Singapore and Hong Kong in limiting private automobile dependence.

Transit-orientated, mixed-use developments are purported to abate dispersed urbanisation and are therefore among the proposed remedies for urban sprawl and automobile dependency (Filion 2001). Filion (2001) cautions, however, that on their own, mixed-use centres fall short of their planning objectives, whereas they are found to be more effective when combined with high-density, transit-orientated corridors. “The advantage of such a configuration would be to secure advantageous conditions for transit both at the origin and at the destination of a journey, hence creating sectors rather than points of transit viability” (Filion 2001: 156). A suggestion made by Coovadia & Shaw (1997) is that public transport has a greater chance of success if directed towards high-density locations, especially along transport corridors.

Suggestions on how to achieve the high-density nodes and links to transportation have been made by Green, Maré & Naudé (1992), who propose that the following land use arrangements can be considered in the development of a good public transport system and a reduction in car use:

- optimal co-ordination of demand locations (residences) with supply (transit stations);
- higher residential and employment densities;
- optimal land use mix; and
- reduction of travel distances through compact land use arrangements.

Daniels (1997) suggests that a possible strategy for attaining higher-density, mixed-use developments is by focussing development on particular spatial areas, such as corridors or through development concentrated around activity focal points or nodes. This view is also supported by Spence (1998: 19) who states that “an integral component of restructuring and reintegration will be the promotion of development corridors and nodes within which public passenger transport services provide the principal means of accessibility”.
The IDP process also provides an opportunity for co-location of different types of facilities. In a study done for the eThekwini (formerly Durban) Municipality, Morojele, Green & Ramduny (2002) identified areas that have poor access to a number of public facilities and, where possible, identified transport nodes or other facility clusters nearby where new facilities could be planned.

The Council for Scientific and Industrial Research (CSIR) has also been involved in the development and application of accessibility analysis tools and the identification of suitable locations for the development of multi-purpose nodes. Using public facilities such as clinics, police stations and libraries, these tools can be used to identify poorly served areas at which new facilities can be provided and it also examines co-location possibilities. These locations can then be used to attract private sector development and housing, and can be the basis for nodal development. Railway stations are also possible locations for nodal developments as has been the case in Europe. The following section describes the reasons underlying such thinking.

2.6 Railway station area redevelopment

In terms of nodal development, the redevelopment of railway stations and their surroundings forms part of ambitious plans throughout Europe (Bertolini, 1999; Bertolini & Spit, 1998). These plans are driven by diverse factors, which include:

- promotion of sustainable transport and land use;
- stimulation of local economies;
- technological and institutional change;
- market conjunctures; and
- the spatial impact of globalisation (Bertolini, 1999; Bertolini & Spit, 1998).

A railway station has two basic identities – it is both a node and a place (Bertolini & Spit, 1998). As a node, it refers to a point of access to trains and other transportation modes and is part of a transportation network. A railway station also occupies a specific location in the city, with a diversity of activities around it, and is therefore a place. “Basically, the unique challenge of the development of node-places is the need to deal, at the same time, with both transport and urban development issues” (Bertolini & Spit, 1998: 17).
Given the reluctance and difficulty of attracting private investments in peripheral disadvantaged communities, the idea of rather bringing development closer to established areas and around transport nodes may offer a suitable form of development. The benefits of such ‘inward’ development being:

- proximity to employment centres, and therefore savings on commuting costs;
- proximity to public transport services, thereby improving accessibility to other parts of the city;
- proximity to commercial and other higher-order facilities; and
- favourable conditions for small businesses through higher customer flows and access to spending power.

Rapid urbanisation and apartheid planning have also resulted in massive housing backlogs across the country. In the Cape Town metropolitan area, the housing backlog is estimated at around 350 000 – 400 000 housing units (Cape Times, 2003). A possible strategy for housing the poor would be through the development of brownfield areas in the vicinity of the railway stations. While the amount of redevelopable land around railway stations may not be adequate to address all of the housing needs, it nevertheless cannot be overlooked in preference to larger, mainly peripheral greenfield sites. The development of station areas therefore also provides a housing provision option, especially suitable for the emerging middle class that can be accommodated in refurbished buildings.

The location of transport interchanges also formed the basis for the investigation of a facility investment plan for eThekwini Municipality that would address the needs of communities with poor services to existing social facilities (Morojele, Green & Ramduny, 2002). The following section describes a selection of tools that support the integration of land use and transport planning.

### 2.7 Selected tools in support of node development

This section describes three planning tools that can be used in nodal development. They all combine aspects of transport with land use decisions.
2.7.1 The ABC location policy

Realising the need for better integration between transport and land use planning, the Dutch found an innovative land use strategy that exploits different land uses and the mobility they generate (Department of the Environment & Department of Transport, 1994; Vanderschuren & Van Maarsseveen, 2001). Three basic accessibility profiles of areas are identified as:

- A-locations – highly accessible by public transport;
- B-locations – reasonably accessible by both public transport and by car; and
- C-locations – typical car-orientated locations (Department of the Environment & Department of Transport, 1994; Vanderschuren & Van Maarsseveen, 2001).

Likewise, mobility definitions for employment were defined thus:

- A-mobility – people-intensive land uses with a high need for public transport;
- B-mobility – includes commercial services, sports and recreation and retail which have a moderate need for public transport; and

The aim of the strategy is to match mobility and accessibility whereby businesses of mobility A can only be located in locations of accessibility A, and likewise for types B and C.

2.7.2 Accessibility modelling

Accessibility modelling assists in the identification of areas that have poor access to existing spatial distribution of point-based facilities such as schools, clinics, police stations, libraries and community halls. A GIS-based accessibility modelling software referred to as AccessMap has been applied in the Cape Town and eThekwini municipalities to assess the spatial coverage of a number of selected social facilities and to determine the location and size of new facilities as well as possible co-location options (Morojele, Green & Ramduny, 2002).

Examples of outputs from the accessibility model are indicated in Figures B1 and B2 (see Appendix B). Figure B1 is an example of a catchment area analysis output, indicating areas that fall within specified primary catchments or service areas of facilities. Figure B2 is a type of demand density mapping, which indicates accessible locations for people in poorly-served
areas as well as the magnitude of the demand at these locations. The values relate to the potential demand that is accessible at each location. Therefore locations with high values would be suitable locations for planning new facilities. In terms of nodal development, this model can be used to identify areas suitable for multi-facility development, which can then be used to attract other forms of investment from the private sector.

2.7.3 The node-place model

The node-place model was developed to chart differences in transportation and land use developments of nodes and, by implication, to assist in the identification of their development potential. The model is described by Bertolini (1999) in a simple xy-graph as shown in Figure 3. The x-value represents the place index, which corresponds to the intensity and diversity of activities in an area and thus to the degree of actual realisation of the potential for physical human interaction. These activities include residential and economic development, as well as the availability of entertainment, recreation and other services. The place index aims to give an indication of the mix and diversity of activities around a transport node.

![Node-place model expressed as a graph](Source: Bertolini, 1999: 202)

The node index is represented by the y-value and corresponds to the accessibility of a node by various transportation modes such as rail and bus, and thus provides an indication of the potential for human interaction at a node. This index is calculated by combining several

variables representing the intensity and diversity of transport supply, using a multi-criteria assessment (MCA) tool.

In an ideal situation, the node and place characteristics of a location should be equally strong, and would typically lie in the part of the graph noted as accessible. There are four typical situations which would require some intervention to shift them towards this ideal situation, namely:

- areas under stress – the intensity and diversity of transportation flows and urban activities are maximal;
- dependent areas – the demand for transportation services and urban activities is low;
- unsustained nodes – transportation facilities are more advanced than urban activities; and
- unsustained places – urban activities are more developed than transportation facilities.

The node-place model was selected for use in this research as it combines the land use and transportation aspects and gives an indication of the degree of balance between the two, thereby providing the general developmental inclination of a node in terms of these two factors. The following section describes the methodology followed in applying the node-place model for the purpose of node profiling.

### 2.8 Research design methodology

The node-place model described above was chosen to be evaluated in terms of a set of railway stations in the Cape Town metropolitan area. Due to time and data constraints, only a few stations were selected to demonstrate the application of the model. The selection of the nodes was influenced largely by:

- their relationship to the proposed MSDF corridors and nodes and their significance in the metropolitan context; and
- data availability.

After selecting stations for inclusion in the study, Arcview GIS was used to delineate 1 kilometre radius zones around the stations to represent ‘walkable’ stations areas. The next step involved the identification of data required as input into the node-place model. The place index, which represents the mix of activities in a node, is based on population and
employment. The most comprehensive source of demographic information is the population census and it can be made available to the public at various spatial units. The latest population census done in 2001 could only be provided at mapping units much larger than the demarcated areas around the stations, which would have complicated the allocation of population into the smaller station areas. The population data used in this study was obtained from the GIS-based Census ’96 database provided per enumerator area, being the basic unit at which this data was collected. An overlay technique in Arcview GIS was used to identify census enumerator areas falling inside or intersecting the ‘walkable’ areas for each station and to estimate the size of the population in the station’s catchment area. Data on employment by economic sector were drawn from the 2000-2001 Regional Services Council (RSC) levy database of the City of Cape Town. This information indicated the number of employees in each major economic sector per erf (cadastral parcel). As with the population data, a selection of erven within the catchment area of each station was done by overlaying the station areas and the cadastral layer to estimate the number of jobs in each station catchment. The population and employment information were put into an MS Excel spreadsheet, using a formula developed by the University of Utrecht to calculate the degree of functional mix described in Chapter 4 of this report.

For the calculation of the node index, which represented an accessibility indicator, the following information was used:

- frequency of train, bus and taxi services;
- average metropolitan-wide distance to each station; and
- railway station modal transfer status or type.

