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**THE IMPACT OF RAPID URBAN GROWTH ON THE
COMMUTER RAIL SECTOR:
THE CASE OF GAUTENG PROVINCE**

BY

SOLOMON LEBOTLWE KEKANA

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SUPERVISOR : PROF. JHC PRETORIUS

CO-SUPERVISOR : MR. LSJ KRUGER

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DEDICATION

I would like to send a special gratitude to my maternal family and my fiancé Ms. Ballerina Masoetsa for always being there, your prayers and continued support is much appreciated.

DECLARATION

I hereby declare that all the research work, except where it has been appropriately acknowledged by relevant references, is my own work.

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
AsgiSA	Accelerated and Shared Growth Initiative of South Africa
BRT	Bus Rapid Transport
CBD	Central Business District
CoE	City of Ekurhuleni
CoJ	City of Johannesburg
CoT	City of Tshwane
DoT	Department of Transport
GEGDS	Gauteng Employment, Growth and Development Strategy
GDP	Gross Domestic Product
GHS	General Household Survey
GSDF	Gauteng Spatial Development Framework
HIV	Human Immuno-deficiency Virus
HST	High Speed Train
IDP	Integrated Development Plan
IMF	International Monetary Fund
IRPTN	Integrated Rapid Public Transport Networks
ITP	Integrated Transport Plans
MTSF	Medium-Term Strategic Framework
MSA	Moving South Africa
N1	National Road 1
NATMAP	National Master Plan
NLTA	National Land Transport Act
NMBM	Nelson Mandela Bay Municipality
NMT	Non-Motorized Transport
NSDP	National Spatial Development Perspective
NSSD	National Strategic Sustainable Development
PGDS	Provincial Growth and Developmental Strategies
PRASA	Passenger Rail Agency of South Africa

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PT	Public Transport
PTIS	Public Transport Investment Strategy
R21	Regional Road 21
R24	Regional Road 24
RDP	Reconstruction Development Programme
SA	South Africa
SARCC	South African Rail Commuter Corporation
SDF	Spatial Development Framework
SDI	Spatial Development Initiatives
StatsSA	Statistics South Africa
TOD	Transit Oriented Development
UN	United Nations
USA	United States of America

ABSTRACT

Commuter rail in South Africa faces many challenges as a result of a long history of inadequate investment in rail rolling stock, infrastructure, operations as well as the loss of appropriate managerial and technical (engineering) skills within the industry. Over time, commuter rail services have continued to fail to respond adequately to the changing passenger demands. On the other hand mobility has undergone constant change in terms of both population growth and spatial patterns. For an effective and viable country, the transport infrastructure and operations have to respond to this continual process of change.

From the transport context, South Africa is still haunted by its poor transport legacies of the past, which emerged mainly as a result of dysfunctional institutions. The dysfunctional institutional arrangements have resulted in poor accountability in the provision of public transport services, which were found to be largely disempowering. Government's socio-economic and transport policies could not be supported adequately by such institutional arrangements. As South Africa embarks on a journey of turning its public transport system around, the challenges for public transport are to simultaneously transform through meaningful integration, whilst at the same time enhancing capacity through upgrading and modernization in order to meet long-term needs of the economy.

This research focuses on the impacts of urbanization, commuter rail network and planning interventions aimed at an integrated public transport solution.

Firstly, the research investigates the impact of urbanization in relation to public transport and in addressing the ongoing challenge of rapid growth and thereby perpetuating social, economic and spatial inequalities.

Secondly, there is a disjuncture between legislation and implementation that the research investigates.

Thirdly, the study investigates the connectedness of Gauteng in relation to economic opportunities, social facilities and amenities. It aims to explore the extent of integration of Gauteng institutionally, spatially and socio-economically.

The study concludes that transportation is the single most important factor in shaping the economy. Transportation should therefore be highlighted in the spatial development planning framework and processes in Gauteng.

The key in addressing the impact of urban rapid growth on commuter rail is managing land use and transport networks in such a way that the highest level of access to services and employment opportunities are maintained.

CHAPTER 1

INTRODUCTION

1.1 Background

1.1.1 Commuter Rail Context

Commuter rail in South Africa faces many challenges as a result of a long history of inadequate investment in rail rolling stock, infrastructure and operations as well as the loss of appropriate managerial and technical (engineering) skills within the industry.

In the urban-metropolitan areas the provision of new rail corridors has not kept pace with the rapidly changing urban landscape, resulting in limited coverage in key areas of urban expansion with the consequential loss of significant market share. Over time, commuter rail services have continued to fail to respond adequately to changing passenger demands.

1.1.2 Population Growth and Spatial Context

“According to the United Nations, the proportion of urban dwellers among the world’s total population hit the 50% mark in 2008 and is currently estimated at 3.36 billion inhabitants, two thirds of whom live in the developing world. This population is expected to see a massive increase over the next few decades, rising from today’s 50% to 60% by around 2030”^[1]

Mobility is undergoing constant change, in terms of both population growth and spatial patterns. The transport infrastructure has to respond to this continual process of change. Where bottlenecks emerge, required improvements can be made from various measures that also have an impact on socio-economic aspects

that vary from land use and urban sprawl, environmental aspects, traffic management and fares structure.

1.1.3 Public Transport Context

According to the Passenger Rail Agency of South Africa (PRASA) Corporate Plan (2010/11-2012/13) ^[2], after many years of neglect, the existing commuter rail transport system, inherited from the apartheid past, has reached saturation levels and is unable to satisfy commuter demands while its infrastructure is not able to meet the requirements of a rapidly changing and modern society. The dysfunctional institutional arrangements have meant poor accountability in the provision of public transport services, which were found to be largely disempowering. Government's socio-economic and transport policies could not be supported adequately by such institutional arrangements ^[2].

The country is seeking to move away from the current commuter-based transport provision into a more integrated public transport system that meets growing and changing passenger demands in an efficient, effective and sustainable manner. The challenges for public transport are to simultaneously transform through meaningful integration whilst at the same time enhancing capacity through upgrading and modernization in order to meet the long-term needs.

1.1.4 Focus of Research

This research focuses on the impacts of urbanization, commuter rail network and planning interventions aimed at disrupting apartheid planning pattern and that leads to an integrated public transport solution.

1.2 Purpose of the study

Firstly, the research seeks to investigate the impact of urbanization in relation to public transport and in addressing the ongoing challenge of rapid growth and thereby perpetuating social, economic and spatial inequalities.

Secondly, there is a disjuncture between legislation and implementation that the research seeks to investigate.

Thirdly, the study investigates the connectedness of Gauteng in relation to economic opportunities, social facilities and amenities. It aims to explore the extent of integration of Gauteng institutionally, spatially and socio-economically.

The success or failure by impact of urban rapid growth on commuter rail to disrupt class and spatial inequalities will inform future planning policy and decision making.

1.3 Research Questions

PRASA is currently implementing an Accelerated Rolling Stock Investment Program, aimed at accelerating the rate of coach overhauls and upgrading in the short-term, which is expected to improve the service efficiency and performance of the fleet in the near future.

This approach has offered some degree of consolation for some time, but now, the need arises to completely review and rethink the whole structure of the commuter rail network:

- Does the existing structure come to terms with changing mobility patterns?
- Are Infrastructural modifications necessary, such as a reconsideration of the categorization of roads and the associated road design; rail technology
- Expanding the strength (mass mode) of the commuter rail network,

- Disentangling traffic flows, or changing the connective structure of urban areas?

In other words, there is a need to redesign the commuter rail network. The problem of network design is a very complex one which requires a paradigm shift in public transportation policies, the political arena and consideration is to be made of the interests of various parties affected.

1.4 Research Methodology

In order to achieve the objectives of this research a two tier approach was adopted and is discussed as follows:

1.4.1 Literature reviews:

The study has undertaken a desktop and library search where academic literature, journals (published and unpublished) addressing the urbanization, public transportation and aspects of integration were interrogated.

Relevant planning theory that focused on issues of social justice was examined to form the framework of the research. The information was also attained from, media and relevant official government websites and other relevant internet sources.

1.4.2 Integration of the subject matter:

This research discusses various subjects that are in line with the course contents of M.Phil: Engineering Management.

The methodology followed throughout this paper is that of interpreting and integrating what is available in the public transport sector for the area of investigation, which is Gauteng.

No empirical study was conducted. Therefore, this study presents the authors knowledge gathered through literature and discussions with experts in the public transport arena.

1.5 Research Parameters

The following parameters were used in undertaking this research. The research is only focusing on the impact of urban rapid growth on commuter rail transportation from the following perspectives;

- Legislation and Policies
- Urbanization and Population Growth
 - Housing
 - Travel Demand Patterns
- Spatial Planning
 - Urban Sprawls
 - Land Use

Any research of this complexity must follow a multidisciplinary approach. This research analysis could not deal with all the factors that impact the very large topic of urbanization or public transport planning. Given the constraints, there are many more factors that could be probed in more depth. However, the study has chosen to focus particularly on the transportation and spatial planning aspect, on socio-economic aspects and also on institutional integration.

This research paper is by no means exhaustive but aims to highlight key urban growth impacts on integration of public transport and solutions which can be mobilized in the public transport sector. The idea is to present a frame of reference for decision-makers.

1.6 Exposition of the Research Report

Chapter 1 (Introduction) is an introductory chapter and contains background information to the study, purpose of the study (objectives), research methodology as well as the research parameters.

Chapter 2 (Public transport and Planning Policies) provides an overview of the transport and planning policies within all three spheres of government. It seeks to draw the attention from a commuter rail view point when addressing the impact of rapid urban growth.

Chapter 3 (Population Growth and Travel Demand Patterns) introduces some of the key provincial demographics issues that will be analyzed at the later stage of the study. It presents the basic population statistics, housing, transport and travel demand profile in Gauteng, drawing on the analysis from various planning reports.

Chapter 4 (Economic Growth) considers at a high level, economic growth factors that are likely to determine a future role for commuter rail in South Africa and Gauteng in particular. It further analyzes the impacts of rapid urban growth on the socio-economic aspects and the lessons learned from the economic history.

Chapter 5 (Transport, Spatial Planning and Land Use) is designed to stimulate constructive debate within the overall study in anticipation of a more detailed consideration in public transport planning arena.

Chapter 6 (Analysis of the findings) presents some emerging strategic and policy issues. On the other hand, whilst South Africa and Gauteng in particular is still in the urbanization phase the demand for land for urban expansion is the reality.

Chapter 7 (Conclusions and Recommendations) provides conclusions and recommendations which can be mobilized in the public transport sector. Finally the chapter provides the principles to achieve the public transport supportive structure necessary for fundamental restructuring. The idea is to present a frame of reference for decision-makers.

CHAPTER 2

PUBLIC TRANSPORT AND PLANNING POLICIES

2.1. Introduction

The apartheid racial laws disrupted communities and entrenched social inequalities in the built environment, marginalizing much of the population ^[3]. This spatial division was enforced through the legislation known as the Group Areas Act of 1950 ^[4]. Town planning and “Bantu” housing development in accordance with existing legislation (Native Resettlement Act of 1954 and Native (Urban Areas) Act of 1955) in the apartheid period were key instruments of oppression and basic social engineering ^[5].

According to the South African Constitution, legislative powers and responsibilities for transport are shared between local, provincial and national government. It is therefore important to take into consideration the policies of the different spheres of government when planning for a public transport.

Figure 2.1 below ^[6] represents the supporting national documents used by the various spheres of government and which feed into the Integrated Transport Plan (ITP).

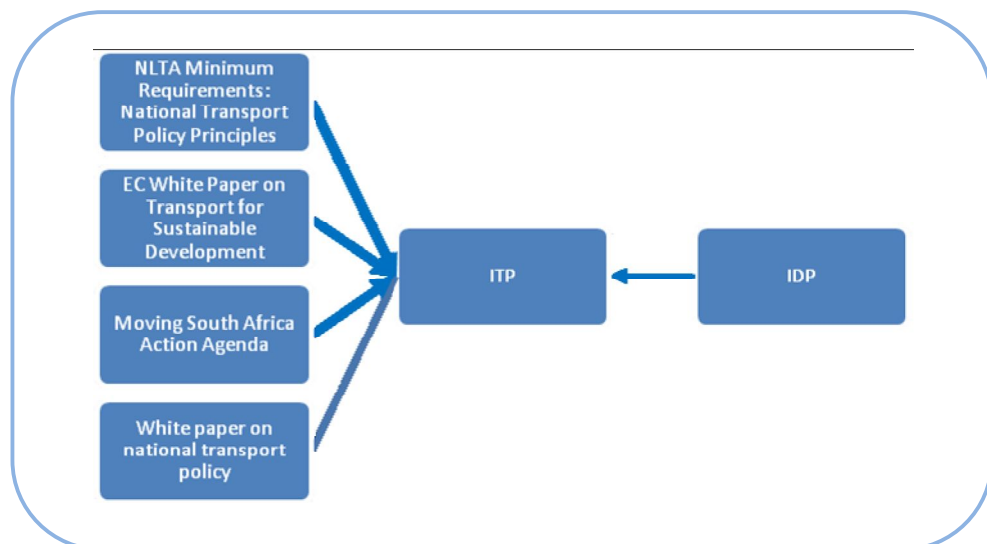


Figure 2.1: NMBM CITP Report (2011-2012)

Below is a brief summary of the national policy statements from the five supporting documents in Figure 2.1^[6].

- Support socio-economic growth and development
- Determine and meet customer needs
- Provide safe, affordable and improved transport services
- Enhance city functions through integrated land use and transport planning
- Provide and maintain improved transport infrastructure
- Minimise impacts and promote environmental sustainability
- Provide accessible transport for all users
- Consult and involve all stake holders
- Provide responsive, people centred and integrated institutional structures

2.1.1 National Land Transport Act (No. 5 of 2009)

The National Land Transport Act (NLTA) was promulgated in the Government Gazette No. 32110 on 8 April 2009. The NLTA repeals the National Land Transport Transition Act (No. 22 of 2000) in its entirety. In terms of section 2 of the NLTA, the purpose of the Act is ^[7]:

- to further the process of transformation and restructuring of the transport system
- to give effect to national policy
- to prescribe national principles, requirements, guidelines, frameworks and norms and standards
- to consolidate land transport functions and locate them in the appropriate sphere of government

With regards to the ITP, the NLTA proposes the following minimum requirements in terms of National Transport Policy Principles ^[7]:

- a) Enhance city functions through integrated services and infrastructure.
- b) Focus on transport corridors and encourage mixed land use development.
- c) Prioritise public transport.
- d) Enhance accessibility.
- e) Improve maintenance.
- f) Minimise the environmental impact of transport.

2.1.2 White Paper on National Transport Policy

The strategic objectives of the White Paper which are relevant to settlement planning and which should be incorporated in future settlements are summarized below:

- Public transport travel distances and times for work trips should be limited to about 40 km, or one hour in each direction. This means that new settlements should be located no further than 40 km from the major work destinations. Further, as a general guideline, settlements should rather be located as close as possible to places of work and other urban activities so as to facilitate trips by Non-Motorized Transport (NMT). Where this is not possible, settlements should be located close enough to work destinations to enable public transport vehicles to make two or more trips from the settlement to the work place or school in peak-hour periods ^[8].
- An objective has been set to promote the use of public transport over private car travel with an ambitious 4:5 ratio of public to private transport being set as a target. To assist in the achievement of this objective, settlement plans should have circulation systems or movement layouts which make all dwellings accessible to public transport ^[8].