The public transport information was obtained by studying published bus and train schedules and the Current Public Transport Record (CPTR) report for the City of Cape Town. The distance measures were estimated from origin-destination (OD) tables calculated using transport zones to represent origin locations in the metropolitan area and station locations as destinations. All the variables were then combined using a spreadsheet-based multi-criteria assessment (MCA) using equal weights to develop a node index as described in Chapter 4 of the report. The calculated indices were plotted on an xy-scattergram to depict their distribution in terms of land use and accessibility, which was also used to profile them. A summary of the indices and the data requirements for their calculation is provided in Table 1.
Table 1: Data requirements and calculation methods for the node and place indices

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Data requirements</th>
<th>Data sources</th>
<th>Method of calculation</th>
</tr>
</thead>
</table>
| Place Index | Intensity and diversity of activities in an area  | • Population  
              • Employment by economic sector                  | • Census ’96  
              • City of Cape Town RSC levy database          | Degree of functional mix          |
| Node Index | Accessibility of a node                             | Public transport information (all modes). Limited in this study to train and bus service frequencies and station modal transfer status | Metrorail and Golden Arrow timetables | MCA using equal weights |

(Source: Compiled by the author from information in Bertolini, 1999).

Figure 4 encapsulates the methodology for and approach to the study. The process followed is indicated in terms of 4 main steps comprising:

- a literature study on the relationship between transport and land use planning;
- identification and collection of data for use with the node-place model;
- processing of the data and calculation of the node and place indices; and
- development of profiles or typologies of the nodes investigated.

The preceding chapters of the report have summarised the findings from the literature review and the rest of steps are elaborated in the subsequent chapters.

Transit-orientated development offers an alternative model for urban development but effective nodal development will be informed by understanding the type and magnitude of activities in the nodes. The node-place is used to quantify activities in a node and by
implication assists in nodal profiling. Chapter 3 describes the data used and its allocation into demarcated station areas prior to running the model.

Figure 4: Research design for the application of the node-place model and node profiling of railway stations in the Cape Town metropolitan area
3. DESCRIPTION AND DATA REQUIREMENTS OF THE NODE-PLACE MODEL

3.1 Description of the study area

Cape Town is the third largest metropolitan area in South Africa in terms of population with its 2.9 million inhabitants and it ranks second in terms of employment, with 0.94 million workers (City of Cape Town, 2004). The Cape Town metropolitan area still reflects racially segregated residential areas. The lack of residential integration and the inequity in service provision between former White and Black residences is a major source of concern and an underlying motive for enquiry into alternative and sustainable forms of development.

The study area includes selected railway stations in the Cape Town metropolitan area along two of the proposed MSDF corridors. The area incorporates the Cape Town station on the west of the City; the southern peninsula stations including Claremont; and the east-bound railway line to Bellville; and Phillipi in the south-east of the City. Cape Town, Claremont, Bellville and Phillipi are also significant nodes in the MSDF, presently exhibiting varying development characteristics and intensities. For instance, the Cape Town CBD and its environs is predominantly a medium- and high-income office and retail employment node with some residential development. The Claremont node has a more mixed-use development, with both office and retail employment as well as residential uses. Bellville is also predominantly an employment node with most jobs being in the manufacturing sector. The Phillipi station node is predominantly residential with very little employment. The proportion of employment and resident population in the immediate vicinity of the railway stations used in this study is indicated in Appendix C.

The location of the stations and the alignment of the MSDF corridors in the study area is shown in Figure 5.

3.2 Selection of nodes

As noted elsewhere in this report, the selection of stations was informed by their alignment to the MSDF corridors. Specifically, the selection includes the majority of stations along two of
the city’s mature corridors which include the major destination nodes of Cape Town, Bellville and Claremont, as well as Phillipi, which has been identified as a major node in the south-east of the city. These nodes are therefore of particular interest to the city’s envisaged spatial development and the identification of realistic development proposals in these nodes in terms of the compact development aspirations espoused in the MSDF and other spatial development objectives of the city is important.

Figure 5: Location of study area indicating the MSDF corridors and the 1km station buffers
3.3 Defining station precincts

Station precincts are areas in the immediate vicinity of a station accessible by walking which is the most convenient mode of transportation for short distances. Acceptable walking distances vary considerably depending on a number of factors such as weather conditions, trip purpose and topography. Some of the issues to consider when determining walking distances are:

- the walkway system itself in terms of whether it is direct and complete and whether the walk environment is enjoyable and safe;
- people walk farther to transit stations that provide a high level of transit service;
- people tend to walk farther between a station and residence or place of employment than to retail establishments; and
- people walk short distances when transferring between modes (Puget Sound Regional Council, 1999).

Station precincts were defined on what was perceived as convenient walking distances. Most research on pedestrian walking distances provides only a rough guide of what is considered acceptable distances without distinguishing between the purpose of the journey. Hoffa (1999) cites a few international reports on walking distances. In Sweden, a generally accepted walking distance to public transport is 1 kilometre, while in the United Kingdom a ten-minute walk is considered acceptable by most people. Hoffa (1999) also mentions 400 metres as a general guide to accessing lower order activities, including walking to public transport. Examples are also given from the Netherlands and Canada, which cite varying distances to accessing public transport. For example, in a study done in Toronto, Canada, only 15 per cent of commuters were willing to walk more than 1 kilometre to a station (Coovadia & Shaw, 1997) and in a study of the Amsterdam and Utrecht stations in the Netherlands, Bertolini (1999) defined a station precinct as an area within a ‘walkable’ radius of 700 metres.

Coovadia & Shaw (1997) also indicate that high residential densities within 600 metres of public transport stops significantly increase the probability of public transport support. In the same study, Coovadia & Shaw (1997) found that in Atteridgeville, Pretoria, more than 50 per cent of commuters were willing to walk 1.5 kilometres to access rail transport. However, a walking time in excess of 20 minutes to a public transport stop was regarded as unsatisfactory.
by the majority of Black commuters. Where distances exceeded 1.3 kilometres, the majority of rail commuters were prone to use a taxi as a feeder mode.

For the purpose of this study, the following were considered:

- the international and local research cited above;
- an assumption that poorer people in Third World countries are probably willing to walk farther, especially for journeys to work; and
- the MSDF’s rough guide of 800 – 1000 metres for corridor buffers.

A 1-kilometre radius was accepted as an appropriate distance to use in this study.

3.4 Using a geographic information system (GIS) to demarcate station precincts

The Arcview GIS system was used for the spatial analyses undertaken in the study. Most of the data used in the study, including population, employment and the location of stations were already available as layers in a GIS format. The ability of a GIS to integrate different data layers, especially for purposes of transferring data between different spatial layers, was a key factor in the decision to use a GIS for the preparation of data for use in the node-place model at a later stage.

A GIS has the capability to store and manipulate geographic data. Among the functions found in most commercial GIS software is the buffering function used to demarcate an area of influence or catchment around a point. The analysis is based on airline (or as the crow flies) distances and does not take into consideration an actual transport network. Other more advanced GIS systems such as ArcInfo and Flowmap have the capability to define travel time or distance catchments using an actual transport network and therefore, by implication, consider physical barriers such as railway lines or rivers that may impede movement.

Ideally therefore, the demarcation of station precincts should be based on actual road network distances. However, for the purposes of this study, a straight-line buffering technique in Arcview was used to demarcate a 1km-buffer around each station as indicated in Figure 5. Each buffer zone was assigned the name of its corresponding station for ease of reference and to aid in subsequent spatial overlay analyses to allocate population and employment. Having defined the extent of the station precincts, the next step involved adding the required
information on population, employment and transportation services to these zones as described in the following sections.

3.5 Allocating population and employment to station areas

This section describes the sources of the population and employment data and the method used to link this information with the identified station areas. As the information used was already captured as thematic layers in a GIS, the ensuing steps involved some GIS manipulation.

The main source of population information is the official population census. The 2001 population census provides the latest population counts. However, at the time of doing this research, the data could only be provided by sub-place, which can be equated to suburbs and are therefore larger zones than enumerator areas. Disaggregating and allocating data from large to small zones is not only complex but it can also introduce large margins of error and therefore the accuracy of the results can be compromised. The Census '96 data therefore had to be considered as an alternative.

Although outdated, Stats SA disseminated the Census '96 data by enumerator areas, which are the smallest units used for collecting demographic data. Allocating data from enumerator areas into the station precincts would give a more accurate estimate, hence the Census '96 dataset was used in this study. Figure 6 illustrates these concepts of data and allocation between different zones.

Figure 6: Complexity of disaggregation and allocation of data between different zones
Although employment information is also collected during the census, it does not indicate the number of jobs at place of work. Instead, the City of Cape Town’s RSC levy database was used to estimate employment in each station precinct. The RSC levy database contains information on the location of businesses, number of jobs and an economic classification of the business. However, it must be noted that the accuracy of the information is questionable due to:

- some businesses not providing information on the number of employees they have,
  and
- in some cases an absence of accurate indication of the erf or plot number where the business is located.

In order to overcome the first problem, the City of Cape Town’s officials estimate values for the unknown instances by calculating the average employment in businesses with the same economic classification. With regard to the second problem, approximately 25 per cent of businesses do not provide an erf number which can be used to precisely locate the business. However, the database contains additional location information such as a street address or suburb name which can be used to approximate the location of the business.

The proximity of the railway stations to each other results in overlapping catchments and thereby double counting of population and employment data. This affects the global estimates for these two variables but should not have a negative impact on the calculation of the indices for individual nodes. In the following sections descriptions of the spatial allocation process used for estimating the population and employment in station precincts is provided.

### 3.5.1 Population estimates for railway station precincts

For reasons mentioned earlier, the Census ’96 population data was used as the basis for estimating the population of each station precinct. The allocation was achieved by performing a spatial intersection in Arcview between the enumerator areas, containing population data, and the station precincts, defined by a 1 kilometre radius around each station. All enumerator areas inside or crossing a station precinct were identified and their population allocated into the station precinct. It is important to note, however, that there are other ways and assumptions of dealing with enumerator areas that have a large portion outside the station precinct. The enumerator area can be discarded altogether from the calculation unless the portion falling inside the station precinct can be identified as a built-up area. In that case the
population of the enumerator area can be allocated to the station precinct or an area-proportional allocation method can be applied to only allocate a proportion of the population.

A GIS layer of built-up areas (Figure 7) was used to determine if and how to incorporate the population in enumerator areas in the calculation of population estimates of station precincts. If available, aerial photography can also be used to identify built-up areas. To further provide an indication of the extent of residential development, a population density map was produced using the enumerator area population data (Figure 8). In most cases all enumerator areas that intersected a station precinct were used to estimate the population of the precinct.

3.5.2 Estimating economic development in the station precincts

The number of jobs around each station was estimated from the 2000 – 2001 RSC levy database of the City of Cape Town. This database contains information on the number of employees for each registered business and in turn, each business is classified into one of nine major economic activities based on the Standard Industrial Classification (SIC) codes (Table 2). An erf number and other location information such as suburb name or physical address are also provided.

Table 2: Employment in the Cape Town metropolitan area according to major economic activity division, 2000

<table>
<thead>
<tr>
<th>Economic activity division</th>
<th>SIC code</th>
<th>Total employment</th>
<th>% of total employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, hunting, forestry and fishing</td>
<td>01</td>
<td>3 334</td>
<td>0.3</td>
</tr>
<tr>
<td>Mining and quarrying</td>
<td>02</td>
<td>179</td>
<td>0.01</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>03</td>
<td>130 580</td>
<td>10.8</td>
</tr>
<tr>
<td>Electricity, gas and water supply</td>
<td>04</td>
<td>70</td>
<td>0.006</td>
</tr>
<tr>
<td>Construction</td>
<td>05</td>
<td>18 230</td>
<td>1.5</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>06</td>
<td>201 197</td>
<td>16.7</td>
</tr>
<tr>
<td>Transport, storage and communication</td>
<td>07</td>
<td>11 772</td>
<td>1.0</td>
</tr>
<tr>
<td>Financial, insurance, real estate and business services</td>
<td>08</td>
<td>794 703</td>
<td>66.0</td>
</tr>
<tr>
<td>Community, social and personal services</td>
<td>09</td>
<td>43 100</td>
<td>3.6</td>
</tr>
<tr>
<td>Other e.g. private households, diplomatic service, industry not elsewhere classified (NEC) or unspecified</td>
<td>00</td>
<td>1 266</td>
<td>0.1</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>1 204 431</td>
<td>100.016</td>
</tr>
</tbody>
</table>

(Source: City of Cape Town, 2000)
Figure 7: The built-up land area and station precincts in the Cape Town metropolitan area
Figure 8: Population density in the vicinity of stations in the Cape Town metropolitan area, 1996
The classification of employment by economic activity is essential because the node-place model distinguishes between jobs in service-orientated industries and other jobs such as in offices and manufacturing, the premise being that service-orientated economic activity will attract users or demand from other areas requiring these services. The intensity of service-orientated businesses provides an indication of the potential of an area to attract people other than those who work or reside in the area. Approximately 40 000 formal establishments were recorded in the RSC levy database in 2000, the majority being in the finance (SIC 08) and trade (SIC 06) sectors which accounted for 66 per cent and 17 per cent respectively.

Table 3 shows that in terms of the geographic distribution of economic activities in the Cape Town metropolitan area, the older established economy of Cape Town and the Bellville/Parow areas are the dominant employment centres, together accounting for 37 per cent of employment in the metropolitan area.

Table 3: Geographic distribution of employment in the Cape Town metropolitan area, 2000

<table>
<thead>
<tr>
<th>Area</th>
<th>% of total employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Town</td>
<td>22.8</td>
</tr>
<tr>
<td>Bellville/Parow</td>
<td>14.2</td>
</tr>
<tr>
<td>Maitland/Paardeneiland</td>
<td>11.0</td>
</tr>
<tr>
<td>Goodwood</td>
<td>7.0</td>
</tr>
<tr>
<td>Claremont/Mowbray</td>
<td>6.5</td>
</tr>
<tr>
<td>Observatory/Salt River/Woodstock</td>
<td>6.3</td>
</tr>
<tr>
<td>Milnerton/Melkbosstrand/Table View</td>
<td>5.9</td>
</tr>
<tr>
<td>Wynberg/Plumstead/Ottery/Grassy Park</td>
<td>5.1</td>
</tr>
<tr>
<td>Somerset West/Strand/Gordon's Bay/Mfuleni</td>
<td>4.9</td>
</tr>
<tr>
<td>Airport Industria/Elsies River/Belhar</td>
<td>2.9</td>
</tr>
<tr>
<td>Gugulethu/Crossroads/Langa/Athlone</td>
<td>2.7</td>
</tr>
<tr>
<td>Atlantis/Mamre</td>
<td>1.8</td>
</tr>
<tr>
<td>Lansdowne</td>
<td>1.8</td>
</tr>
<tr>
<td>Khayelitsha/Mitchell's Plain</td>
<td>1.7</td>
</tr>
<tr>
<td>Kuilsrivier</td>
<td>1.5</td>
</tr>
<tr>
<td>Brackenfell</td>
<td>1.4</td>
</tr>
<tr>
<td>Durbanville</td>
<td>1.4</td>
</tr>
<tr>
<td>Kraaifontein</td>
<td>0.5</td>
</tr>
<tr>
<td>Constantia/Hout Bay/Sea Point/Camps Bay</td>
<td>0.4</td>
</tr>
<tr>
<td>Eersterivier</td>
<td>0.2</td>
</tr>
<tr>
<td>TOTAL (% employment)</td>
<td>100.0</td>
</tr>
</tbody>
</table>

(Source: City of Cape Town, 2000)
The employment data from the RSC levy database was provided in tabular form (dbf format) which was ultimately linked to a GIS layer of the cadastre using the unique erf identifier as a common field in both the table and the GIS. However, the structure of the employment table had to be re-arranged before it could be linked to the cadastral map. This is because when two or more businesses are recorded per erf, they are indicated in separate rows in the table. This creates duplication of the erf information in the table which complicates the link to the GIS as only one record in the table will be linked to the GIS. To overcome this problem the economic data table was re-arranged by cross-tabulating using the MS Excel software program, to create a table with the erf identifier as the primary key column. Additional columns indicating the major economic activities (SIC code) and the number of jobs in each activity (employment) were added as shown in this skeleton table:

\{Erf\_ID, SIC code (x), Employment (x), SIC code (y), Employment (y) \ldots\}

The table was then linked to the GIS layer of the cadastre using the erf number as the link, to enable the mapping of this information.

Once the employment data was linked to the cadastral map, an overlay procedure was done between this map and the station precincts in order to calculate the number of jobs in each economic sector for each node. Similar to the approach used for estimating the population of each node, the employment information was estimated by adding together the number of jobs belonging to all parcels found inside or crossing a station precinct. The Woodstock and Salt River nodes have the most jobs (approximately 710 000 each), the majority being in the financial sector. Although these values have not been confirmed, they do not appear realistic. Cape Town has the third largest number of jobs after Woodstock and Salt River (52 000) of which the majority (approximately 23 000) is in the financial sector, followed by approximately 17 000 jobs in the retail sector. Phillipi has the least number of jobs totalling 115 of which 80 are in construction and 35 in the community sector. Table 4 provides an example of the result of this process, illustrated for the three main metropolitan nodes. The Cape Town station area has the most jobs of the three nodes, with the financial and retail sectors being the predominant economic activities at 45 per cent and 33 per cent respectively. The Claremont and Bellville station areas have approximately 10 000 and 4 000 jobs.
respectively, with retail being the predominant activity in Claremont and finance the main activity around Bellville station.

Table 4: Employment by sector for selected station areas in the Cape Town metropolitan area, 2000

<table>
<thead>
<tr>
<th>Station zone</th>
<th>Agriculture</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Retail</th>
<th>Transport</th>
<th>Financial</th>
<th>Community</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bellville</td>
<td>0 (0%)</td>
<td>163 (1.9%)</td>
<td>231 (5.4%)</td>
<td>1 409 (32.8%)</td>
<td>57 (0.9%)</td>
<td>1 904 (44.4%)</td>
<td>547 (12.7%)</td>
<td>1 (0.02%)</td>
<td>4 292 (100.02%)</td>
</tr>
<tr>
<td>Claremont</td>
<td>2 (0.02%)</td>
<td>183 (1.9%)</td>
<td>191 (2.0%)</td>
<td>4 502 (46.2%)</td>
<td>559 (5.7%)</td>
<td>1 912 (19.6%)</td>
<td>2 363 (24.3%)</td>
<td>25 (0.3%)</td>
<td>9 737 (100.02%)</td>
</tr>
<tr>
<td>Cape Town</td>
<td>863 (1.7%)</td>
<td>5 167 (10.0%)</td>
<td>451 (0.9%)</td>
<td>16 846 (32.5%)</td>
<td>1 468 (2.4%)</td>
<td>23 088 (44.4%)</td>
<td>3 766 (7.3%)</td>
<td>159 (0.3%)</td>
<td>51 808 (100.1%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>865 (1.3%)</td>
<td>5 513 (8.4%)</td>
<td>873 (1.3%)</td>
<td>22 757 (34.6%)</td>
<td>2 064 (3.1%)</td>
<td>26 904 (40.9%)</td>
<td>6 676 (10.1%)</td>
<td>185 (0.3%)</td>
<td>65 837 (100%)</td>
</tr>
</tbody>
</table>

(Source: City of Cape Town, 2000)

The ten economic activity groups were further aggregated into two categories to conform to the requirements of the node-place model. The model distinguishes between jobs in service orientated or population serving sectors, which have the potential to attract passing traffic or the population from other areas that require these services (e.g. hotels, restaurants, retail and community services) and jobs in office and manufacturing that mainly attract the workers. The division of the economic sectors into the two categories is not a straightforward process and requires additional information to allocate the jobs in these two groups. For this study, it was achieved in the following manner:

- Workers in population serving industries which comprises SIC 06 (wholesale and retail trade) and SIC 09 (community, social and personal services).
- Workers in all the other SIC categories.