- Within the strategic objectives for improving accessibility, a target has been set of reducing walking distances to public-transport facilities to within a one kilometer radius. Most people take about 15 minutes to walk one kilometer, so this objective should be regarded as a minimum. A far more desirable target for settlement planning will be to place every dwelling within about seven minutes of a public transport boarding point (around 500 m) ^[8] .
- A final strategic objective which should be taken into account in settlement planning is the object of promoting and planning for the use of non-motorized transport. Accordingly, settlements should be planned as places with a variety of urban activities, containing workplaces, schools, shops, recreational and community facilities, and dwellings. They should also have movement networks which permit direct pedestrian access to activities and public transport facilities ^[8] .

The White Paper also contains a number of policy statements that should be taken into account in settlement planning. These include the following:

- Land-development proposals (which include settlement plans) should be subject to a spatial policy framework within an agreed development planning process. This means that the settlement plan must be approved in terms of an Integrated Development Plan (IDP), part of which is an ITP. Accordingly, settlement planners will, at the outset, need to consult transport authorities to ensure that the planned settlement will be complementary to the ITP, which includes public transport strategies and operations ^[8] .
- Land use development at local level (settlements) will be subject to development approval in conformity with integrated development plans ^[8] .

- The settlement plan should be cognisant of the designated public transport corridors and nodes contained in regional, metropolitan or urban IDP's. Thus, it will be necessary to contextualize the settlement within such a spatial plan ^[8].

At this juncture, it is sufficient to note that in terms of the White Paper, settlement plans will need to give effect to the policy of locating employment activities within (or close to) the public transport corridors and nodes (interchanges). Likewise, the settlement plan should facilitate the provision of higher density and mixed land uses adjacent to public transport facilities.

- A high density of development is important for public transport, in that it supports differentiated public-transport provision and enhances operating efficiency ^[8].

2.1.3 Moving South Africa (South Africa, Department of Transport 1998)

Moving South Africa (MSA) was a project of the National Department of Transport, completed in September 1998, which aimed to develop a long-term transport strategy for South Africa.

The strategies identified in MSA entitled "Towards a transport strategy for 2020", will impact on settlement-planning ^[9].

The following are the main features of MSA which are significant to settlement planning:

- Mass public transport will be concentrated into relatively few public transport corridors to provide conditions that will attract high-density mixed land uses. The corridor densification strategy is expected to locate urban employment and residential activities to be within such corridors ^[9].

- The quality of public transport and the extent of social support for the services will depend on the market segments served in each of the corridors. Settlement planners should thus be aware of the customer segmentation in the settlement, as this will provide an indication of the type of service that can be expected ^[9].
- Moving South Africa has developed a broad set of guidelines for determining the type of public transport infrastructure which will be appropriate to each corridor. These serve only as guidelines because, in due course, transport authorities will examine corridors on their own merits and determine their particular public transport policies ^[9].

The guidelines will, however, influence settlement planning from the following criterion:

- High passenger-volume corridors with more than 40 000 passengers per direction per day will probably support a rail or dedicated public transport road infrastructure in congested areas. Public transport nodes (stations and interchanges) in these high-ridership corridors will be supported by feeder services rendered by buses or minibus taxis ^[9].
- Moderate ridership corridors with 10 000 to 40 000 passengers per day per direction are likely to be served by a road infrastructure, with priority or dedicated lanes for public transport over parts of the corridor. The services in these corridors will largely be provided by buses, supplemented by mini-buses taxis at nodal public transport interchanges ^[9].
- Low ridership corridors will characteristically have fewer than about 10 000 passengers per day per direction, and are likely to have some road-based priority schemes. Many of these low ridership corridors will be feeder

corridors. Feeder function will fall primarily to taxis or small road-based vehicles ^[9].

Settlement planners will need to ascertain where the existing public transport corridors are located, relative to the proposed settlement. In planning the settlement it will be necessary to ascertain the type of corridor that will serve the settlement. This means negotiating with transport authorities to identify whether there will be extensions to nearby line haul services, or whether the settlement will be served by a feeder service. In the case of the latter, the location of existing nodal points and modal interchanges will be an important consideration in the alignment of the low-ridership feeder corridor serving the settlement.

Figure 2.2 below shows the urban densification options considered by MSA ^[9]. MSA notes that high central city densities will enhance public transport use and sustainability, but in South Africa this solution is problematic due to historic land tenure patterns.

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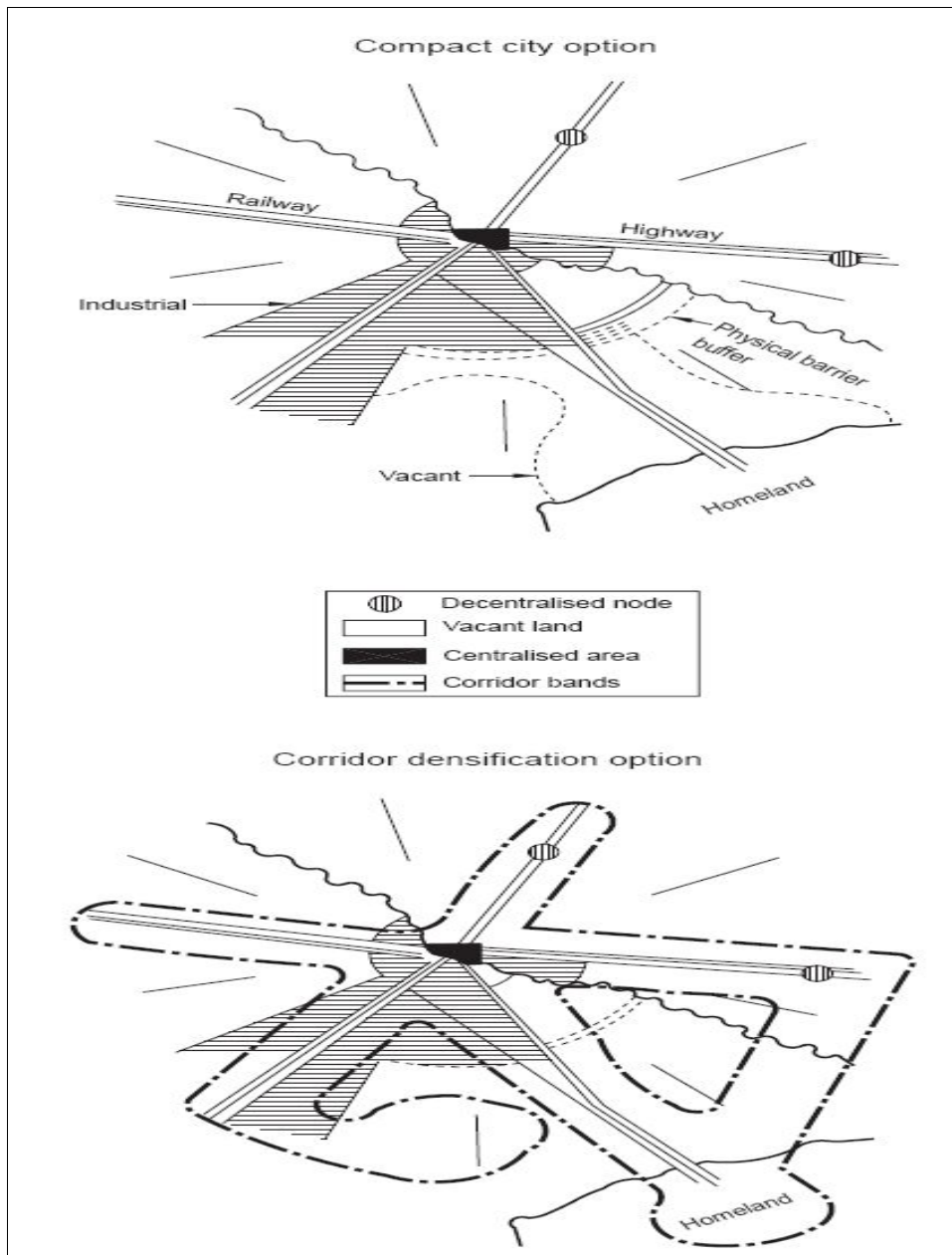


Figure 2.2: Urban densification options (Adopted from MSA) ^[9]

2.2 Conclusion

The integration of land use planning and transport planning to achieve sustainable travel behaviour has been adopted as a desirable outcome for many years. Development and establishment of appropriate institutional arrangements coupled with effective policy and planning processes is a crucial component in achieving this outcome.

MSA states that corridors already exist to some extent in South African cities and accordingly, their strategy focuses on densification of existing corridors and the creation of new corridors for future urban settlement planning. The short-term focus should be on influencing the centrifugal tendencies in South African cities to prevent the future dispersion of development. MSA will be looking for strategies to attract decentralizing activity towards public transport corridors. This approach should have a strong influence on settlement planning ^[9].

The MSA notes that the tendency towards continuing decentralization of workplace locations is complicating the task of creating “compact cities”. While it is argued that some compaction may be achievable as a means of increasing density in some cities, it is suggested that the predominant pattern in South Africa should be the “corridor city”. MSA argues that the corridor approach fits more easily with existing South African urban land-tenure patterns ^[9].

The appropriateness of the corridor approach is driven not only by the already decentralized distant townships and the low density of inner ring suburbs, but also by recognition of the decline in Central Business District (CBD) vitality and the dispersion of development to satellite nodes. The favoured corridor option recognizes the existing vacant land between townships and suburban areas which should be taken into account in settlement planning ^[9]. These areas, if developed, can build on existing flows on major current corridors.

CHAPTER 3

POPULATION GROWTH AND TRAVEL DEMAND PATTERNS

3.1 Introduction

According to the South African State of the Cities Report, Gauteng is the smallest, most urbanized and economically powerful province in South Africa ^[10].

The report, furthermore explains that the Gauteng province contributes towards 40% of the South African Gross Domestic Product (GDP) and it is the most populous province, with a population of approximately 9.5 million people.

The demographic projections of 2006, projected urban Gauteng will be home to 14.6 million people and will also be the 14th largest urban region in the world by 2015.

The province dominates the greater regional economy, constituting 9% of Africa's Gross Geographic Product ^[10].

In general, travel demand analysis considers both public and private transport modes. Rail-Road based public transport and private transport trips are taken into account, because mode choice is, in part, a function of the interaction between supply and demand. Capacity constraints on the rail-road network and on public transport services influence not only mode choice and routing, but also the ability of commuters to gain access to public transport services.

3.1.1 Basic population statistics

The basic population statistics contained in this section are not meant to replace the official Statistics South Africa mid-year projections. The basic population data provided forms an analysis and benchmarking process. Users who need official population estimates for South Africa outside the context of the General Household Survey (GHS) should use the official estimates contained in Statistical Release ^[11].

According to the GHS (2010), the most populous provinces in 2010 were Gauteng with 10.8 million residents, followed by KwaZulu-Natal and Eastern Cape with 10.6 million and 6.7 million residents respectively. Northern Cape remains the least populous province in the country ^[11].

As shown in Figure 3.1, Gauteng is dominated by its urban population, accounting for 90% of the total. The major cities and towns include:

- Johannesburg, Tshwane and Ekurhuleni. Johannesburg forms the main economic area and concentration of people in the Province. Pretoria is the political capital.
- Large towns including Mogale City, Westonaria and Vereeniging.
- Smaller towns such as Heidelberg and Bronkhorstspuit.

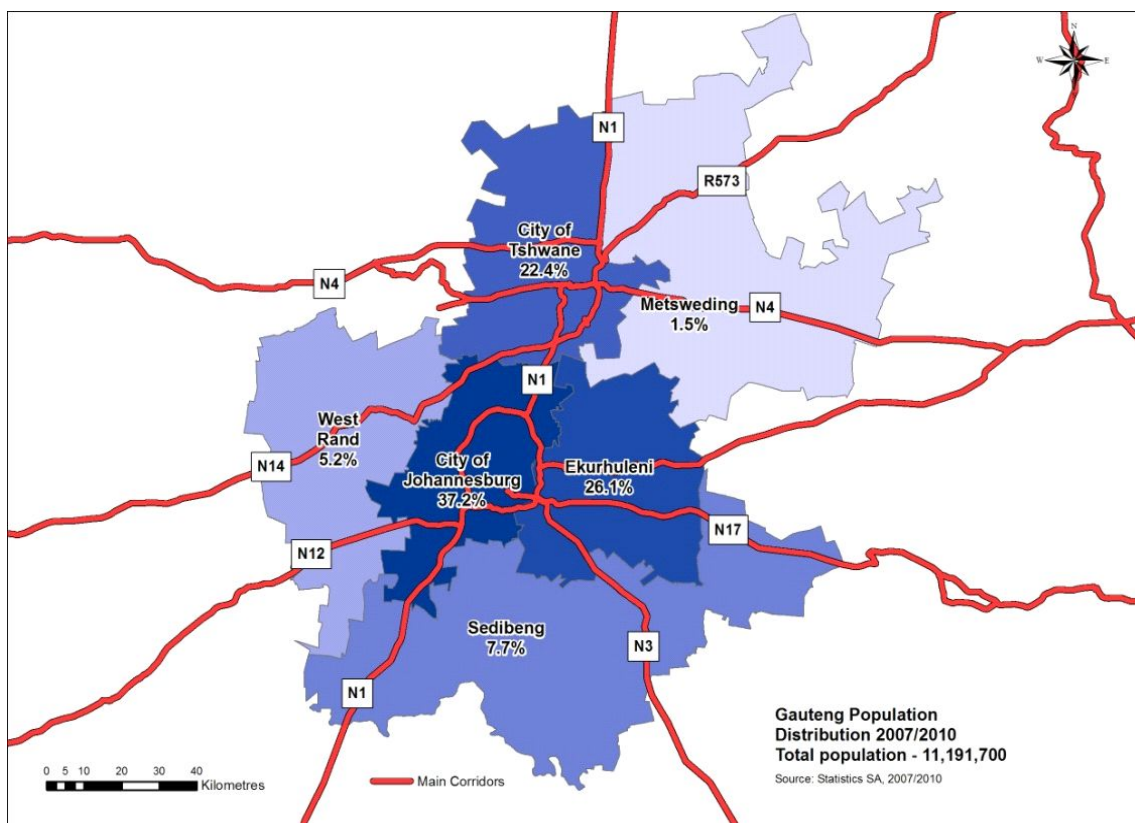


Figure 3.1: Population Distribution in Gauteng (Source: StatsSA)

3.1.2 Housing

Housing types and ownership

The GHS 2010 indicates that there has been continued growth since 2002 in the ownership of dwellings, from 53.1% in 2002 to 58.1% in 2010. Concurrently the percentage of the households who were renting decreased from 22.5% in 2007 to 20.6% in 2010 while the percentage of dwellings that were partially owned declined jaggedly to 10.9% ^[12].

According to the GHS 2010, the rapid economic growth that took place between 2002 and 2007 probably fueled increases in full ownership. An increase of 2.1% in the ownership of dwellings was most likely to be caused by the recovery from recession which impacted severely on households' liquidity during most of 2009. There has been an inverse relationship between fully owned dwellings and renting since 2002. This was expected as ownership increases and renting decreases. The percentage of households whose tenure status was classified as 'other' decreased slightly from 11,8% in 2002 to 10,4% in 2010 ^[12].

Although the proportion of households living in informal dwellings has apparently remained unchanged between 2002 and 2010 at 13.0%, the intermediary period has been characterized by uneven changes. While the proportion of informal dwellings declined in provinces such as KwaZulu-Natal, Limpopo and Mpumalanga, increases were observed in Gauteng, North West and Western Cape ^[12].