Based on these two employment groupings, the Cape Town node has the greatest number of jobs in the services industries (approximately 21 000) and Phillipi has the least jobs in this group with only 35 jobs. Again Woodstock and Salt River both have the most jobs (in excess of 700 000) combined for all the other sectors besides the services industry with the Cape Town node third with approximately 31 000 jobs while Phillipi has the least at 80. Table 5 summarises the distribution of employment using these two categories for the three main metropolitan nodes.
Table 5: Number of employees in services and other industries

<table>
<thead>
<tr>
<th>Station zone</th>
<th>Number of workers in the services industries</th>
<th>Number of workers in all other industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bellville</td>
<td>1 956</td>
<td>2 336</td>
</tr>
<tr>
<td>Claremont</td>
<td>6 865</td>
<td>2 872</td>
</tr>
<tr>
<td>Cape Town</td>
<td>20 612</td>
<td>31 196</td>
</tr>
<tr>
<td>Total</td>
<td>29 433</td>
<td>36 404</td>
</tr>
</tbody>
</table>

(Source: City of Cape Town, 2000)

The focus of this section was to identify data sources for the population and employment variables and to describe processes for allocating the data to the nodes under investigation. This data is required in the node-place model for calculating the place index, which describes the intensity and diversity of activities in an area. The use of this data to calculate the place index is discussed in Chapter 4. The calculation of the node index requires information on existing public transport services and other relevant indicators that can be used to provide a measure of accessibility at a location. This information and the variables identified for use in the model are described below.

3.6 Public transport assessment

The public transport system in Cape Town consists primarily of rail and bus systems operated with financial assistance from central government and secondarily by privately owned minibus taxi services. In the 2001/2 financial year, the annual subsidy to Cape Metrorail Services was R240 million and the bus service received an annual subsidy of R275 million (City of Cape Town, 2002).

The performance of a public transport system is a determinant of the accessibility of an area. Accessibility can be defined for personal travel as the ability to reach desired destinations such as jobs or shopping. According to the City of Cape Town (2004), on average, 66 per cent of the city’s population are reliant on public transport to access economic and social opportunities, with most poor residents almost entirely dependent on public transport. (Appendix D indicates the public transport variables identified for the calculation of the accessibility index).
3.6.1 Rail-based network

Currently, all commuter rail services in the Cape Town metropolitan area are provided by Cape Metrorail, a business unit of the parastatal company Transnet (Pty) Ltd. The Cape Town metropolitan area has a 250-km electrified railway network servicing a total of 117 passenger stations. This railway network, comprising seven rail routes, serves mainly the southern and the eastern areas, with no commuter rail routes to the northern area of the city (City of Cape Town, 2003).

The commuter rail network in Cape Town is regarded as the most extensive of any city in South Africa (City of Cape Town, 2002). Rail commuting remains the preferred choice of public transport users in Cape Town (Cape Metropolitan Council, 1999). The black commuter modal split trends in Cape Town for a five-year period between 1990 and 1994 indicate a preference for the train as a public transport mode which, according to Van der Reis (1995), is the most affordable mode of transport in Cape Town.

According to the Current Public Transport Report (CPTR) for 2000/1 (City of Cape Town, 2002), the metro southeast area which includes the previously disadvantaged communities of Gugulethu, Khayelitsha and Mitchell’s Plain, shows the heaviest demand for rail services. The Khayelitsha service carries 20 per cent of the total morning peak period rail passengers, which is a greater share of passengers than any other individual service line. The Simon’s Town and Mitchell’s Plain services carry 17 per cent and 14 per cent respectively.

3.6.2 Road-based public transport services

Road-based public transport services are provided by bus and minibus taxis. Bus services are highly structured with well-defined routes and timetables. Road-based travel by commuters constitutes 71 per cent of all commuter trips in the morning peak period. Busses and minibus taxis are the dominant vehicular modes of transport for commuters from the southeast and currently make up 37 per cent of all modes of transport. In peak periods, 43 per cent of the capacity of buses and 59 per cent of minibus taxis’ capacity is utilised (City of Cape Town, 2003).
The largest and almost exclusive operator of passenger bus services in the Cape Town metropolitan area is Golden Arrow Bus Services (Pty) Ltd. Buses operate at approximately 43 per cent capacity during peak periods (City of Cape Town, 2003). The bus routes indicated in Figure 9 show that the bus network is extensive, but according to the CPTR report, it is underutilised. Taxi routes mirror those of bus routes as Figure 10 indicates, however they do not penetrate into residential areas as much as bus routes do, although taxis exercise greater flexibility in terms of where they can go if they are carrying passengers who require to divert from the prescribed routes. Unlike bus services, taxi services are unscheduled and depart from terminals when they are full.

The variables used for the calculation of an accessibility index in this study were determined largely by available data. While public transport services are provided through three transport modes, namely train, bus and minibus taxi, it is difficult to obtain information relating to the number of services and service frequencies for minibus taxis mainly because service frequencies for this transport mode are largely determined by the presence and number of passengers.

The status of each station facility in Cape Town in terms of its design to accommodate different transport modes was obtained from the City of Cape Town: Directorate of Transport. Four types of stations were identified based on the types of public transport modes operating at each station, namely:

- all three public transport modes (namely bus, rail and taxi);
- taxi and rail only;
- bus and rail only; and
- rail only.

The interchange status of the stations used in the study is indicated in Appendix E. It indicates the diversity of transport supply at each station and was included as a variable in the calculation of the node (accessibility) index. The station type was used mainly to assign a weighting factor to stations depending on the number and type of public transport modes a station is able to accommodate. Using a scale of 1 to 4, the weights were assigned as follows:

Stations with all three public transport modes – 4
Rail and bus only – 3
Rail and taxi only – 2
Rail only – 1.

According to Appendix E, eight (32%) stations have facilities for all three public transport modes, two (8%) for bus and rail, four (16%) for taxis and rail and 11 (44%) have rail facilities only.

Figure 9: Bus and commuter rail networks in the Cape Town metropolitan area (Source: Cape Metropolitan Council, 1999: 47)

3.6.3 Metropolitan-wide accessibility of stations

In the absence of other relevant information such as availability of parking space or the number of directions served from each station, a third variable was introduced that was based
on estimating average distances to each station from all origins in the city represented by transport zones, which are the basic unit of analysis used in transport planning. Using Flowmap software, an origin-destination matrix between stations and transport zones was created to derive road-based travel distances from each transport zone to a station.

Figure 10: Taxi and commuter rail networks in the Cape Town metropolitan area (Source: Cape Metropolitan Council, 1999: 63)

The distances are computed in Flowmap using a least-cost or shortest-path algorithm which in this case indicates the shortest distance using the metropolitan road network between each
origin and destination pair. An average travel distance to each station was then calculated (see Appendix F) and these average distances were used to provide an indication of the centrality of each station within the metropolitan context. In other words, the shorter the distance the more accessible and central the station. Based on these average distances, Cape Town station is the least central of all stations at approximately 22.3 kilometres, while the other major metropolitan destinations, Claremont and Bellville, are at 20.1 kilometres and 19.0 kilometres respectively, and Phillipi is at 18.9 kilometres. The most accessible location in terms of distance is Elsiesrivier station at 17.8 kilometres, followed by Vasco and Goodwood stations (18.0 kilometres).

The node index was calculated using the following variables:

- Train, bus and taxi service frequencies – number of departing trains, busses and taxis from each station on a weekday (Monday – Friday).
- Metropolitan-wide accessibility indicator for each station – calculated as the average travel distance to each station from all the transport zones in the City of Cape Town. Transport zones are used as the basic building blocks in transport planning exercises for which information is collected.
- Availability and type of intermodal transfer facility, which refers to whether a facility has been designed to accommodate more than one type of transport mode.

Before running the model it was important to collect the required data and to arrange it appropriately. This process, including the allocation methods from various layers into the station precincts, has been described in this chapter of the report. Chapter 4 describes how this information was used with the node-place model to calculate the node and place indices of each node.
4. ASSESSMENT OF DEVELOPMENT POTENTIAL OF RAILWAY STATION PRECINCTS IN CAPE TOWN

The node-place model combines a number of indicators to calculate two indices that are used to assess the status of each node in terms of the urban activities and its accessibility. This section describes the node-place model, and in particular, the processes used to calculate the node and place indices using the information identified in the preceding section.

4.1 Land use and accessibility variables in selected nodes

Land use development varies from node to node in terms of the land use or mix of activities described by the population and employment variables (see Appendix C). Despite the varying compositions of the land use categories, it is possible to categorise the nodes based on the type and intensity of development around each node. For example, Woodstock and Salt River are overwhelmingly employment nodes categorised almost exclusively as office and manufacturing centres. Cape Town is also an employment node but with jobs in both the office and manufacturing (56%) and services-related categories (37%). Residential nodes have more residential development than employment. They include Phillipi (99%), which has very little employment activity and others with small residuals of employment such as Vasco (10%), Wynberg (18%) and Mowbray (24%).