The provinces with the highest percentage of informal dwellings in 2010 were Gauteng (21.5%), North West (18.8%), Western Cape (17.1%) and Free State (13.3%). By contrast, the smallest proportion of informal dwellings was reported in Limpopo (3.8%), KwaZulu-Natal (7.2%) and Eastern Cape (7.4%) ^[12].

3.1.3 Transport

This section primarily focuses on the use of public and state-subsidized transport, the cost of transport to households and the types of transport and time needed to travel to work, school and health facilities.

According to the GHS (2010), 40.9% of South African households had at least one household member who used a minibus taxi or a sedan taxi. Provinces with the highest levels of use of minibus taxis were: KwaZulu-Natal (47.5%), Mpumalanga (47%), Gauteng (41.7%), and North West (42.8%). Although only 7.8% of South Africans used a bus, the figures were particularly high for Mpumalanga (20.8%). Use of trains was most common in the Western Cape ^[12].

3.1.3.1 Mode of transport Statistics (2010)

The GHS (2010) indicates that, nearly three quarters (72.9%) of the individuals attending school walked to get there. A further 7.8% travelled by private car while another 8% used taxis. The most commonly used mode of transport to go to work was a private car (32.9%), followed by taxis (23.7%) and walking (19.0%). The GHS 2010 study found that 10.9% of the working population worked from home and that they therefore had no need for transport ^[12].

3.2 Travel Demand Profile

3.2.1 Travel Patterns

Millions of individuals recognize Gauteng Province as a place of employment, residence and social interaction. This may be on a temporary or permanent, formal or informal basis. For others it may be one of these aspects e.g. unemployed but resident, resident but employed elsewhere, unemployed and un-housed ^[13].

Beyond undeveloped and developed skills, the ability of an individual to access economic opportunities is largely based on their ability to physically move between their place of residence and the latent opportunities. The individual ought to locate either within a comfortable walking distance of the opportunity or have access to a transport mode (private or public) to exploit the opportunity ^[13].

An analysis from the inter-provincial migration revealed that Gauteng, Western Cape and Kwazulu-Natal experience positive net migration. There seems to be a high migration movement from Limpopo and the North West provinces into Gauteng. The provinces with the highest outflow of people were Eastern Cape and Limpopo ^[13].

	Scenario						
	Base yr	2007 Trend (demographic) Trend (transport)	2014 Trend (demographic) Trend (transport)		2007 Corridor (demographic) Trend (transport)	2014 Corridor (demographic) Trend (transport)	2014 Corridor (demographic) PT (transport)
Modal split							
Car	44%	44%	45%		43%	44%	44%
Gautrain	0%	0%	0%		0%	0%	1%
Bus	12%	11%	11%		12%	11%	13%
Taxi	36%	36%	35%		36%	36%	35%
Rail	8%	8%	9%		8%	9%	7%
Time-of-day							
Peak	78%	76%	73%		76%	74%	74%
Off-peak	22%	24%	27%		24%	26%	26%

Table 3.1: Impact of Regional Growth on Travel Patterns ^[14]

3.2.2 Impact of regional growth on travel patterns

Table 3.1 above, shows an analysis that the overall effect of projected growth over the forecast horizon for the greater Gauteng area is almost negligibly small, as measured in terms of mode shifting. The modal split basically remains unchanged,

indicating that there is little scope for commuters to adapt to increasing population and traffic levels by choosing different modes. This seems to be in line with expectation, that, most people are more or less captive to their current modes ^[14]. Furthermore, as observed that some amount of switching of trips from the peak to the off-peak period takes place and the percentage of one-way trips made in the peak period declines from 78% in the base year to 73%-74% in 2014, mostly as a result of non-work, non-school trips that are shifted out of the increasingly congested peak periods ^[14].

3.2.3 Impact of regional growth on congestion levels

The congestion growth is indicated by the number of trips that are made.

Gauteng's transport network had to accommodate a considerable increased travel volume over the past decade. A corridor focused on demographic-scenario leads to a lower overall growth in trips as compared to the trend-scenario. It is also clear that the corridor driven scenario favours public transport more, as public transport modes grow at a faster rate than the car mode. This is as a result of the slightly higher accessibility of public transport when housing is more directed towards corridors served by buses, taxis and rail ^[14].

The survey suggested that, it is also informative to compare the average travel times experienced by different population groups, as these are directly influenced by congestion:

High-income commuters' car travel times increase from the base year to 2014 under the trend scenario which is not insubstantial, as a consequence of the adaptive behaviour where people switch routes, destination and time of day to cope with increasing congestion, so bringing down the average travel time ^[14].

Over the forecast period, public transport show an increase in travel times, due to increasing congestion, but this is not nearly as significant as for the car mode ^[14].

	Scenario					
	Base yr	2007 Trend (demographic) Trend (transport)	2014 Trend (demographic) Trend (transport)	2007 Corridor (demographic) Trend (transport)	2014 Corridor (demographic) Trend (transport)	2014 Corridor (demographic) PT (transport)
Average trip time (mins)						
Low Inc - PT	74.79	75.01	76.61	75.81	76.86	77.90
High Inc - Car	22.75	24.35	29.58	24.11	26.81	26.28
Low Inc - All modes	67.68	67.43	68.21	67.74	68.21	68.89
Med Inc - All modes	51.65	51.77	54.20	52.27	53.28	53.12
High Inc - All modes	27.46	28.92	34.07	29.08	31.91	31.48
Average trip cost (R/trip)						
Low Inc - All modes	4.70	4.68	4.81	4.89	5.01	5.11
Med Inc - All modes	6.19	6.10	6.20	6.13	6.13	6.17
High Inc - All modes	6.12	6.17	6.48	6.14	6.22	6.57

Table 3.2: Impact of Regional Growth on subgroups of population ^[14]

3.2.4 Impact of regional growth on subgroups of population

Table 3.2 above allows comparison of the aggregate travel times and costs across different income groups. The analysis indicate that on average, low income persons spend longer time than high income persons travelling, but pay lower fares per trip. This reflects the higher use of public transport among low income travelers ^[14].

Medium income travelers seem to be in some senses worst off, their average travel times are towards the higher end due to their higher use of public transport modes, but their average trip costs are also high due to their long travel distances and higher

use of cars which are more expensive to run. It may be that medium income residents are deserving of more attention in strategy formulation ^[14].

3.2.5 Impact of implementing growth scenarios

An overall travel patterns imply the amount of trips captured by these modes are small. Gautrain has about 1% while the Bus Rapid Transport (BRT) leads to an increase in bus mode share from 11% to 13%. Their impacts are indeed more significant in terms of overall travel times, they reduce car travel times slightly (due to the reduced congestion on certain road corridors), which benefits medium-high income car users ^[14].

However, the BRT options do not bring down public transport travel times for low income travelers. The average travel times are approximately equal for the Public Transport (PT) and the trend network scenarios. The travel costs also do not come down for the PT investment scenario, as a result of the fact that travel distances increase slightly as longer distance traveler's shift to the BRT mode. It is specifically from some rail routes (operating parallel to BRT lines) that the demand for the BRT comes from ^[14].

Figure 3.2 below, illustrates the 2008 average daily vehicle flow in Johannesburg, the inflow varies in capacity networks from 0-20 000 (NMT, private vehicles & taxis; 20 000- 40 000 (mini-bus taxis, buses & BRT) and greater than 40 000 (Mass transit – Rail) ^[15]

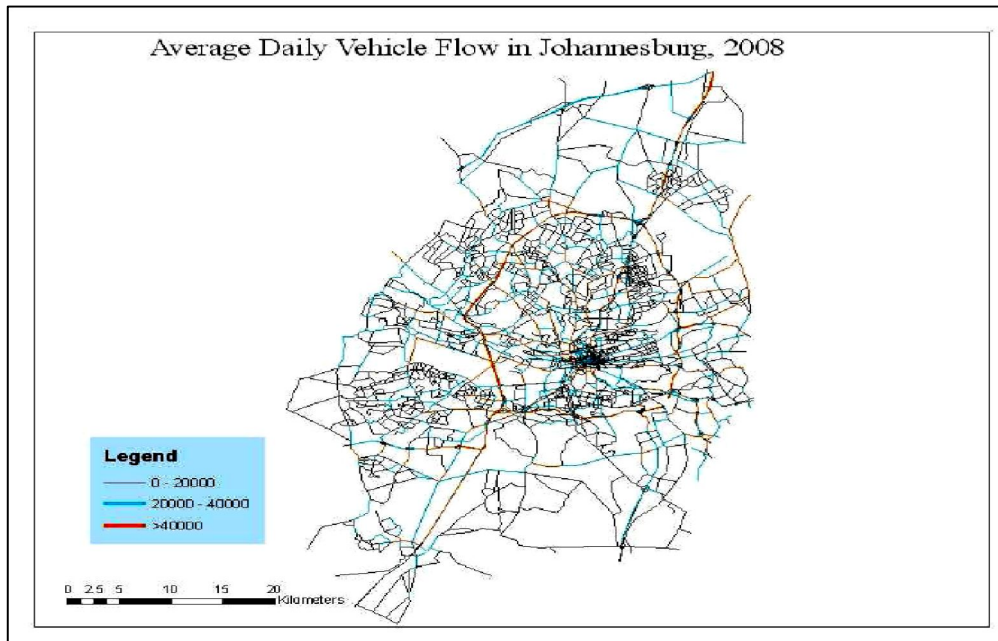


Figure 3.2: Average daily vehicle flow in Johannesburg - Gauteng Province's transport scenarios^[15]

3.3 Other Travel Markets in Gauteng

An understanding of the alternative travel markets is fundamental to identify the competitive threats affecting rail, together with the opportunities to develop new markets. Firstly, the public / private transport modal split is 47% and 53% respectively, with the proportion of trips by public transport comprising rail (14%), minibus-taxi (72%) and bus (9%)^[16]. In contrast, the City of Tshwane has a higher mode share in favour of public transport and non-motorized transport comprising about 66% of the total^[17].

To supplement this initial analysis, a more detailed review of each administrative area has been conducted using data collated to support the 2006 Rail Plan^[18].

Each diagram from Figure 3.3 to Figure 3.8 illustrates the total number of public transport trips during the AM peak, the mode split (bus, rail and taxi) and the number of rail trips (based on 2002 data). Although the age of the data means the conclusions should be treated with some caution, it is understood that the movement

patterns highlighted in the earlier analysis have not changed significantly during the intervening period. Although a data collection programme is expected imminently, no other information has been collected since 2002. Data illustrating the number and distribution of private car trips is not recorded by this dataset, so the availability of high capacity routes has been used as proxy instead. The following summarizes the main trends:

Johannesburg: The largest flows are to / from Soweto and the city centre, plus an area to the east towards the N3. Despite the large number of passengers using some of the rail corridors, the taxi industry still records a mode share of 75%. The busiest individual movement corridors serve Johannesburg. This analysis reinforces the importance of Johannesburg in terms of the overall movement patterns. The parallel M2 (Municipal) and N12 (National) routes reinforce the popularity of these corridors for trips by minibus-taxi and private transport.

Pretoria: The busiest movement corridors include Mabopane to central Pretoria and Akasia. Buses attract a higher mode share compared with the results for Johannesburg, although taxis still account for over 50% of the total. The Mabopane corridor attracts a smaller number of trips versus the Johannesburg corridors. Other popular corridors include Mamelodi to central Pretoria, with buses accounting for two-thirds of the total journeys. The N4 and the R80 represent the main alternatives for car drivers.

Ekurhuleni: The main public transport flows are to / from Kempton Park, Germiston, whilst the expansion at OR Tambo Airport means this is becoming an important trip generator. The total number of trips is comparable to Johannesburg, whilst taxis are the dominant mode.

Metsweding: The public transport journeys are predominantly taxi-based, although the actual number of trips is significantly lower compared with the flows identified in the three other municipal areas.

Sedibeng: The main focus on public transport trips in this location is Vereeniging and Vanderbijlpark, predominantly towards Johannesburg. There are a smaller number of trips during the AM peak period compared with other corridors in Gauteng. Taxis account for about two thirds of the total. The rail mode share is very small.

West Rand: The busiest flows are Randfontein to Johannesburg, although the number of trips is comparable to the Sedibeng corridor. Around 75% of public transport trips are made by taxi.

THE IMPACT OF RAPID URBAN GROWTH ON THE COMMUTER RAIL SECTOR:
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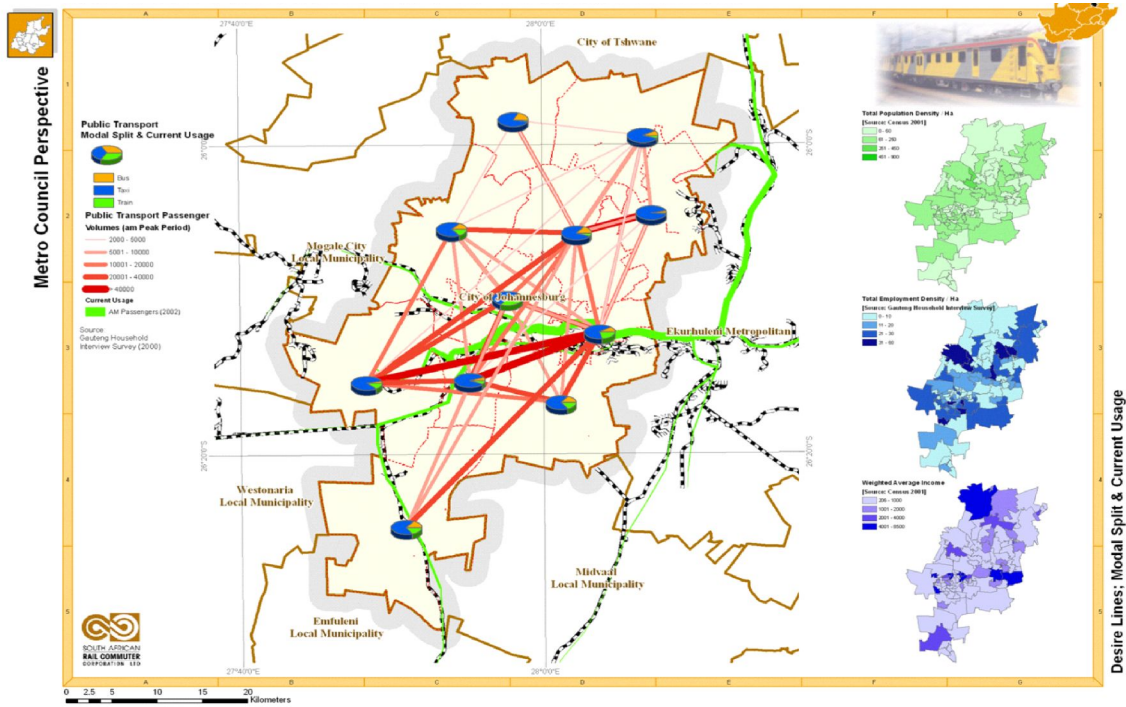