The development of public transport services also varies among the nodes (see Appendix D). For example, Salt River, Woodstock and Cape Town have the greatest number (more than 300) of departing trains daily (Figure D1, Appendix D), however both Salt River and Woodstock do not have any taxis operating from them, while Cape Town (4 700), Wynberg (4 310) and Bellville (2 890) have the most taxis (Figure D2, Appendix D). Figure D3, Appendix D indicates that significant bus services operate from Cape Town (1 243), Claremont (594), Wynberg (530), Bellville (507), Mowbray (378) and Elsiesrivier (155).

Although the distance variable was used to indicate metropolitan-wide centrality, the differences in the distance variable are not very large. Cape Town has the longest distance due to its location not being central in comparison to the others (Appendix F).

The node and place indices combine the land use and accessibility indicators in a way that enables a comparative assessment between the nodes. The place index combines the land use
information into a single measure that gives an indication of the intensity and diversity of activities in the areas around the stations. Similarly the node index combines several accessibility-related variables into a single measure of accessibility. The procedures for calculating these indices are described below.

4.2 Calculation of the place index

The place index requires information on the population size and the number and type of jobs in each station precinct. Information on the jobs is needed in order to distinguish between service rendering and other types of jobs, hence the use of the RSC levy database which contains the economic sector classification of the jobs. For each station precinct, three variables were calculated to represent:

- the number of jobs in the services sector – used to indicate the “pull” of an area to attract demand for these services from outside the area;
- the number of jobs in sectors such as offices and manufacturing that attract mainly the workers; and
- the total population.

The place index was calculated using the degree of functional mix formula developed at the University of Utrecht (L. Bertolini, personal communication, June 2001), viz:

\[
\text{Functional mix} = 1 - \frac{(\text{max-min})/\text{total} + ((\text{max-1} + \text{min})/\text{total})}{2}
\]

where:
max = number of people in the class with the most people
min = number of people in the class with the least number of people
1 + min = number of people in the class with the second least people.

The degree of functional mix is maximum (=1) when: max = min = 1 + min and the degree of functional mix is minimum (=0) when: min = 1 + min = 0.

In order to aid interpretation of the results and to distinguish the nodes in terms of this index, the calculated results were categorised into five classes as shown in Table 6.
Table 6: Classification categories for the place and node indices

<table>
<thead>
<tr>
<th>Class</th>
<th>Place index range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>≥ 0.8</td>
</tr>
<tr>
<td>High</td>
<td>0.6 – 0.79</td>
</tr>
<tr>
<td>Average</td>
<td>0.5 – 0.59</td>
</tr>
<tr>
<td>Low</td>
<td>0.2 – 0.49</td>
</tr>
<tr>
<td>Very low</td>
<td>≤ 0.19</td>
</tr>
</tbody>
</table>

Table 7 shows the variables used and the application of the functional mix equation described above to calculate the place indices for each node.

Table 7: Functional mix (i.e. place index) of station areas based on population and employment, Cape Town metropolitan area

<table>
<thead>
<tr>
<th>Station Services Office &amp; manufacturing</th>
<th>Population</th>
<th>Total</th>
<th>max-min</th>
<th>max-1 + min</th>
<th>Place index</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koeberg</td>
<td>2 948</td>
<td>3 133</td>
<td>4 123</td>
<td>12 197</td>
<td>2 159</td>
<td>0.86</td>
</tr>
<tr>
<td>Maitland</td>
<td>1 710</td>
<td>5 655</td>
<td>4 723</td>
<td>11 488</td>
<td>3 345</td>
<td>0.84</td>
</tr>
<tr>
<td>Mutual</td>
<td>1 394</td>
<td>5 694</td>
<td>5 450</td>
<td>12 538</td>
<td>4 300</td>
<td>0.82</td>
</tr>
<tr>
<td>Claremont</td>
<td>6 863</td>
<td>2 872</td>
<td>8 426</td>
<td>18 163</td>
<td>5 554</td>
<td>0.76</td>
</tr>
<tr>
<td>Cape Town</td>
<td>20 512</td>
<td>3 156</td>
<td>23 696</td>
<td>55 729</td>
<td>10 611</td>
<td>10 584</td>
</tr>
<tr>
<td>Woltemade</td>
<td>1 482</td>
<td>4 507</td>
<td>6 287</td>
<td>12 236</td>
<td>4 805</td>
<td>1 780</td>
</tr>
<tr>
<td>Newlands</td>
<td>5 424</td>
<td>1 894</td>
<td>7 318</td>
<td>15 354</td>
<td>6 418</td>
<td>2 588</td>
</tr>
<tr>
<td>Bellville</td>
<td>1 956</td>
<td>2 336</td>
<td>4 680</td>
<td>9 162</td>
<td>2 914</td>
<td>2 534</td>
</tr>
<tr>
<td>Observatory</td>
<td>4 203</td>
<td>2 321</td>
<td>5 252</td>
<td>13 830</td>
<td>5 851</td>
<td>5 221</td>
</tr>
<tr>
<td>Tygerberg</td>
<td>2 448</td>
<td>2 321</td>
<td>7 068</td>
<td>11 837</td>
<td>4 747</td>
<td>4 620</td>
</tr>
<tr>
<td>Eilandenvlei</td>
<td>1 281</td>
<td>3 934</td>
<td>10 034</td>
<td>13 419</td>
<td>6 823</td>
<td>6 270</td>
</tr>
<tr>
<td>Parow</td>
<td>1 155</td>
<td>3 116</td>
<td>4 271</td>
<td>15 460</td>
<td>9 885</td>
<td>9 380</td>
</tr>
<tr>
<td>Hatfield</td>
<td>2 240</td>
<td>1 756</td>
<td>11 977</td>
<td>15 973</td>
<td>10 221</td>
<td>9 737</td>
</tr>
<tr>
<td>Mowbray</td>
<td>1 141</td>
<td>1 948</td>
<td>9 816</td>
<td>12 905</td>
<td>8 675</td>
<td>7 868</td>
</tr>
<tr>
<td>Kenilworth</td>
<td>1 721</td>
<td>1 066</td>
<td>10 783</td>
<td>15 570</td>
<td>9 717</td>
<td>9 062</td>
</tr>
<tr>
<td>Rosebank</td>
<td>1 149</td>
<td>1 810</td>
<td>12 097</td>
<td>13 596</td>
<td>10 948</td>
<td>10 287</td>
</tr>
<tr>
<td>Wynberg</td>
<td>1 465</td>
<td>1 122</td>
<td>11 990</td>
<td>14 572</td>
<td>10 808</td>
<td>10 525</td>
</tr>
<tr>
<td>Thornton</td>
<td>448</td>
<td>434</td>
<td>4 276</td>
<td>11 518</td>
<td>3 842</td>
<td>3 828</td>
</tr>
<tr>
<td>Wittebome</td>
<td>1 878</td>
<td>1 495</td>
<td>16 528</td>
<td>19 900</td>
<td>15 933</td>
<td>14 650</td>
</tr>
<tr>
<td>Rondebosch</td>
<td>1 141</td>
<td>883</td>
<td>11 109</td>
<td>13 133</td>
<td>10 226</td>
<td>9 968</td>
</tr>
<tr>
<td>Goodwood</td>
<td>1 005</td>
<td>647</td>
<td>9 501</td>
<td>11 153</td>
<td>8 854</td>
<td>8 496</td>
</tr>
<tr>
<td>Vasco</td>
<td>900</td>
<td>401</td>
<td>11 611</td>
<td>12 912</td>
<td>11 219</td>
<td>10 711</td>
</tr>
<tr>
<td>Woodstock</td>
<td>3 063</td>
<td>707</td>
<td>9 621</td>
<td>12 212</td>
<td>7 203</td>
<td>697 700</td>
</tr>
<tr>
<td>Salt River</td>
<td>2 982</td>
<td>706 336</td>
<td>8 115 717 433</td>
<td>703 354</td>
<td>698 221</td>
<td>0.02</td>
</tr>
<tr>
<td>Phillippi</td>
<td>35</td>
<td>80</td>
<td>21 085 21 200</td>
<td>21 050</td>
<td>21 005</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Source: Compiled by the author from various sources. The employment data was derived from City of Cape Town (2000) and the population data from Stats SA (1996).

A high place index score indicates a better mix between the three variables representing population and employment activities. The results indicate that only four (16%) and six (24%) station precincts have place indices categorised as very high and high respectively. For the remainder, there is one (4%), 10 (40%) and four (16%) station precincts in the average, low and very low categories respectively. The four locations with very high place indices are Koeberg (0.87), Maitland (0.84), Mutual (0.82) and Claremont (0.80). The very high and high values indicate a good proportional mix between the population and the two employment categories. Vasco (0.15), Woodstock (0.03), Salt River (0.02) and Phillippi (0.01) have very...
low place indices, indicating a dominance of one type of activity over others. For example, the population around Vasco and Phillipi stations is un-proportionally high in comparison to the number of jobs in these locations. And the reverse is true for Woodstock and Salt River station precincts. Although the employment figures for Salt River and Woodstock could not be verified, they do not appear realistic.

4.3 Calculation of the node index

The node index was calculated using a number of public transport indicators, the station type and a distance measure which gave an indication of the metropolitan accessibility of each location. These variables are shown in Table 8 and the definitions of station types are provided in Appendix E. A multicriteria analysis method was used to combine the variables using the expectation-value method which sums the scores in a linear fashion.