Figure 3.3 Summary of Principal Movement Patterns – City of Johannesburg

Source: Data presented as part of the 2006 Railplan report

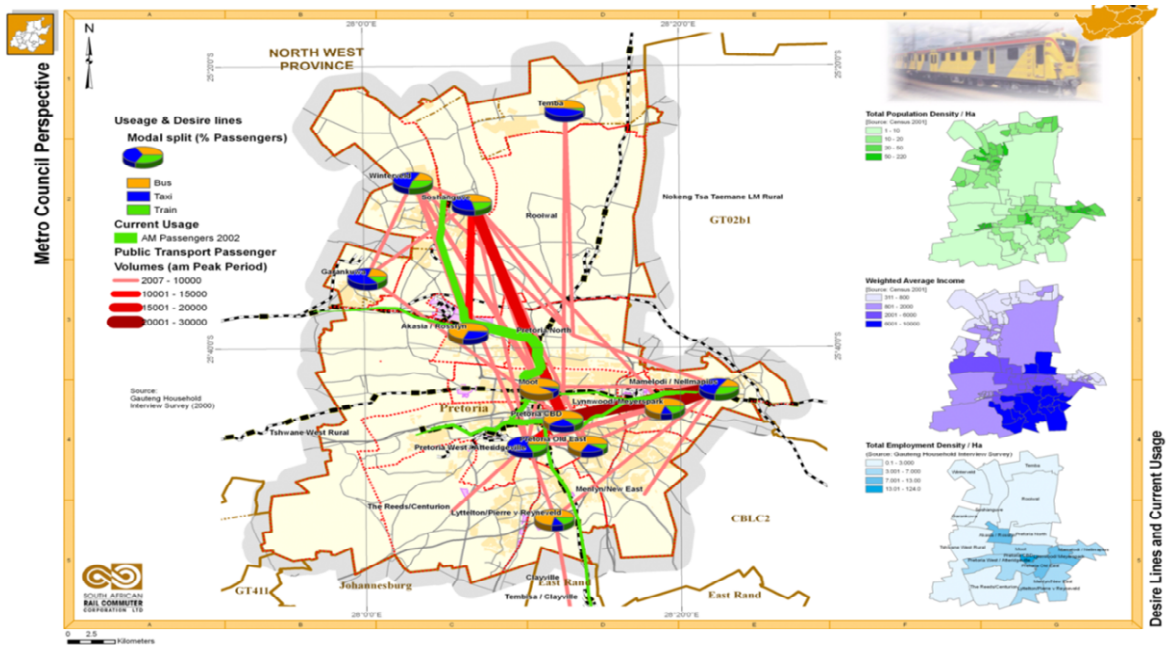


Figure 3.4 Summary of Principal Movement Patterns – City of Pretoria

Source: Data presented as part of the 2006 Railplan report

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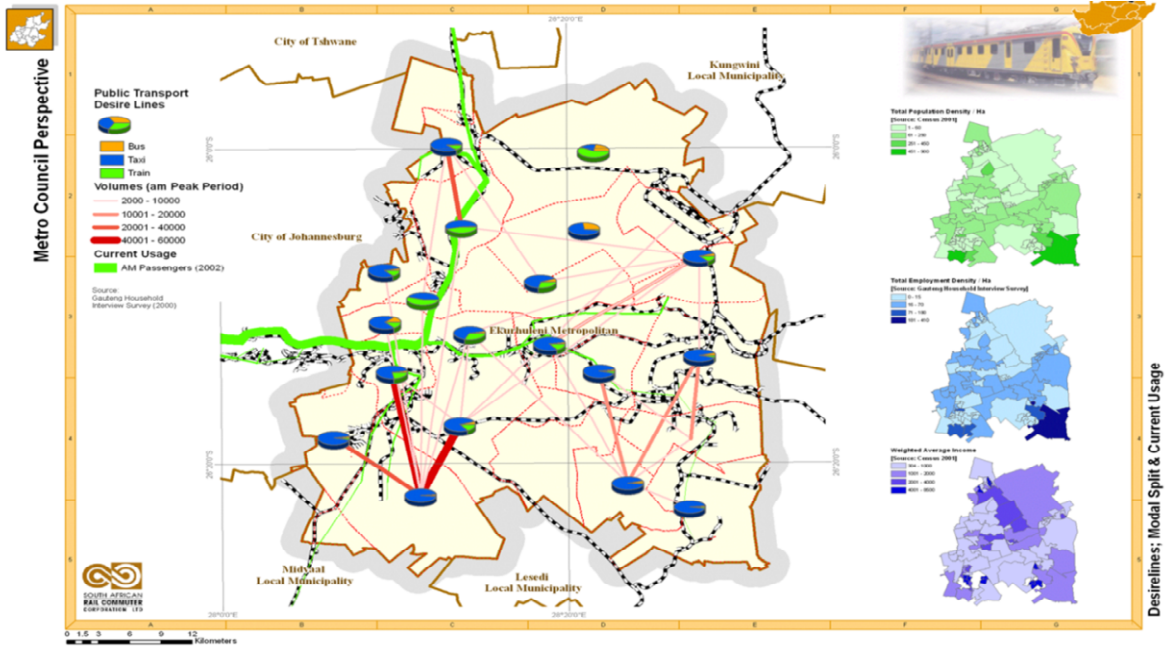


Figure 3.5 Summary of Principal Movement Patterns – Ekurhuleni

Source: Data presented as part of the 2006 Railplan report

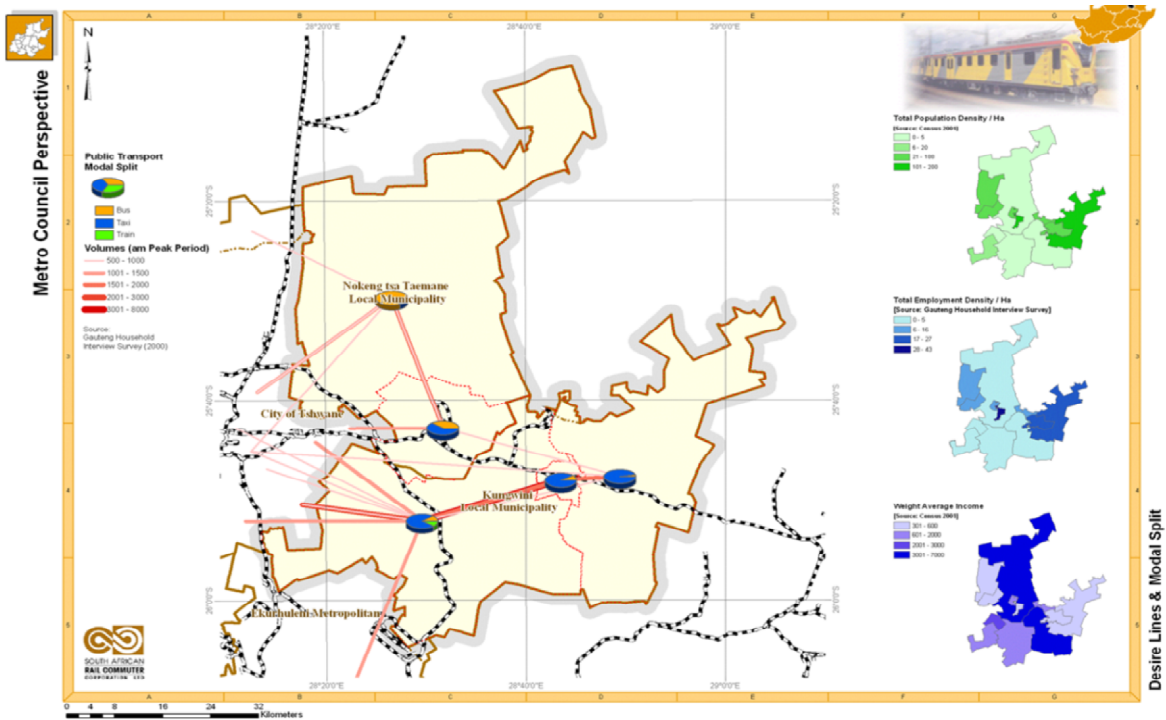


Figure 3.6 Summary of Principal Movement Patterns – Metsweding

Source: Data presented as part of the 2006 Railplan report

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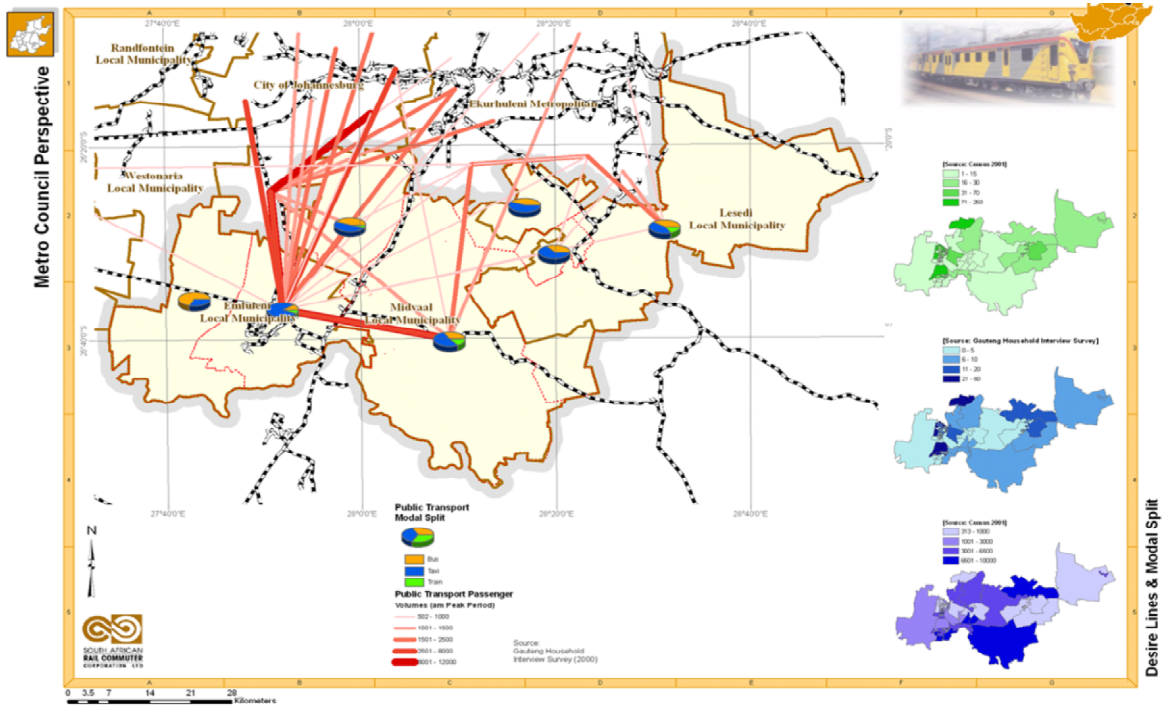


Figure 3.7 Summary of Principal Movement Patterns – Sedibeng

Source: Data presented as part of the 2006 Railplan report

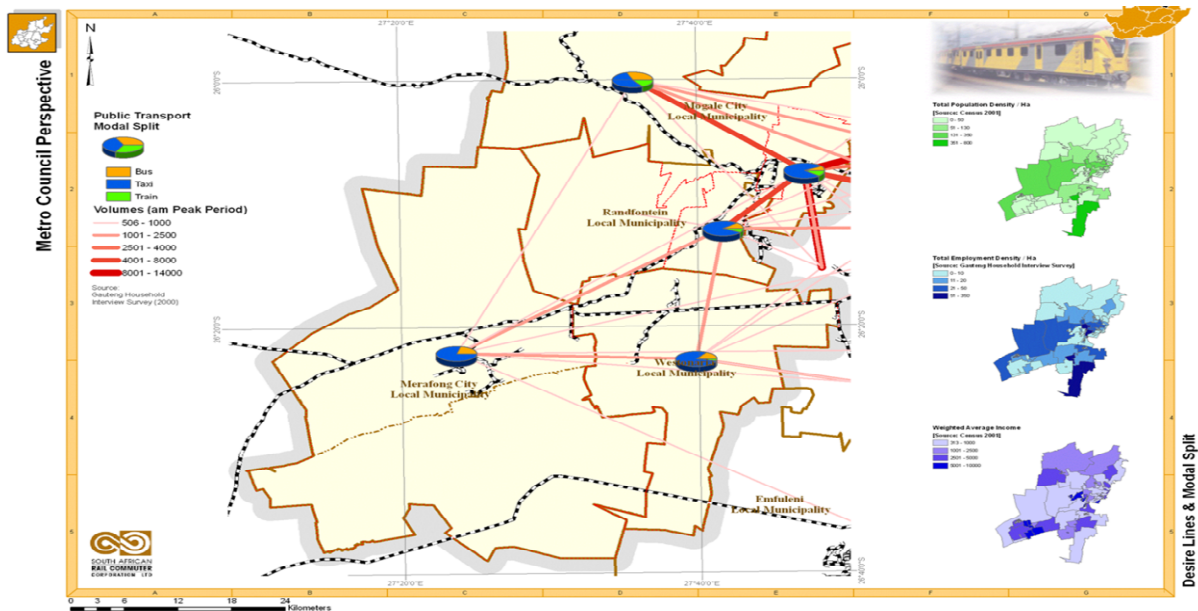


Figure 3.8 Summary of Principal Movement Patterns – West Rand

Source: Data presented as part of the 2006 Railplan report

3.4 Drivers of Change

3.4.1 Role of Rail in Gauteng's Main Travel Corridors

This section highlights some of the main public transport movement corridors based on analysis presented in the 2006 Rail plan ^[18].

Table 3.3 illustrates the mode share by rail, bus and taxi for the busiest movement corridors in Gauteng. This reinforces the potential for rail to further expand its existing market to attract new passengers. With taxis accounting for at least 50% mode share on all the movement corridors, including some routes where the percentage of trips rises to about 80%, this demonstrates the level of competition with alternative modes.

Corridor	Total number of trips (morning peak period)	Mode share (%)		
		Taxi	Rail	Bus
Soweto to George Goch	>40,000	75	20	5
Soweto to Johannesburg CBD	20,000-40,000	75	20	5
New Canada to George Goch	>40,000	80	10	10
Soweto to Tembisa	20,000-40,000	75	20	5
Stretford to George Goch	20,000-40,000	66	20	14
Mabopane to Pretoria	15,000-20,000	50	25	25
Mabopane to Akasia	10,000-15,000	50	25	25
Mamelodi to Pretoria	20,000-30,000	50	25	25
Germiston to Boksburg	40,000-60,000	75	20	5
Sebokeng to Vereeniging	10,000-12,000	75	10	15
Sebokeng to Johannesburg CBD	10,000-12,000	75	10	15
Randfontein to Roodepoort	8,000-14,000	75	15	10
Mogale City to Roodepoort	8,000-14,000	75	15	10

Table 3.3 Public Transport Mode Share for the Busiest Corridors in Gauteng (Source: Data presented as part of the 2006 Railplan report)

3.4.2 Other Potential Drivers of Change

In addition to the land use and economic factors, there are a number of other issues that can influence future rail demand.

Improved Rolling Stock Level and Reliability: The analysis also indicates that rolling stock is outdated and does not provide a comfortable service to the customers compare with other modes. The reliability of the trains is also poor with significant train cancellation. With the new rolling stock PRASA is currently procuring, service standards are expected to improve accordingly and it is envisaged that rail demand will also increase.

Journey Time Improvements: Rail journey times are notably higher than car timings on most corridors. Apart from rail systems factors contributing to these long journey times, Gauteng has less relatively uncongested roads outside the peak periods.

Fluctuation in Fuel Prices for Cars: South African fuel prices are generally influenced by the international oil price and the US Dollar/Rand exchange rate thus the fuel prices fluctuate accordingly as changes in these two factors occur. The fluctuating oil prices have a major effect on the taxi industry as it is not subsidised by government. Thus the majority of the public transport users are affected as the taxi industry serves a bigger share of the public transport compared to buses and rail.

Potential Rail Fare Increases: Rail fares have generally been consistent and affordable throughout the country for the low income population. Keeping the rail fare at an affordable price will not only ensure that the rail business keeps at the current demand but also increase its demand when service standards compete with other modes of transport.

Airport Access: OR Tambo Airport is a major generator and is connected to the Gautrain network. With about 18.4m passengers per annum, improved surface access links, either through a bus feeder service from Rhodesfield and / or the

construction of a dedicated link from the Metrorail network could help to boost the number of rail passengers.

3.5 Conclusion

Growth has been driven by megatrends such as population growth, road congestion and urbanization. Across the province, urban sprawl and traffic congestion in cities have created a growing need for urban transportation, which in turn, creates demand for collective transportation systems.

This rapid urban growth trend, with improved effects of behavioural adaptation, congestion does not become quite as bad as expected given the magnitude of population growth, as travelers become flexible and respond by changing their departure times, routes and destinations in response to congestion ^[14].

A more corridor densification focused development trend seems to aid somewhat in reducing congestion, as does public transport investment, but much of the benefit of the latter falls on medium and high income car users who benefit from reduced congestion. It might be worthwhile to include the various scenarios in a cost benefit framework which could investigate the impacts of transferring income or assets from higher income to lower income users ^[14].

If the modal share of rail, bus and taxi on the busiest movement corridors in Gauteng is optimized such that each mode will be utilized to its capacity, then this will reinforce the potential for rail to further expand its existing market to attract new passengers.

CHAPTER 4

ECONOMIC GROWTH

4.1 Introduction

Macro-economic policies determine the parameters within which economists view other policies, including transport policies.

The concern of economists in transport policies is the provision of an efficient transport system which reduces the costs of doing business as was indicated by the former President Thabo Mbeki in his State of the Nation Address in May 2004 ^[19]. This is an ongoing concern of the government and will continue to be as the world markets globalize further, and cheaper transport alternatives for transport users emerge. Transport policy reformulation must respond to this threat to the economy of the country.

Economists also concern themselves with the ability of the population to move to areas of business where they can apply their labour and wealth to procure commodities which generate the economic wealth of the country. A united approach of both the state and the economists' desires is for an affordable provision of public transport.

4.1.1 Socio-Economic Impact

Ticket pricing policies are guided by the need to fund public transport at a cost which is socially acceptable to the commuters and which does not penalize the most underprivileged segment of the population. The role of public transport in an economic development of a metropolitan area means that the fares structure must not dismiss commuters.

Various studies undertaken by the World Bank show that if spending on transport is more than 15% of a household's income, public transport loses its appeal.

An acceptable fare can then be examined on the basis of indices of what the poorest groups of people can pay by comparing the cost of a daily return trip with the minimum household income.

It is important to consider the elasticity of demand in an economic and sociological context. The use of public transport by the middle classes is generally less affected by a rise or fall in the fare than the use by lower social classes. A high fare could therefore constitute a factor of social exclusion as it would not allow the poorest in society to easily access public transport system.

4.2 South Africa: Economy Overview

4.2.1 Economic Growth

South Africa's economy has been totally overhauled since the dawn of democracy in 1994. Bold macroeconomic reforms have boosted competitiveness, growing the economy, creating jobs and opening South Africa up to world markets ^[20].

Over the years these policies have built up a solid macroeconomic structure. Taxes have been cut, tariffs dropped, the fiscal deficit has been maintained, inflation curbed and exchange controls relaxed.

Until the global economic crisis hit South Africa in late 2008, economic growth had been steady. According to Statistics South Africa, Gross Domestic Product (GDP) rose by 2.7% in 2001, 3.7% in 2002, 3.1% in 2003, 4.9% in 2004, 5% in 2005, 5.4% in 2006, 5.1% in 2007 and 3.1% in 2008 ^[21].

From the first quarter of 1993 to the second quarter of 2008, the country enjoyed an unprecedented 62 quarters of uninterrupted economic growth. But as the crisis was felt, GDP contracted in the third and fourth quarters of 2008 where the economy officially plunged into recession. This contraction continued into the first and second quarters of 2009, with GDP growth at 6.4% and 3% respectively ^[22].

Statistic South Africa indicates that the economic growth and prudent fiscal management have seen South Africa's budget deficit drop dramatically, from 5.1% of GDP in 1993/94 to 0.5% in 2005/06, the second lowest fiscal deficit in the country's history after the 0.1% reached during the gold boom in 1980 ^[21].

In 2006/07, the country posted its first ever budget surplus, of 0.3% ^[23].

Consumer inflation came in at under 5% from 2004 through 2006 before global prices pushed it up to 6.5% in 2007. In 1994 it stood at 9.8% ^[21].

4.3 Gauteng: Economy Overview

4.3.1 Background

Gauteng has developed as the commercial and industrial hub of both South Africa and sub-Saharan Africa. Resembling the country as a whole, it has observed substantial growth over the last decade, followed by difficult conditions during the economic downturn that started in late 2008 ^[24].

The Gauteng unemployment rate had fallen by 8.1 percent between 2002 and 2007, while economic growth was an average 5.0 percent per annum over the same period. This was better than the national unemployment and Gross Domestic Products (GDP) statistics. Despite the successes, the unemployment rate has remained high, many prospective economic players are still marginalized from the economy, and many with formal wage employment are poorly paid and vulnerable. These are symptoms of deep structural weaknesses in the economy ^[24].

4.3.2 Economic Sectors

The economy of Gauteng was originally based on the mining sector, due to a wealth of natural resource endowments. Over the last century mining has provided a platform for manufacturing, trade and finance sectors. Today, Gauteng is predominantly a tertiary economy, with some of the strongest and most advanced financial and business institutions globally, and a trade sector that is unparalleled in Africa, serving the needs of both local citizens and international visitors^[24].

4.3.3 Impact of the Economic Recession

Gauteng is responsible for the bulk of South African trade, with the rest of the world, contributing around 60 percent to the national trade balance. However, export composition is still weighted towards the mining sector, coupled with strong imports of capital machinery. This, combined with other factors, has meant that Gauteng is therefore a fairly open economy, with the recent economic recession impacting the province significantly^[24].

Employment has fallen sharply over the downturn. In percentage terms the most seriously affected sectors have been agriculture and mining. Mining alone shed a third of all jobs in the province in a year. In terms of the number of jobs lost, manufacturing and trade have been the worst affected. Only the finance and business services sector continued to grow jobs^[24].

4.3.4 Unemployment Rate

Just over 25 percent of the labour force was unemployed by the end of 2009. Despite average economic growth of 5 percent through much of the 2000s, and 6.3 percent between 2005 and 2007 (the highest growth phase for the province in many years), the unemployment rate never fell below 20 percent. Nearly 3 million people in the province have no income^[25].

In addition, more than a third of the population in the province has the educational levels that range between grades 0 and 9. This is one of the contributing factors that has a direct impact to the inequality factors, that highlights the unevenness in the distribution of income and opportunities in the province and these were measured through the Gini co-efficient as 0.65 and the HDI as 0.68 ^[25].

4.3.5 Unbalanced Socio-Economic Factors

Low labour absorption rates, low levels of education, high income poverty and persistent inequality all stem from apartheid. But it is fair to say that the nature of economic growth in South Africa over the last decade has not been able to address the legacy. These structural weaknesses have simply been exposed and exacerbated by the recent global economic crisis ^[25].

4.4 Gauteng Province Economic Growth Challenges: Challenges, Risks and Obstacles

The province faces a series of challenges that will impact the economic growth. According to the Gauteng Employment, Growth and Development Strategy for 2009-2014 (GEGDS), the Gauteng economy displays the strengths and weaknesses of the national economy. An advantage of the province is that it is relatively highly developed, since it forms the mining, manufacturing and financial crux of the national economy ^[24].

However, there are three primary challenges that impact the province significantly.

Firstly, the unemployment rate (aggravated to some extent by migration into the province) is very high, as are the inequalities of income and wealth. The international crisis has exacerbated these inequalities coupled with the slowing growth of heavy industry. Secondly, the Gauteng provincial economy is largely built around emissions-intensive industries.

Thirdly, one-fifth of the population resides in the province and the financial requirements to develop the infrastructure networks are very costly, unless innovative ways are looked at in order to address this problem.

4.5 Lessons from Economic History

Economic historians have attempted to measure in many countries the impact of the diffusion of railroad networks on economic growth and development. The USA and many countries in Latin America and India witnessed rapid growth in their railroads in a comparable period ^[26].

Some of the related and interacting technical, market, and institutional developments yield additional economic effects. Like a major transformation of the regional economies in the USA ^[27].

The Gauteng strategic interventions, as suggested in the GEGDS document seeks to inform the following five strategic pillars ^[24]:

- Transforming the provincial economy through improved efficiency (economic dimension)
- Sustainable employment creation (economic dimension)
- Increasing economic equity and ownership (equality dimension)
- Investing in people (social dimension)
- Sustainable communities and social cohesion (social dimension)

These five pillars are considered to ensure convergence between the economic and social strategies of the province, underpinned by environmental strategies to ensure sustainable resource usage. The pillars assume a strong, developmental state able to intervene to shape the economy that the province needs.

4.6 Further Case Studies from other countries

In 19th century India, railroads lowered transport costs by 80% per mile.

In a separate study of factor markets in India, it showed that falling transport costs on Indian railroads facilitated regional wage convergence by facilitating both labour mobility and inter-regional commodity trade, especially in the areas surrounding the premier cities of Calcutta and Bombay ^[28].

In the late 19th and early 20th centuries European rail networks promoted market integration, based on the realization of gains from trade ^[29].

The narrowing of the commodity price increased regional specialization of production thereby improving resource allocation. In this regard, the benefits from market integration are additional to those embodied in social savings^[30], and these integration benefits lead to internal and external economies that promote efficiency and enhance production (as compared to the pre-railroad situation) ^[31].

Railroad investments in Brazil represented a purchase of specialization and enhanced productivity ^[32]. This impact was large for overland movements given the absence of an affordable alternative to railroads, which further attracted large inflows of labour and capital which were used in other activities that raised national income.

In the case of Argentina, the benefits from railroads built with British capital went largely to Argentine producers and consumers, enhanced aggregate productivity gains, and the transformation of the Argentine pampas ^[33]. The gains derived from the Spanish railroads were substantial, both through the shift from alternative modes of transport and through productivity improvements within the railroad networks.

4.7 Conclusion

Since 1994, South Africa has achieved a lot of changes from political, economic and social landscape, and has shown an increasing commitment to sustainable development. The following are key international and national milestones and drivers [34].

- The United Nations Conference on the Human Environment, Stockholm (1972), where environment was recognized as a development concern.
- The 1992 Earth Summit, where Agenda 21 was agreed upon as a blueprint for sustainable development, reflecting global consensus and political commitment to integrate environmental concerns into social and economic decision-making processes.
- A decade of UN summits and conferences between 1992 and 2002 that focused on the social, economic and environment-related fields and widened the concept of sustainable development.
- The 2000 United Nations Millennium Summit at which the Millennium Development Goals were adopted.
- The World Summit on Sustainable Development, Johannesburg (2002), which reaffirmed the commitment to sustainable development, placed poverty eradication at the centre of efforts to achieve sustainable development, and reinforced the notion of development that aims for equity within and between generations.
- South Africa's RDP with its focus on inter alia building the economy, democratizing the state and meeting basic social needs.
- The development of various social policies and strategies and the National Environmental Management Regime.
- The emergence of Institutionalized Cooperative Governance Systems and stakeholder engagement processes.
- The development of planning tools such as the National Spatial Development Perspective (NSDP) and Medium-Term Strategic Framework (MTSF),

Provincial Growth and Developmental Strategies (PGDS), Integrated Development Plans (IDP) and the Accelerated and Shared Growth Initiative of South Africa (AsgiSA).

The NSSD addresses the need to pursue and assess the key stated objective of increased economic growth via environmental integrity, social equity and economic development^[34].

Higher growth must put South Africa on a higher development trajectory that ensures overall improvement in the peoples quality of life and that protects the natural resource base for future generations^[34].

According to the NSSD, this will require communication across all levels of government and within society to build a unified commitment, to a vision that places sustainable economic growth and development at the core.

Key to overcoming the challenges of urbanization will be the economic integration of South Africa's previously disadvantaged majority. South Africa's economy has a marked duality, with a sophisticated financial and industrial economy having grown alongside an underdeveloped informal economy^[34].

While SA's financial and industrial "first economy" has an established infrastructure and economic base with great potential for further growth and development, its informal "second economy" presents both untapped potential and a developmental challenge for the country^[34].

The socio-economic challenges to economic growth were presented by the International Monetary Fund (IMF) in its 2007 annual country assessment report, the report cited that South Africa was also confronted by the long standing issue of unemployment as one of the biggest challenges to economic growth in the country, along with poverty, large wealth disparities and a high incidence of HIV/Aids^[35].

CHAPTER 5

TRANSPORT, SPATIAL PLANNING AND LAND USE

(The Case of Gautrain Rapid Rail Project)

5.1 Introduction

Several studies have examined integrated land use and transport policy strategies as a way to mitigate the transportation sector's contribution to climate change ^[26]. Some studies have examined the land use effects of climate change adaptation strategies and some impacts of transport and accessibility to land use policy strategies, on expected climate changes, i.e. limiting urbanization to the existing built up areas ^[36].

Traditional approaches to accessibility measurement are not ideal for land use policy appraisal. These accessibility measurements are often based on the 'stand-alone' transport models, and their outputs, such as travel times or costs, are used as input in the measure of consumer surplus typically applied in transport project appraisals ^[36].

An integrated land use requires that important interactions between land use and transport developments be considered. This is not only important for land use policies. Transport policies may have an impact on land use, which will in turn lead to additional costs or benefits from an integrated approach.

5.2 Public Transport's Impact on Spatial Development

As more people want to live in the suburbs more urban sprawl is created. Rapid urbanization and its associated environmental impact are posing serious challenges for South African planners and environmentalists ^[37].

Up to 16 000 ha of farmland is lost to urban development each year. Low density urban sprawl and the rapid growth of informal settlements contribute to increasing competition between urban land users for diminishing space and resources ^[37].

When travelling to the city for work or leisure, families take longer journeys by car. Traffic congestion and carbon dioxide emissions increase as a result of urban sprawl. Household transport costs also become more expensive in areas with urban sprawl ^[37].

The preservation of green areas along residential borders is an important element in regional planning.

An efficient public transport will impact positively on spatial development whereby high density areas are developed along the route.

5.3 Provincial Corridors

A number of provincial corridors serve Gauteng. This serves both a number of important residential catchments and connects with a number of employment centres, including the Blue IQ automotive cluster. The road corridor is also served by bus and taxi, whilst there is a competing rail service. The R21 corridor between Tshwane and Germiston serves Centurion, Midrand, Tembisa and Kempton Park which includes a number of employment areas. The corridor is also served by the R21 itself, the former road corridor and the rail line. Other important provincial corridors include the link from Randfontein to Johannesburg in the West Rand where rail links are more limited, the connection from Vereeniging to Johannesburg (the R59 corridor) and Siyabuswa (Kwandebele) to Tshwane (Moloto corridor).

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Figure 5.1 below, shows the Main Transport Corridors in Gauteng. These corridors are amongst the number of important movement corridors in the Province that affect national and provincial trips. Many of the provincial and national corridors are also Spatial Development Initiatives (SDIs). Gauteng is the 'heartland' of South Africa, so most national freeways converge on Gauteng.