Table 8: Transportation indicators and the resultant node index for selected station precincts, Cape Town metropolitan area

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of departing trains/day</th>
<th>Train score</th>
<th>Distance (km)</th>
<th>Distance score</th>
<th>No. of departing taxis/day</th>
<th>Taxi score</th>
<th>No. of departing buses/day</th>
<th>Bus score</th>
<th>Station type</th>
<th>Station score</th>
<th>Node index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Town</td>
<td>342</td>
<td>0.80</td>
<td>22.35</td>
<td>0.04</td>
<td>4 760</td>
<td>1.00</td>
<td>1 243</td>
<td>1.00</td>
<td>4</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Bellville</td>
<td>249</td>
<td>0.58</td>
<td>18.96</td>
<td>0.72</td>
<td>3 000</td>
<td>0.61</td>
<td>507</td>
<td>0.41</td>
<td>4</td>
<td>1.00</td>
<td>0.87</td>
</tr>
<tr>
<td>Wynberg</td>
<td>126</td>
<td>0.29</td>
<td>20.62</td>
<td>0.16</td>
<td>1 370</td>
<td>0.92</td>
<td>530</td>
<td>0.43</td>
<td>4</td>
<td>1.00</td>
<td>0.73</td>
</tr>
<tr>
<td>Elsieivier</td>
<td>126</td>
<td>0.29</td>
<td>17.84</td>
<td>1.00</td>
<td>65</td>
<td>0.20</td>
<td>155</td>
<td>0.12</td>
<td>4</td>
<td>1.00</td>
<td>0.68</td>
</tr>
<tr>
<td>Mowbray</td>
<td>126</td>
<td>0.29</td>
<td>18.99</td>
<td>0.68</td>
<td>1 000</td>
<td>0.20</td>
<td>378</td>
<td>0.30</td>
<td>4</td>
<td>1.00</td>
<td>0.64</td>
</tr>
<tr>
<td>Parow</td>
<td>110</td>
<td>0.26</td>
<td>18.28</td>
<td>0.84</td>
<td>1 428</td>
<td>0.30</td>
<td>28</td>
<td>0.02</td>
<td>4</td>
<td>1.00</td>
<td>0.63</td>
</tr>
<tr>
<td>Mutual</td>
<td>295</td>
<td>0.69</td>
<td>19.18</td>
<td>0.56</td>
<td>1 347</td>
<td>0.03</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>1.00</td>
<td>0.69</td>
</tr>
<tr>
<td>Claremont</td>
<td>132</td>
<td>0.31</td>
<td>20.15</td>
<td>0.28</td>
<td>451</td>
<td>0.10</td>
<td>594</td>
<td>0.48</td>
<td>4</td>
<td>1.00</td>
<td>0.56</td>
</tr>
<tr>
<td>Tygerberg</td>
<td>126</td>
<td>0.29</td>
<td>18.76</td>
<td>0.80</td>
<td>468</td>
<td>0.10</td>
<td>10</td>
<td>0.01</td>
<td>3</td>
<td>0.75</td>
<td>0.51</td>
</tr>
<tr>
<td>Phillipi</td>
<td>187</td>
<td>0.43</td>
<td>18.92</td>
<td>0.76</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>3</td>
<td>0.75</td>
<td>0.51</td>
</tr>
<tr>
<td>Koeberg</td>
<td>285</td>
<td>0.66</td>
<td>19.15</td>
<td>0.60</td>
<td>358</td>
<td>0.08</td>
<td>0</td>
<td>0.00</td>
<td>2</td>
<td>0.50</td>
<td>0.48</td>
</tr>
<tr>
<td>Maitland</td>
<td>299</td>
<td>0.70</td>
<td>19.41</td>
<td>0.48</td>
<td>539</td>
<td>0.11</td>
<td>11</td>
<td>0.01</td>
<td>2</td>
<td>0.50</td>
<td>0.47</td>
</tr>
<tr>
<td>Goodwood</td>
<td>125</td>
<td>0.29</td>
<td>18.03</td>
<td>0.92</td>
<td>77</td>
<td>0.02</td>
<td>1</td>
<td>0.00</td>
<td>2</td>
<td>0.50</td>
<td>0.45</td>
</tr>
<tr>
<td>Thornton</td>
<td>123</td>
<td>0.29</td>
<td>18.06</td>
<td>0.88</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>2</td>
<td>0.50</td>
<td>0.43</td>
</tr>
<tr>
<td>Salt River</td>
<td>430</td>
<td>1.00</td>
<td>19.73</td>
<td>0.36</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.42</td>
</tr>
<tr>
<td>Vasco</td>
<td>124</td>
<td>0.29</td>
<td>18.02</td>
<td>0.96</td>
<td>100</td>
<td>0.02</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.40</td>
</tr>
<tr>
<td>Woodstock</td>
<td>424</td>
<td>0.99</td>
<td>20.74</td>
<td>0.12</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.35</td>
</tr>
<tr>
<td>Woltemade</td>
<td>118</td>
<td>0.27</td>
<td>19.07</td>
<td>0.64</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>Rosebank</td>
<td>124</td>
<td>0.29</td>
<td>19.32</td>
<td>0.52</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.28</td>
</tr>
<tr>
<td>Rondebosch</td>
<td>126</td>
<td>0.29</td>
<td>19.50</td>
<td>0.44</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.26</td>
</tr>
<tr>
<td>Observatory</td>
<td>124</td>
<td>0.29</td>
<td>19.56</td>
<td>0.40</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.24</td>
</tr>
<tr>
<td>Newlands</td>
<td>124</td>
<td>0.29</td>
<td>20.13</td>
<td>0.32</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.22</td>
</tr>
<tr>
<td>Kenilworth</td>
<td>124</td>
<td>0.29</td>
<td>20.26</td>
<td>0.24</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>Harfield</td>
<td>124</td>
<td>0.29</td>
<td>20.32</td>
<td>0.30</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.19</td>
</tr>
<tr>
<td>Wittehome</td>
<td>125</td>
<td>0.29</td>
<td>21.15</td>
<td>0.08</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>1</td>
<td>0.25</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Source: Compiled by the author using various sources. The public transport data was obtained from published service schedules and City of Cape Town (2002)

An automatic standardisation was applied for each criterion prior to calculating the expectation value scores and the result is shown in Table 8. The indicators used to determine
the overall node (transport) index were selected on the basis of data availability at the time of the study for train, bus and taxi schedules. The station type and average distance to each station from various origins in the metropolitan area were also used in the calculation of the node index. Each indicator was normalised to calculate a score for that particular indicator. These scores were then combined to derive the node index, which provides an indication of the overall accessibility of each station precinct. Similar to the place index, the maximum value is 1 and the minimum value is 0.

The node indices were categorised into five classes as shown in Table 6. Based on this classification, the results indicate that two (8%) and four (16%) station precincts have very high and high node indices respectively, and four (16%) have average node indices. The majority (60%) of station precincts have below average node indices. These comprise 13 (52%) and two (8%) stations categorised as low and very low respectively. The maximum value is calculated for Cape Town (1.0), with Bellville (0.87) the only other node with a very high node index, indicating that these two locations are highly accessible by public transport. Conversely Harfield (0.19) and Wittebome (0.16) have very low node indices and by implication have poor public transport accessibility.

4.4 Discussion of findings

The node and place indices for the locations investigated in this study are shown in Table 9. The categorisation of the node and place indices is used as a guide to group these locations according to the intensity and development of activities and transportation services in their vicinity. Four groupings can be distinguished, namely:

- Locations where the node and place indices are either high or very high – two (8%) stations fall into this category, namely the main metropolitan destinations of Cape Town and Bellville. Both locations have high place indices and very high node indices, indicating high concentrations of activities and public transport services.

- Locations where the indices are low or very low – 10 (40%) stations identified in this group are Harfield, Kenilworth, Rosebank, Thornton, Wittebome, Rondebosch, Goodwood, Vasco, Woodstock and Salt River. At these locations, the intensity of transportation and urban activities is significantly low in comparison to other stations.

- Locations where the place index is either high or very high in comparison to a low or average node index – the eight (32%) stations in this group are Koeberg, Maitland,
Mutual, Claremont, Woltemade, Newlands, Observatory and Tygerberg. At these locations the development of urban activities is more advanced than public transport services.

- Locations where the node index is significantly higher than the place index – the five (20%) stations in this group are Elsiesrivier, Parow, Mowbray, Wynberg and Phillipi. At these locations the development of public transport services is more advanced than urban activities.