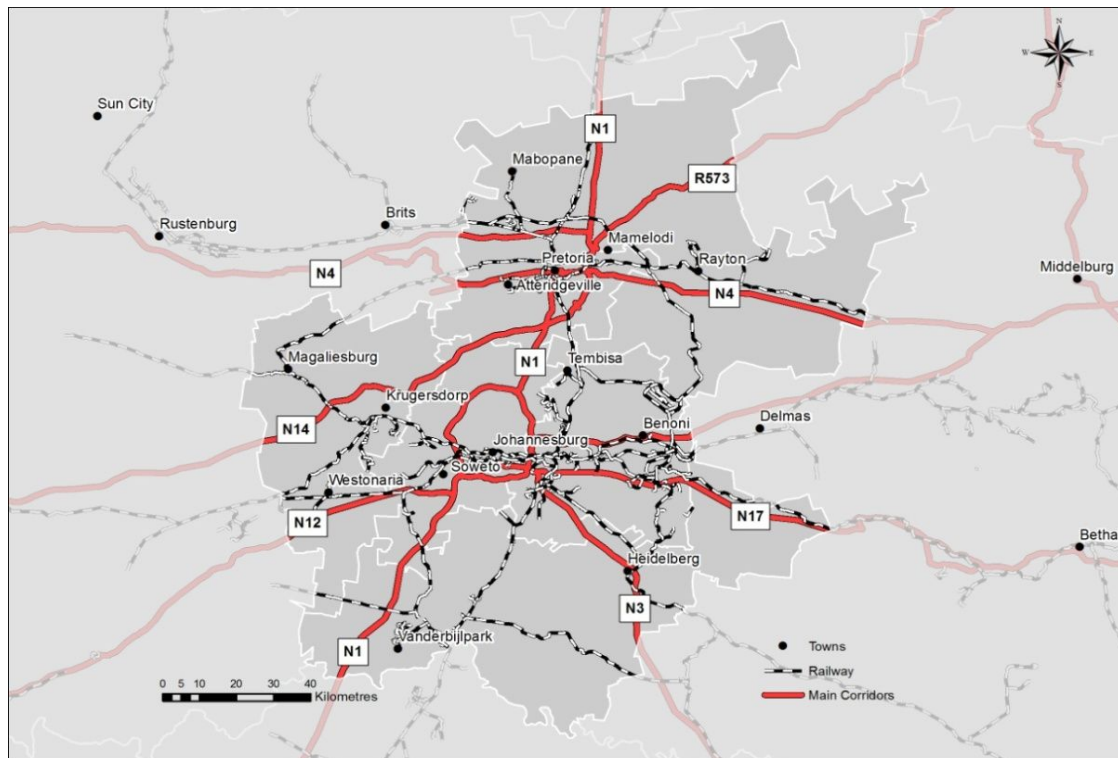


Figure 5.1 Main Transport Corridors in Gauteng (Source: Stats SA, 2007)

5.4 The Current Urban Rail: Metrorail's Status Quo

5.4.1 Overview of the Rail Network

Note - for clarity in this report 'Tshwane' refers to the larger Metropolitan Area, and 'Pretoria' to either Pretoria CBD or the PRASA/Gautrain stations.

The Metrorail network in Gauteng form a significantly more complex compared with other Metrorail networks in South Africa. There are a number of rail corridors towards central Johannesburg and Tshwane, plus various branch lines or other routes which do not serve these urban centres. The Johannesburg to Tshwane via Leralla, George Goch to Vereeniging and Tshwane to Mabopane corridors are the principal routes.

According to Metrorail, the Gauteng Metrorail network covers about 921 route km with 213 stations, including 59 serving the Tshwane routes and 154 on the Johannesburg services. Fourteen services are operated as shown in Figure 5.2 below. Approximately 1.18m passengers use Metrorail on a typical weekday^[38]. This total is about double compared with the passenger numbers using the Western Cape network, and almost four times larger versus the total rail journeys using the KZN network. Metro and Metro Plus services are available on some routes, although the latter category only accounts for about 1% of total trips. This is significantly lower compared with the proportion in the Western Cape, although this percentage is comparable to the results for KZN^[38]. The majority of trains serve all intermediate stations, although there are a small number of peak trains which adopt a skip-stop calling pattern. Similar to Cape Town, there are also two Business Express services operating in Gauteng:

- The Soweto Business Express serves Merafe, Ikwezi, Dube and Park Station in Johannesburg (Naledi corridor);
- The Tshwane to Johannesburg Business Express serves Pretoria, Centurion, Kempton Park and Park Station in Johannesburg.

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These Business Express services provide a higher quality alternative for passengers able to pay the higher fares. The Gautrain also provides a further option for passengers, given the connections at Johannesburg Park station, Rhodesfield, Pretoria and Hatfield.



Figure 5.2: Gauteng Metrorail Network (Source: Metrorail website)

5.4.2 Timetables

Table 5.1 below summarizes the number of trains per weekday (by time of day), plus the totals for Saturday and Sunday. The three corridors with the highest number of weekday trains are Johannesburg to Pretoria and Leralla, the routes between George Goch / Johannesburg and Naledi / Vereeniging, plus Pretoria to Mabopane and De Wildt.

Route	Number of Weekday Trains						Total No. of Saturday Trains	Total No. of Sunday Trains
	< 06:00	06:00-09:00	09:00-16:00	16:00-19:00	> 19:00	Total		
Johannesburg – Springs	12	12	14	12	2	52	32	24
Johannesburg - Dunswart – Daveyton	18	25	21	25	7	96	30	31
Nigel – Springs	5	7	2	6	1	21	12	n/a
Germiston – Kwesine	9	13	13	13	6	54	32	18
Johannesburg - Leralla - Pretoria	35	42	55	47	7	186	70	51
Germiston - Booyens - New Canada	5	7	3	8	1	24	14	0
George Goch - Langlaagte - Faraday - Westgate - Naledi - Vereeniging	24	38	40	38	5	145	74	44
Germiston - Kliprivier - Vereeniging	7	5	9	7	2	30	26	26
Johannesburg - Randfontein	21	29	29	28	5	112	64	60
Johannesburg - Midway - Oberholzer	2	3	1	4	0	10	5	4
Pretoria - Pienaarspoort	18	28	22	27	4	99	33	24
Pretoria - Belle Ombre - Mabopane - De Wildt	31	32	39	44	9	155	60	48
Hercules - Pienaarspoort	6	8	6	9	1	30	48	10
Pretoria - Saulsville	13	12	13	17	5	60	33	13

Table 5.1: The Number of Commuter Rail Services – July 2010

Source: Metrorail Website (2010 Timetables)

Although there are minor differences for individual routes, the number of trains on Saturday is about 50% lower compared with the weekday total, whilst the total for Sunday is about 30% less than the number for Saturday.

The comparison of train frequencies in 2007 and 2010 demonstrated there was a significant reduction in number of trains operated in the former period versus the total for the latter. In particular, there has been a substantial reduction in the number of trains affecting the George Goch to Naledi / Vereeniging route between 2007 and 2010. Other routes affected by a large reduction in train frequencies include Germiston to Vereeniging^[38].

In contrast, the number of trains between Johannesburg and Pretoria via Leralla remained constant during this period highlighting the importance of this route. The number of trains per weekday between Johannesburg to Randfontein and Pretoria to Pienaarspoort has broadly doubled in response to demand growth.

Figure 5.3 illustrates the busiest stations in Johannesburg, with the size of each circle proportional to the daily usage of each station. The areas shaded in blue and red indicate the percentage of trips boarding or alighting respectively. The busiest stations include Johannesburg (170,000 daily trips), Germiston (121,000), Kempton Park (65,000) and New Canada (63,000)^[39].

The stations used by the largest number of passengers in Tshwane are shown in Figure 5.4 below and includes Pretoria (132,000 daily trips), Mabopane (64,000) and Saulsville (32,000)^[39]. In Johannesburg, demand is more evenly spread across a number of stations, including some which are adjacent to employment centres. This reinforces the spatial trends which highlights the polycentric employment patterns. In contrast, the results for Tshwane demonstrate demand is mainly focus towards two stations.

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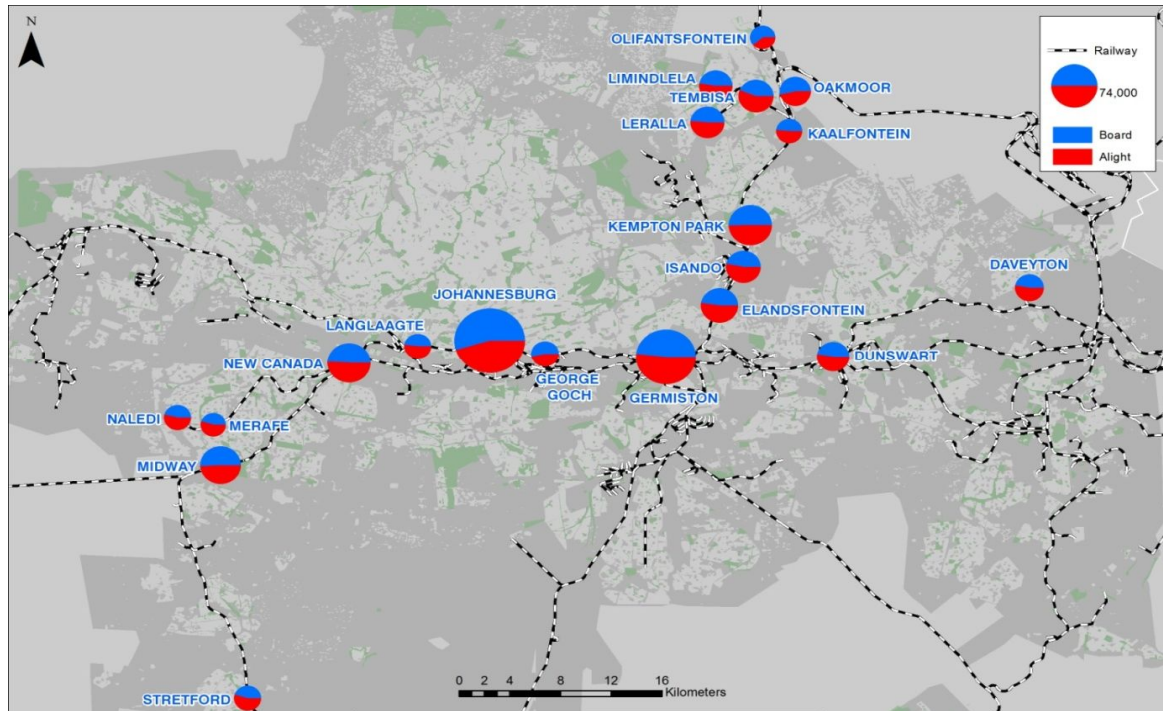


Figure 5.3 Busiest Stations in Johannesburg (Analysis of the 2007 Rail Census)

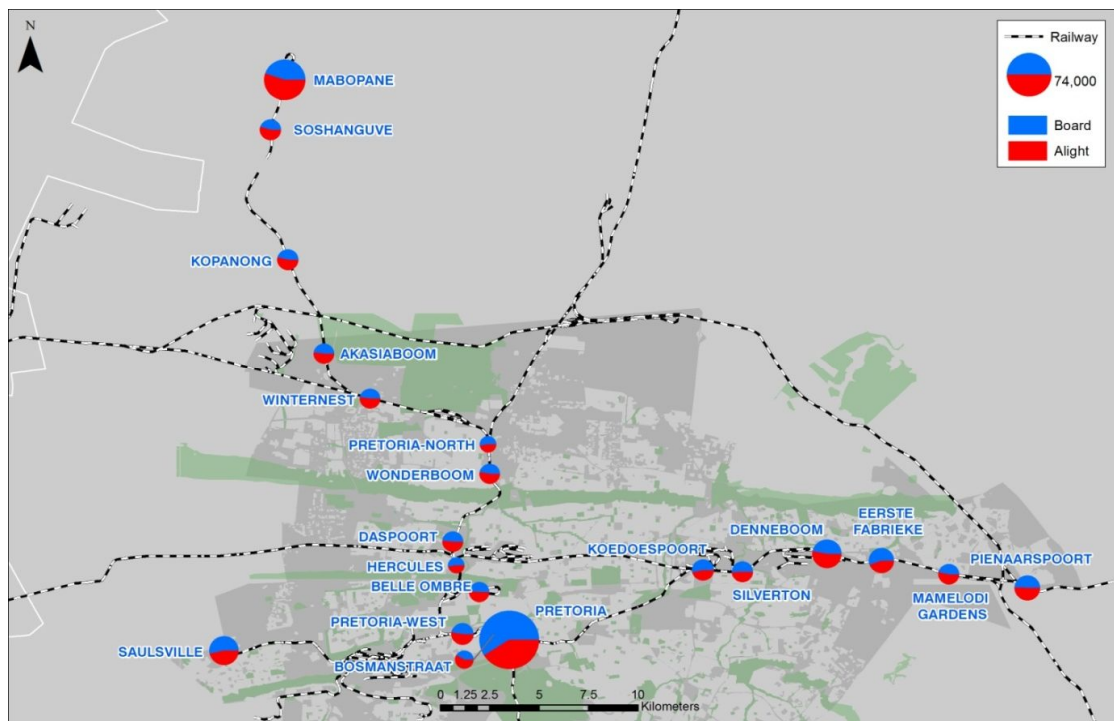


Figure 5.4 Busiest Stations in Tshwane (Analysis of the 2007 Rail Census)

5.4.3 Overall Trends

Both the Johannesburg and Pretoria networks attracted an extra 10-15% of passengers in September 2007 compared with March 2006. A combination of economic growth and maintaining fares contributed to this outcome ^[38].

According to Metrorail, there was an exception of a small increase during early 2009, the number of passenger journeys in Pretoria stabilised compared with the September 2007 patronage levels. In contrast, usage of the Johannesburg continued to rise until 2009, with a 30% increase compared with March 2006 ^[38]. A significant employment growth at Midway and Kempton Park, at locations adjacent to the railway has contributed to this outcome.

There was a significant reduction in trips affecting both networks between March 2010 and March 2011. There was a 40% drop in trips in Johannesburg and a 30% reduction in Pretoria during this 12 month period ^[38]. A tightening of the economy, fare increases, changes to security levels and revenue enforcement has contributed to the decreases. The reduction in rolling stock availability was the main contributory factor. However, the change in revenue has been smaller, demonstrating the impact of revenue protection measures and fare increases.

5.4.4 Impact on Rail Demand

In the context of the present study, the impact of rapid urban growth on the commuter rail is to inform an assessment of what role commuter rail should play in Gauteng in the coming decades. This analysis is the main subject of the study and a number of important principles can be suggested. This includes:

- The primary nodal structure of the Gauteng city region is likely to remain broadly the same as it is now but with a number of additional economic nodes emerging.

- Much of the existing Metrorail network will continue to enjoy a good 'fit' with residential and economic nodes that will grow in coming decades.
- Significant adjustments and / or extensions to the Metrorail network could further enhance the fit between transport services and growing residential nodes
- The Gautrain network fits well both with the commercial nodes that will retain their dominance and also with strongly emerging economic nodes.

Given the relatively good fit between rail networks and policy prioritised growth areas, the critical issue facing PRASA in Gauteng is how it can capitalise on these opportunities, rather than lose further market share to other transport modes.

The first phases of the BRT network (particularly in Johannesburg, now supplement rail on certain corridors but will take market share away from rail if the service levels do not improve) in subsequent development phases, will provide public transport to nodes currently not served by rail.

The minibus-taxi industry remains the strongest, most flexible mode of transport in the Province. Again, rail will lose market share to this mode as people's incomes increase – unless rail's capacity and reliability improves radically.

The Gauteng Freeway Improvement Project is almost complete and together with its proposed tolling, presents both a threat and an opportunity to rail:

A threat: because of the anticipated improved traffic conditions and lower tolls payable by public transport, this will enhance the competitiveness of these modes.

An opportunity: the higher immediate financial costs associated with use of private cars will improve the relative competitiveness of rail.

Gautrain presents both a threat and an opportunity to Metrorail/PRASA:

On the Pretoria-Johannesburg route, Gautrain services offer a far superior service to Metrorail, making it more difficult for PRASA to attract users.

Interchange options at Hatfield, Pretoria, and Rhodesfield and Park stations mean that opportunities will be available, with good timetable planning and proactive service marketing, to create synergies between the two services.

The Rhodesfield station could be used to provide a bus link to OR Tambo, for air passengers or airport workers, but has almost no relevance.

The key challenge, not only for rail but for all public transport service offerings in the Province, will be to identify and implement strategies that permit each transport mode to perform to its strengths and manage its weaknesses. While the details of how to achieve the optimum role for rail in Gauteng will be the proper subject, the following principles can be set forth as a basis for this rail exercise:

- Using each transport mode in roles that optimise its technological economies;
- Making the most of interchange options to capture integration economies;
- Focusing public transport services on the strongest development nodes to capture urban economic productivity gains – or agglomeration economies;
- Using public transport to support trends towards and policies supportive of densification in order to achieve operational and infrastructural efficiencies.

In these ways, the future role of commuter rail in the Gauteng Province can be strengthened. In addition to positive guiding principles such as those listed above, it will also be necessary for certain negative principles for mitigation:

Income levels are rising thus strengthening current trends away from rail and indeed away from public transport as a whole.

Provincial and national housing strategies which result in continued development in peripheral areas at very low densities will make high capacity public transport services such as rail, increasingly unviable.

If the existing commuter rail network is to recover lost ground and develop a stronger role in supporting social and economic development in the Province, PRASA will have to strengthen the relationship with all spheres of government to ensure that there is focus on inclusiveness, equity and sustainable agreements.

What these positive and negative principles mean is that there are some 'drivers of change' in Gauteng that could assist a commuter rail renaissance and others which are undermining it. The potential for a much greater role for rail is possible in the future.

5.5 Urban Rapid Rail: The Case of Gautrain Rapid Rail

Gauteng, the country's economic hub, is currently experiencing traffic congestion on its major routes, especially between Pretoria and Johannesburg, as illustrated below by Exhibit 5.1. The current transport facilities and services between these two cities are mainly road based. The land required for a rapid rail system is far less than that of a road system. Apart from alleviating the severe traffic congestion, economic development will be stimulated by the rapid rail system and it will have distinct environmental advantages over other modes of transport.



Exhibit 5.1: Traffic flow on the M1 carriage way ^[37]

The Gautrain is aimed at providing an alternative public transport mode to car users and therefore to attract private car users to the train. This service will help alleviate the congestion on the roads between Johannesburg and Pretoria.

According to the Gautrain publications, the traffic congestion on the N1 Freeway was estimated to cost more than R300 million per year, including production time lost during travelling time, higher transport costs and above average accident rates. Furthermore, traffic congestion impacts negatively on the quality of life. The carbon emissions from vehicles also increase levels of pollution ^[37].

5.6 Spatial Development Planning

The Gautrain's role in the spatial development of Gauteng was assessed to the extent in which Gautrain meets current planning criteria. The project is expected to facilitate new spatial development in the Province.

5.6.1 Gautrain Spatial foundation

The establishment of Gautrain and all spatial planning is embedded in two parallel strategies that were initiated by the Gauteng Provincial Government. The first strategy is the Gauteng Spatial Development Framework (GSDF) 2000 and the second strategy is the Gauteng Spatial Development Initiatives (SDIs).

Both strategies seek sound provincial development. The end results of these two strategies are aligned, both intending to direct the Province towards efficient and effective form. The GSDF focused on achieving development by implementing spatial planning principles and improving the urban form and the SDIs focused on achieving development through economic growth, direct investment and in creating a smart Province ^[40].

The GSDF based the Province's future development on the five critical factors, which are:

- **Resource-based economic development:** Urban advancement cannot be achieved without economic growth and economic growth can best be achieved if prevailing resources are used, which is a principle of both the SDIs and the GSDF. The Gautrain aims to achieve economic development as a spin-off, is in itself an economic project which will achieve direct investment and will connect the core economic areas (viz. the resources) of the Province ^[40].
- **Contained urban growth:** Sprawl and unnecessary urban expansion are widely discouraged, owing to direct and indirect costs to government and distortion of the urban form. To contain unwanted growth, a provincial urban edge has been delineated, which aims to compact the province, improve the utilization of resources, preserve the rural environment and give structure and form to the cities. However, compact form is not only dependant on an urban edge, but is also dependant on urban intervention elements such as the

Gautrain, which fundamentally necessitates increased densities to enhance feasibility^[40].

- **Re-direction of urban growth:** The current settlement pattern cannot be sustained in the future and in ensuring a new pattern of settlement a catalytic development element, such as the Gautrain, is required. The proposed Gautrain Rapid Rail Link will be adjacent with existing and future urban areas and will, therefore, impact on the future composition of these areas. Since the rapid rail system wants to achieve high levels of ridership, urban structure and density will have to be revised^[40].
- **Rural development beyond the urban edge:** Rural development is to be protected by the urban edge, thereby creating distinctive urban and rural areas. The Gautrain will not serve the rural areas and will therefore, on the one hand strengthen the urban area and on the other hand promote rural retention^[40].
- **Mobility and accessibility:** The GSDF indicates that people in Gauteng will always be reliant on a high level of mobility and accessibility because of the presently dispersed settlement pattern and a culture of private transport. Mobility must be enhanced to improve the movement of people, goods and services, both for public and private transport. But owing to ever increasing road congestion authorities are forced to introduce alternative means of public transport of which a rapid rail system is the most obvious solution^[40].

The above are evidences that the Gautrain is in line with the fundamental spatial planning principles that underpin the GSDF and that such a system will complement the existing and new urban form and in fact, expedite transformation of the old to the new desired urban form^[37].

5.6.2 Creating the new urban form

The Gautrain project is envisaged to respond to the rapid urban growth and to be highly influential in shaping the future urban form in its proximity, firstly the rail corridor is on the core economic area of the Province, secondly it brings many

development opportunities which the private market is certain to identify and explore and thirdly density and land use changes are inevitable. Thus, a medium to long term outcome of the Gautrain will be the creation of a new urban form ^[37].

The new urban form will centre on the two key spatial components of the Gautrain, viz. the stations and the railway line, each having different developmental requirements and thus having different spatial impressions.

Guidelines for new socio-economic developments are ^[37]:

- Economic and employment opportunities must exist and should be provided.
- General amenities should be located within or near to the node to improve access and reduce private transport.
- The areas should cater for a mix of income groups (not only low or high income residents).
- The target for residential densification should be set at a gross residential density of at least 20 dwelling units per hectare within the new developed areas over the next 10 years.
- The residential areas should consist of three to four storey buildings (not town houses or single residential units). This is a minimum requirement and can be increased to achieve more efficient urban spaces.
- An inward focus for the commuter rail should be encouraged.

5.6.3 Principles of spatial development along the railway line

Private transport is increasingly becoming the desired mode of transport because it grants freedom of movement. Movement is determined by roads which essentially relate to a network system and the provincial network facilitates sprawl at a regional level as illustrated in Figure 5.5 below.

Urban development has seldom been hindered and so typically occurred in a concentric fashion radiating out from the development centre. Not being confined by

an urban edge or development perimeter new nodes developed on the outskirts of existing nodes and so sprawl thrived^[37].

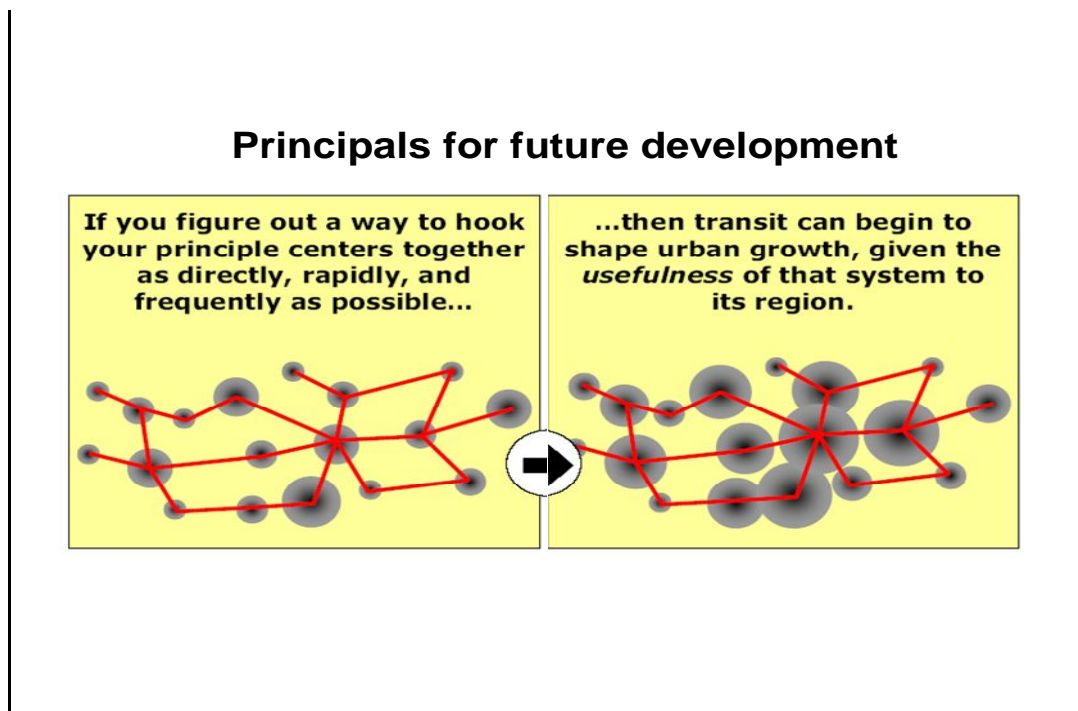


Figure 5.5: Principles for future developments

The Gautrain endeavors' to change this 'free' pattern of development within its proximity by defining a development edge, in which, nodal development will radiate an integrated public transport corridor. In effect feeders to railway corridor will be established from other public transport modes and the nodal points will provide socio-economic opportunities such as Transit Oriented Development (TOD) facilities. See Figure 5.6 below.

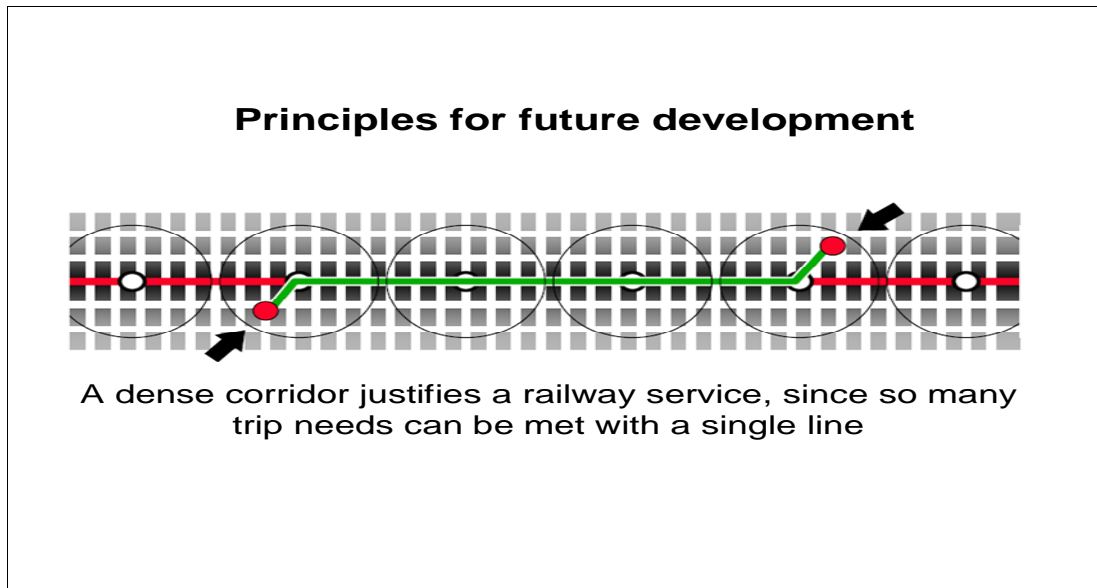


Figure 5.6: Principles for future development

Thus, future spatial development with respect to commuter rail should be outlined to define a corridor of intensive urban development.

5.6.4 The concept of spatial development

The study area comprises three established municipalities, City of Johannesburg (CoJ), City of Ekurhuleni and City of Tshwane (CoT), which are the cornerstones of economic activity in the Gauteng Province. Transforming established areas is more difficult than less developed or undeveloped areas. Accordingly policies must be formulated and implemented for densification. This will be particularly important in proximity to the stations, where both increased densities and a mix of uses are desirable^[37].

CoJ and CoT are connected by the north-south corridor of N1 and R21. The latter, is linking up with the R24 via OR Tambo International Airport. At the midpoint of this connection is Kempton Park in CoE. The east-west link is still lacking behind.

Developments are taking place along these major connecting roads to establish new, highly accessible nodes. Mobility, accessibility and visibility are real economic

variables that have influenced the location of industries and businesses, hence influencing spatial form. The latter has resulted in the development of places such as Centurion, Midrand, Linbro Park, Spartan and Isando. Hence, between the north and the south corridor, new centres are being developed due to rapid growth, to strengthen the connections. These developments offer the greatest opportunity for intervention and for establishing a new urban form and spatial pattern^[40].

5.6.5 Spatial concept of the stations

It is reasoned that the stations may have a greater spatial role than the railway line because the stations are the point of contact between the train and the urban environment and between the users and the transportation system. Thus, the stations are the key intervention area to create a new spatial environment / urban form. The critical focus is to achieve ridership or patronage with a view of creating long-term sustainability. Ridership can be created by improving access to the train through effective feeder and distribution services and or by developing the right type, mix and density of uses around the station^[37].

5.7 Land Use

In catering for the housing demands, housing projects are located at the urban fringe away from economic opportunities^[41]. The mass low-cost housing delivery persisted along the urban fringe because of the unavailability of cheap land close to centres of employment opportunities^[42]. The poor location of low-cost housing and the increased levels of urbanization in the city are seen to be worsening the housing backlog, public transport system and socio-economic condition of the poor.

Figure 5.7 shows the land use and simple type of spatial planning framework that was devised to separate neighborhoods racially and the impacts it had on the communities.