### Table 9: Place and node indices for selected station precincts in the Cape Town metropolitan area

<table>
<thead>
<tr>
<th>Station</th>
<th>Place index (x)</th>
<th>Node index (y)</th>
<th>Groupings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koeberg</td>
<td>0.87</td>
<td>0.48</td>
<td>Very high; Low</td>
</tr>
<tr>
<td>Maitland</td>
<td>0.84</td>
<td>0.47</td>
<td>Very high; Low</td>
</tr>
<tr>
<td>Mutual</td>
<td>0.82</td>
<td>0.59</td>
<td>Very high; Average</td>
</tr>
<tr>
<td>Claremont</td>
<td>0.80</td>
<td>0.56</td>
<td>Very high; Average</td>
</tr>
<tr>
<td>Cape Town</td>
<td>0.76</td>
<td>1.00</td>
<td>High; Very high</td>
</tr>
<tr>
<td>Woltemade</td>
<td>0.73</td>
<td>0.30</td>
<td>High; Low</td>
</tr>
<tr>
<td>Newlands</td>
<td>0.72</td>
<td>0.22</td>
<td>High; Low</td>
</tr>
<tr>
<td>Bellville</td>
<td>0.70</td>
<td>0.87</td>
<td>High; Very high</td>
</tr>
<tr>
<td>Observatory</td>
<td>0.61</td>
<td>0.24</td>
<td>High; Low</td>
</tr>
<tr>
<td>Tygerberg</td>
<td>0.60</td>
<td>0.51</td>
<td>High; Average</td>
</tr>
<tr>
<td>Elsiesrivier</td>
<td>0.51</td>
<td>0.68</td>
<td>Average; High</td>
</tr>
<tr>
<td>Parow</td>
<td>0.49</td>
<td>0.63</td>
<td>Low; High</td>
</tr>
<tr>
<td>Harfield</td>
<td>0.38</td>
<td>0.19</td>
<td>Low; Very low</td>
</tr>
<tr>
<td>Mowbray</td>
<td>0.36</td>
<td>0.64</td>
<td>Low; High</td>
</tr>
<tr>
<td>Kenilworth</td>
<td>0.31</td>
<td>0.20</td>
<td>Low; Low</td>
</tr>
<tr>
<td>Rosebank</td>
<td>0.29</td>
<td>0.28</td>
<td>Low; Low</td>
</tr>
<tr>
<td>Wynberg</td>
<td>0.27</td>
<td>0.73</td>
<td>Low; High</td>
</tr>
<tr>
<td>Thornton</td>
<td>0.26</td>
<td>0.43</td>
<td>Low; Low</td>
</tr>
<tr>
<td>Wittebome</td>
<td>0.25</td>
<td>0.16</td>
<td>Low; Very low</td>
</tr>
<tr>
<td>Rondebosch</td>
<td>0.23</td>
<td>0.26</td>
<td>Low; Low</td>
</tr>
<tr>
<td>Goodwood</td>
<td>0.22</td>
<td>0.45</td>
<td>Low; Low</td>
</tr>
<tr>
<td>Vasco</td>
<td>0.15</td>
<td>0.40</td>
<td>Very low; Low</td>
</tr>
<tr>
<td>Woodstock</td>
<td>0.03</td>
<td>0.35</td>
<td>Very low; Low</td>
</tr>
<tr>
<td>Salt River</td>
<td>0.02</td>
<td>0.42</td>
<td>Very low; Low</td>
</tr>
<tr>
<td>Phillipi</td>
<td>0.01</td>
<td>0.51</td>
<td>Very low; Average</td>
</tr>
</tbody>
</table>

To further illustrate the relationship between land use mix and transport in each of the areas investigated, the node and place indices are plotted on an xy-scattergram (Figure 11). The diagram indicates the current development at each location according to land use and transportation and it also provides a way to visualise similarities and differences between each of the locations in the study. The place index (x axis) on the scattergram indicates the extent of population and employment activities around each station. In general the left hand side of
the scattergram corresponds to areas with a predominance of one activity. For example, Salt River and Woodstock are primarily employment nodes with little residential development while Phillipi is primarily a residential node with none or little employment. The closer the x-value is to 1, the more balanced the mix of residential and employment activities. Thus stations such as Koeberg, Maitland, Mutual and Claremont with place indices categorised as very high, indicate a significant presence of both employment and residential components.

Figure 11: The node-place model indicating the distribution of stations according to land use (place) and accessibility (node) indices

The node index (y axis) denotes the level of public transport development at each station. The closer the y-value is to 1, the higher the accessibility. Therefore stations such as Harfield and Wittebome with very low node indices, indicate poor accessibility while Cape Town and Bellville have very high node indices and therefore good accessibility.
In order to identify development opportunities at each station node, a classification or profile based on the four typical situations identified by Bertolini (1999) was determined using the calculated node and place indices. The node-place model does not dictate how the profiling should be done nor does it prescribe the range of values applicable in each class. For the purpose of this study, the classification was done arbitrarily although informed by the distribution of the stations as depicted in Figure 11 and by comparison with the idealised node-place model (Figure 3). The classification can also be refined by local knowledge of activities and development in the areas under investigation, which can be obtained from planners. Such consultations were not done in this study, and therefore the classification and the resultant profiles are an initial attempt at profiling the nodes. The indicative value ranges for the node and place indices relating to each typical situation or profile are shown in Table 10.

The purpose of classifying locations is to characterise them in order that appropriate development interventions can be identified. In transport-orientated development, the assumption is that an optimum situation will be achieved by a “balance” in transportation services and activities in a node which would result in a clustering around the diagonal line of the node-place model’s xy scattergram. In such a situation, the nodes would be described as accessible (defined by Bertolini (1999) as areas where the node and place characteristics are equally strong). Using the idealised node-place model diagram in Figure 3 as a guide, the intensity of urban development and transportation at these locations should not be too high or low, and should not fit into the four typical situations identified in Table 10. Based on this description, therefore, none of the stations in the study fits the description of accessible areas, despite the fact that Rosebank and Rondebosch have node and place indices that are almost equal.
Table 10: Station area classification based on node and place indices

<table>
<thead>
<tr>
<th>Node index range</th>
<th>Place index range</th>
<th>Typical situation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6 – 1.0</td>
<td>0.6 – 1.0</td>
<td>Areas under stress</td>
<td>Typically located at the top of the graph</td>
</tr>
<tr>
<td>0 – 0.49</td>
<td>0 – 0.49</td>
<td>Dependent area</td>
<td>Typically located at the bottom of the graph</td>
</tr>
<tr>
<td>0.5 – 1.0</td>
<td>0 – 0.59</td>
<td>Unsustained node</td>
<td>Left top part of the graph</td>
</tr>
<tr>
<td>0 – 0.59</td>
<td>0.5 – 1.0</td>
<td>Unsustained place</td>
<td>Right bottom of the graph</td>
</tr>
</tbody>
</table>

Source: Compiled by the author. The typical situations are as identified by Bertolini (1999).

The station profiles were done according to the four typical situations in Table 10 and are mapped in Figure 12. The results indicate that:

- Two (8%) stations (Cape Town and Bellville) are classified as **areas under stress**, indicating that the intensity and diversity of transportation flows and urban activities are maximal.
- Ten (40%) station are classified as **dependent areas**. They are Harfield, Kenilworth, Rosebank, Thornton, Wittebome, Rondebosch, Goodwood, Vasco, Woodstock and Salt River. According to the categories identified in Table 6, the node and place indices at these locations are low or very low.
- Five (20%) stations are **unsustained nodes** due to intense and advanced public transport services in comparison to urban activities. The stations in this group are Elsiesrivier, Parow, Mowbray, Wynberg and Phillipi.
- Eight (32%) stations are classified as **unsustained places**, namely Koeberg, Maitland, Mutual, Claremont, Woltemade, Newlands, Observatory and Tygerberg. At these locations public transport services are not as advanced as the development of urban activities.

According to Bertolini (1999), various planning interventions can be applied to these profiles to shift the location of a node towards the middle of the diagonal line of the model. For each profile a different set of land use and transport development decisions will need to be identified. Such decisions may include whether or not to diversify activities and improve public transport accessibility in a node. The (re)development implications of each profile are as follows:

- There is a possibility of spatial conflicts in **areas under stress** despite the great opportunity for human interaction at these locations. Development of these
locations should therefore be limited. Of relevance to this study is the fact that both Cape Town and Bellville are stronger nodes and can benefit from strengthening the urban activities around them. However, Cape Town can benefit more from residential development and Bellville from developing job opportunities.

- **In dependent areas** the supply of urban activities and public transport is low in comparison to other locations. The demand for services at these locations is also low. There is a high risk of not achieving the minimum thresholds necessary for effective development.

- **Unsustained nodes** can be shifted to the right of the graph by strengthening the place content through the development of residential and employment activities. All five nodes identified in this group have more people than jobs and would therefore benefit from increased job opportunities.

- **Unsustained places** can be improved by investment in public transport supply. For example, some of the stations do not have the infrastructure to accommodate all the public transport modes or in some cases the supply is low.

Thus far the study has achieved in identifying and collecting relevant data as well as applying the model and developing a methodology for node profiling, thereby addressing two of the objectives of this study. The last objective, that is the assessment of the node-place model, is dealt with in Chapter 5.
Figure 12: Profiles of station precincts in the Cape Town metropolitan area according to the node-place model
5. RECOMMENDATIONS AND CONCLUSIONS

The importance of integrating land use and transport planning is regarded as essential in the development of an efficient and effective urban form, with a strong focus on public transport utilisation. Government’s commitment in this regard is contained in various legislative and policy documents, which have identified a need to improve the accessibility of previously disadvantaged communities and the promotion of public transport. The development of high-density, mixed-use nodes is highly regarded amongst possible restructuring elements of the urban landscape that will achieve government’s objectives of improved accessibility and patronage of the public transport services. In this study, an analytical tool was explored in an effort to identify how it can contribute to urban restructuring in particular through nodal development. This final chapter of the report encapsulates the main findings of the study and draws some conclusions regarding the node-place model as a tool that can support restructuring of the urban landscape. The following discussion addresses the extent to which the aim and objectives of this study have been realised.

5.1 Requirements for the node-place model and data sources

The first objective of this study was to assess the node-place model in terms of its data requirements and to identify suitable data sources. The model uses employment information and population statistics which must be suited to the analysis scale, which in this case was a 1-kilometre buffer area around railway stations. The main source of population data is the official census, which provides information at different geographic scales, the smallest of which is the enumerator area. The most recent population census was done in 2001, which, at the time of undertaking this study, was not only dated, but was not provided at the enumerator area level, making it difficult to make realistic population estimates for the station areas. The RSC levy database is an important source of employment information at a suitable scale because, unlike the census data, it provides information on both the location and the number of jobs. Public transport information can be obtained from the Current Public Transport Records (CPTRs), which are statutory requirements for local authorities in terms of the National Land Transport Transition Act (NLTTA). For rail and bus operations it is also possible to obtain information from the relevant organisations charged with the planning of public transport services, which include Metrorail and Golden Arrow Bus Services. Data on
minibus taxi operations can be difficult to obtain as this public transport mode is currently unregulated.

The RSC levy database is a good source of employment data at a local scale. However, its reliability and comprehensiveness for undertaking data-intensive modelling is questionable given the gaps in the database. Where data can only be obtained in aggregated zones, as is the case with the official census, the area proportional allocation method can be used to disaggregate data from large to small spatial units. This method was however not used in this study because both the population and employment data used was provided in small zones (enumerator areas and the cadastre respectively) deemed appropriate for the scale of the analysis.

5.2 Node profiling procedure

The second objective of this study was to develop a node profiling methodology by applying the node-place model. Despite the data problems encountered and described above, the study has demonstrated a process or a methodology for profiling nodes. The application of the model provided a way for quantifying the presence and intensity of mixed-use developments and public transport for the purpose of location profiling which ultimately informs the development potential of the nodes. However, it is important to point out that the calculation of the indices is not the end of the process. The interpretation of the indices and how they relate to the ensuing profiles described in terms of the possible typical situations is the desired end. Correct profiling informs the selection of appropriate development instruments aimed towards transit-friendly community developments. Since the model does not prescribe the categorisation of the indices and the ranges applicable for each of the profiles, it would be recommended that the profiles identified should be discussed and refined with expert knowledge.

Through the application of the model, a process for node profiling was identified although the qualitative assessment of the nodes by wider consultation was not done. All in all the process was able to achieve the objective of developing a methodology for node profiling.
5.3 The node-place model as a tool in spatial restructuring

The third objective was to evaluate the node-place model as an urban restructuring tool and to identify potential challenges which could hamper its effective utilisation. The model provides a mechanism for assessing and comparing nodes within a transport system in terms of the mix of urban activities and accessibility, which provides useful input into how a node can be enhanced to support transit-orientated development. However, it is also important to recognise that each node can have its own characteristics which to a large extent will be informed by whether it is a local or regional node. For instance, Cape Town and Bellville are metropolitan employment nodes with low population figures which could be interpreted as requiring more residential development, but this may not necessarily be true given their metropolitan function as employment centres. Nonetheless, the model provides useful insights into how a node is developing and how it may be developed, but an area’s spatial development vision and knowledge about the node and its function must be considered to inform its redevelopment potential. The following section describes some pitfalls which could constrain the effective use of the model.

5.4 Challenges to the use of the node-place model

5.4.1 Appropriate and accurate data

The issue of data has to be overcome in order to use the node-place model. Disaggregated data on employment was found to be a problem. The RSC levy database was a useful source, but not all eligible businesses indicate the number of employees or the location of their businesses properly. Accurate information on minibus taxi services is also difficult to obtain because of the nature of their operations even though they provide a service to a large segment of the public transport demand.

Another important issue is the possible double counting of the population and employment figures as a result of the proximity of some stations to one another, resulting in overlapping catchments. While the double counting does not necessarily affect the output of the model, it gives an impression of higher totals for population and employment than is the case.
5.4.2 Identification of developable land

An inventory of vacant land is crucial information for decision making with respect to managing the growth of any metropolitan area. The City of Cape Town municipality initiated a study of vacant land specifically to provide base data for the subsequent identification of strategic vacant sites for the MSDF project, the main purpose of which was to guide the form and location of physical development in the Cape Town metropolitan area. All vacant and underdeveloped land needed to be identified to suit the requirement of the MSDF, regardless of size.

In order to provide a meaningful inventory from which subsequent strategic land studies can be undertaken, vacant land has to be defined fairly widely. Thus, the classification of identified strategic parcels must provide an indication of the likelihood of these sites for urban development.

5.4.3 Increasing industry awareness of market potential of TODs

The difficulty of influencing private investment is a major challenge currently facing spatial development planning. Without the buy-in of private investors into such planning, the desired end will not be easily achieved. Therefore an important aspect and one that will determine the success of TODs, is to increase industry awareness of the market potential of this concept. A programme of government assistance would provide information to a variety of industry associations and diversity of companies to increase their awareness and benefits of TODs and sustainable development concepts.

5.4.4 Overcoming complexities of co-ordinated planning

A need to link station area developments to the IDP process so that these nodes have access to public facilities also exists. TODs would require the involvement of various stakeholders and institutions. The complexity of working with many stakeholders who are often isolated and who may have contradicting endeavours requires proper management. Therefore key mandated responsibilities in the institutional arrangements – the roles, functions, mandates and responsibilities in the institutional arrangement – are crucial. The responsibilities must be defined, including financing mechanisms and the framework for dealing with diversification and funding for a vastly improved and expanded public transport system.
5.4.5  Improving the image of public transport

The lower-income and, to a lesser extent, middle-income market segments are largely dependent on public transport for work and other essential journey purposes. The Cape metropolitan rail system represents a large investment in transport infrastructure and carries the vast majority of public transport users in this area. Rail transportation also remains the most efficient and environmentally friendly form of public transport. However, concerns with regard to safety, cleanliness and reliability require attention if public transport is to be promoted.

An efficient public transport system must cater for the travel needs to both work and non-work activities. However, the performance of the subsidised modes, namely bus and rail, in relation to meeting the non-work travel demand must be re-examined.

5.4.6  Definition of a hierarchy of accessible places

It is necessary to define a hierarchy of accessible places where, and between which, public investment should be focused in order to achieve greater equity. According to the City of Cape Town (2004), a three-tier hierarchy of places is appropriate (this, for example, allows for an acceptable walking distance to lower tier places). The lowest-level places, accessible by foot, will have a cluster of basic public facilities as well as a public transport interchange giving access to higher order places (which offers higher order facilities). The second-level places will have more public facilities and facilities of higher specialisation, as well as access to higher-level public transport systems. The highest-level places will contain the major city institutions and facilities and provide access to other regions and places.

The node-place model is a useful tool for assessing the type and intensity of urban and public transport activities in identified locations. Such information is important for identifying and directing urban development responses in suitable areas. The node profiling methodology described in this study provides a useful method for assessing the redevelopment potential of a location and ultimately a restructured urban space geared at improved access to urban activities either through proximity between residential and employment activities or through a good public transport system.

[Word Count: 17 598]
REFERENCES


City of Cape Town. 2000. RSC Levy database.


Department of the Environment & Department of Transport. 1994. *A guide to better practice: Reducing the need to travel through land use and transport planning (PPG13)*. London: HMSO.


Appendix A: Factors determining the success of local and regional-scale TODs

<table>
<thead>
<tr>
<th>Factor</th>
<th>Local (station-area) success</th>
<th>Regional success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of TODs (station areas)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Transit quality</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Transit technology</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Street pattern</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Station-area parking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Employment and housing density</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Commercial mix</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Retail siting criteria</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Regional market structure</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Consumer activity patterns</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Travel behaviour/trip chaining</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Zoning flexibility</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Resident reactions</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Housing type preference/lifestyle &amp; life stage</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Self-selection in residential choice</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Government policies</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Source: Niles & Nelson (1999: 3)
Appendix B: Example outputs from the accessibility model

Figure B1: 7-km clinic catchments – eThekwini Municipality
Source: Green & Morojele (2001)
Figure B2: Demand for new clinic capacity and identified expansion possibilities – eThekwini Municipality

Source: Green & Morojele (2001)
Appendix C: Proportions of population and employment per node

[Graph showing proportions of population and employment for various locations]
Appendix D: Charts of the transport related variables

Figure D1: Number of departing trains per day
Figure D2: Number of departing taxis per day
Figure D3: Number of departing buses per day
Appendix E: Interchange status of stations

<table>
<thead>
<tr>
<th>Station</th>
<th>Interchange type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Town</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Mutual</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Bellville</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Claremont</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Elsiesrivier</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Mowbray</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Wynberg</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Parow</td>
<td>Bus, rail and taxi</td>
</tr>
<tr>
<td>Phillipi</td>
<td>Bus and rail only</td>
</tr>
<tr>
<td>Tygerberg</td>
<td>Bus and rail only</td>
</tr>
<tr>
<td>Maitland</td>
<td>Rail and taxi only</td>
</tr>
<tr>
<td>Koeberg</td>
<td>Rail and taxi only</td>
</tr>
<tr>
<td>Goodwood</td>
<td>Rail and taxi only</td>
</tr>
<tr>
<td>Thornton</td>
<td>Rail and taxi only</td>
</tr>
<tr>
<td>Salt River</td>
<td>Rail only</td>
</tr>
<tr>
<td>Woodstock</td>
<td>Rail only</td>
</tr>
<tr>
<td>Rondebosch</td>
<td>Rail only</td>
</tr>
<tr>
<td>Wittebome</td>
<td>Rail only</td>
</tr>
<tr>
<td>Harfield</td>
<td>Rail only</td>
</tr>
<tr>
<td>Kenilworth</td>
<td>Rail only</td>
</tr>
<tr>
<td>Newlands</td>
<td>Rail only</td>
</tr>
<tr>
<td>Observatory</td>
<td>Rail only</td>
</tr>
<tr>
<td>Rosebank</td>
<td>Rail only</td>
</tr>
<tr>
<td>Vasco</td>
<td>Rail only</td>
</tr>
<tr>
<td>Woltemade</td>
<td>Rail only</td>
</tr>
</tbody>
</table>

(Source: Information on the interchange types was obtained from the Directorate of Transport and Traffic, City of Cape Town.)
Appendix F: Average metropolitan distances to stations

Average City-wide distance (km) to stations

[Bar chart showing the average distance to various stations across the city, with distances ranging from 0 to 25 km.]