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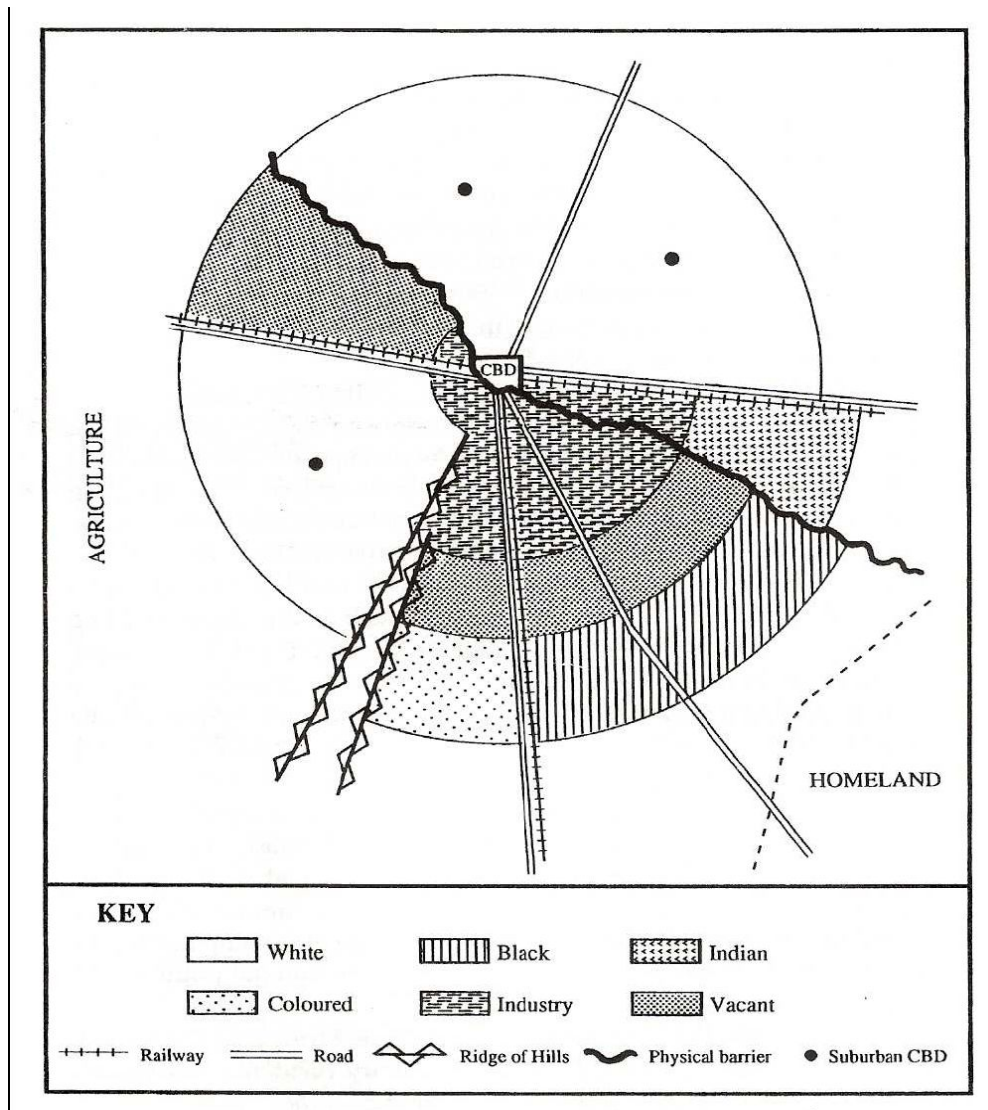


Figure 5.7: The simple type of spatial planning framework ^[3]

The structure of the urban spatial structure of a city is underpinned by the impact of the CBD, i.e. the centre of higher land value than its peripherals. Theories and empirical studies explaining the existence and impact of a CBD almost always rest on commuting costs, job availability, social factors and demographics ^[43]. Furthermore, household location choice studies often found downward sloping housing price gradients originated from the CBD ^[44].

Traditional analyses of household location choice assumed zero variance of commuting cost savings, thus predicting the downward price gradient from the CBD ^[45]. However, in case of multiple workplaces and hence a polycentric city, with uncertain commuting frequency, i.e. when the variance of commuting cost savings is not negligible, the best strategy is not to select household location close to a business centre or the CBD but locate in-between the many workplaces, which offer the commuter the same benefits as holding a portfolio of investments ^[46].

This theory predicts the formation of new centres in-between existing centres, which agrees closely with intuition and casual observation. Pragmatic evidence to this theory is the case of Midrand and Centurion in Gauteng.

The determinants of the location of a CBD are often explained by the competition of accessibility, but many early studies assumed monocentric situation, i.e. one-centre only ^[47]. However, a polycentric hierarchy of market centres had been observed ^[48]. More and more recent studies emphasize the polycentric framework ^[49]. For example, theories of the existence of many centres in a city ^[50]; the empirically price gradients ^[51] between centres were tested ^[52] and refined polycentric models of cities were developed ^[53-59].

However, their rationale of polycentric structure relies on the decentralization of business activities due to the technology development of communication and transportation.

For example, in Los Angeles, a generalized employment dispersion trend was found ^[60] and yet, these trends did not differentiate between single workplace and multiple workplaces for each employee in their studies ^[61]. A more comprehensive review of these studies in which these trends could be clearly differentiated was conducted by Yiu and Tam ^[62].

However, the rapid decentralization of economic activity and the availability of transport mean that classical negative price gradient no longer fits distances from

many employment centres. A sub-centre employment is widely dispersed and households may have distinctive preferences for particular locations ^[63]. It is also contended that improvements in telecommunications and transportation have aided suburbanization of households ^[64]. Decentralization of employment along with high levels of car ownership would seem to not only result in edge cities, but also create the multiple workplaces as an important feature ^[65].

5.7.1 Station development principles

The following essential principles relate to station development and will therefore inform land use and spatial form:

5.7.1.1 Densities

A certain density should exist or be attainable to ensure that there are or will be enough people within a determined catchment area who will use the train. The more densely populated an area, the higher its potential ridership. According to international examples, a gross density of ± 25 dwelling units per hectare should be able to attain acceptable ridership levels. Without sufficient density, proper feeder and distribution systems become critical ^[37].

5.7.1.2 Access to the station

Access determines the ease with which people can reach the station to use the rail as a means of transport. In areas of dispersed settlement, access is more complex because the time, money and effort incurred to reach the station is higher than in densely populated areas. To promote access in less dense areas, complex feeder and distribution systems need to be established to facilitate access to the station, whereas, in concentrated areas, people can effectively reach the station by walking, requiring limited expenditure. However, walking is restricted to a defined area because people are seldom willing to walk for longer than five or ten minutes to reach the station. Thus the area of high density must be no more than ten minutes walk from the station or within 1km radius ^[37].

5.7.1.3 Land Use Patterns: Influence on different types of trips

Land use influences ridership and hence appropriate uses should be established to advance ridership and to achieve densities. Residential development (with the correct density) is the prime land use for trip generation, because people need to move around. Therefore, property developments in and around the stations area and along the length of the corridor is important.

Development of the Retail sites will generate more trips per unit than office space, indicating that retail facilities can act as anchors to encourage ridership to a specific destination (station). This type of ridership also occurs during off-peak periods. Compared to retail space, office space has higher peak period trips, as people travel to and from work on a daily basis. To achieve office-based travel, good feeder and distribution systems must be provided, as well as ample parking, park-and-ride facilities and safe walking areas. Manufacturing and warehousing have a limited impact on train trips, possibly because of the reduced density of people in these establishments ^[37].

It is evident that a land use mix is desirable to ensure that each station can act as an origin and destination and that two-way travel is achieved which makes the rail system more cost effective.

The following should be undertaken where station development is concerned ^[37]:

- Maximize ridership
- Increase residential densities
- Strengthen existing land uses and
- Increase the land use mix.

Applying the above will certainly lead to the creation of a different more intense urban form particularly around the stations.

5.8. A Sustainable Urban Rapid Rail System

The Gautrain has aligned itself with prevailing planning principles viz. the GSDF and SDI's. To comprehend the inevitable and desired changes a spatial concept was formulated, which encourages the creation of a new urban form capable of sustaining the rapid rail system and achieving economic upliftment by producing a more effective and efficient urban environment.

Figure 5.8 shows two scenarios where rail and bus are compared. It is evident that rail as a backbone can provide many advantages to the public transport arena because of its characteristics of promoting the socio-economic aspects amongst communities. Rail as a mass mover requires less land reserve and has a low carbon footprint.

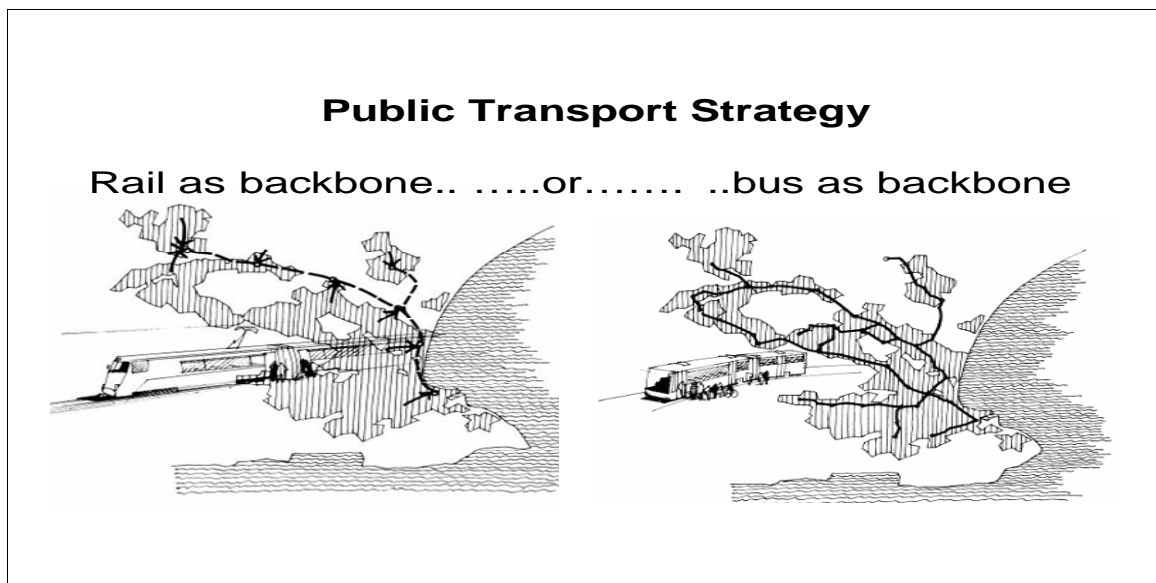


Figure 5.8: The interrelationship on spatial and land use with respect to transport planning

The development pattern described above is underpinned by economic criteria and the present road network system. The Gautrain rail system is expected to strengthen the development pattern, as it will enhance access, mobility and visibility. In addition, like the road network system, the rail will have a linear alignment and will therefore promote the creation of a linear urban form.

By a linear urban form it is meant that rail will be aligned with land use patterns, where other modes of transport will be encouraged to feed into the mainstream rail network. This will be achieved by reducing duplication of resources for the same travel purpose, hence the concept of corridor densification.

The functioning and sustainability of the rail system will depend on ridership. Hence, it is important that the urban form be compacted along the central spine to create a high intensity urban environment ^[37].

Within this urban spine, nodal points should be developed, where they will represent the centre of economic activity, around which high-density residential development takes place.

In view of these new developments, the nature of housing consumption above, it was recognized that households do not know all the factors with certainty when making housing consumption and location decisions.

Hence, the introduction of uncertainty into the urban location theory then blossomed. They can be categorized into four types of uncertainty, namely:

- (1) Uncertainty in income ^[66-69]
- (2) Uncertainty in housing user cost ^[68-69]
- (3) Uncertainty in transportation cost ^[68-70]
- (4) Uncertainty in quality and neighborhood externalities ^[71]

Incorporating these uncertainties into the urban location model, however, does not affect the general downward sloping bid-rent curve from the CBD ^[72].

5.9 Planning Principles

As part of a planning framework, the rules need to be based on principles that are general enough to be interpreted in different contexts but specific enough to inform decision-making. Below are some of the suggested principles for a sustainable transport planning that the authorities/policies will need to address ^[73].

- Preserve the natural environment
- Maintain human health and safety
- Meet the travel needs of the population
- Support a good economy
- Minimize transport costs for access and mobility
- Minimize infrastructure costs
- Maintain energy security

The Public Transport Strategy aims to accelerate the improvement in public transport by establishing Integrated Rapid Public Transport Networks (IRPTNs), which will introduce priority rail corridors and BRT systems in cities ^[74].

5.10 Conclusion

It is concluded that the stations are critical city structuring elements. The present urban environments have insufficient density and mix of uses to achieve desired ridership and hence, intervention in station areas will be required. This intervention will lead to the creation of changed urban environments and hence, the rail network will have a definite impact on the spatial development of the core economic areas of the Province.

However, it should be noted that the Gautrain and its outcomes will be realised in the medium to long term, but such intervention is needed today to ensure a better tomorrow.

Cognisance should be taken that the rail system will not and cannot replace the extensive road systems that exist, but the two should operate in support of one another to establish an integrated modal system.

The interrelationship on the spatial planning and land use with respect to transport planning cannot be over emphasized because of the contributions to the socio-economic benefits to the communities. This can be supported by the fact that rail use less land reserve and has minimal carbon footprints in comparison to road transportation.

A rail network takes up less space than would be the case if the existing road surface was simply increased. High-density, mixed-mode developments are preferred to uncontrolled urban sprawl. In the case of Gautrain, these developments have already started to take place along the route^[37].

CHAPTER 6

ANALYSIS OF THE RESEARCH FINDINGS

6.1 The Public Transport Strategy

The Public Transport Strategy aims to accelerate the improvement in public transport by establishing Integrated Rapid Public Transport Networks (IRPTNs), which will introduce priority rail corridors and BRT systems in cities.

These networks comprise of an integrated package of rapid rail, BRT and taxi and metered taxi priority networks, especially in major cities. The strategy is expected to improve public-transport services for over half the country's population.

The Gautrain Project is envisaged to reduce the severe traffic congestion along the Johannesburg-Pretoria corridor. It is estimated that the Gautrain Rapid Rail Link will reduce this (approximately 300 000 vehicles per day) congestion by 20%.

6.2 Public Transport

The public transport system contributes significantly to shaping the provincial infrastructure interconnectivity. The viability of a public transport system rests on the number of commuters using a system. As such densification of land uses, especially housing and mixed uses at and along public transport nodes is strongly encouraged.

Due to the influx and rapid urban growth in the province, an efficient public transport system is crucial for the integration of urban spaces and to contribute significantly to the efficiency of the provincial system. In addition, efficient public transport will assist in reducing the number of vehicles on the road and contributes to a safe and more secure environment.

The planning strategies seek to address the following questions which relate to a sustainable public transport system:

- Proximity of public transport facilities and services to residential and non-residential developments
- Access to a choice of public transport facilities and services (BRT, Bus, Rail & taxi-rank)
- Walkability and the distance to two or more local amenities and services (e.g. schools, police stations, clinics, post offices, libraries, sports fields, parks, residential developments & retail stores etc)
- Walkability and the distance to employment opportunities (mix uses, offices, industrial parks, nodes etc)

6.3 State of Commuter Rail in South Africa

Internal: Commuter rail in South Africa is facing many challenges as a result of inadequate investment in rail infrastructure, operations, ageing train fleet (rolling stock) and the severe shortage of managerial and technical skills.

Limited coverage has also meant that rail lost a significant market share as a result of commuter rail services that fail to respond adequately to passenger demands.

The under-investment of almost 30 years has resulted in a situation where services are experiencing continued decline in the availability of rolling stock. The condition of the rolling stock is deteriorating faster than the rate of overhauls. Unless the rate of overhauls can be greatly accelerated in the short-term, the level of services is expected to deteriorate. The impact of this means that commuter rail will eventually lose its public transport market share in the long term.

External: Commuter rail has the potential to be the most efficient, affordable and safe mode of public transport. It could form the backbone of an efficient and reliable public transport system. With its fixed nature, rail has the potential to defend the urban edge and ensure greater integration between land use planning and transport infrastructure provision.

This is vital to creating sustainable communities where people's access to economic and social opportunities is enhanced.

6.4 Positioning Rail for Competitiveness and Sustainability

Rail is inherently competitive when it exploits the strengths of its three genetic technologies which are

- Bearing, or carrying heavy axle load,
- Guiding, or travelling at high speed, and
- Coupling, or linking coaches to raise capacity.

Noting that Metrorail has comparatively light axle load, and operates at low speed ($\approx 80\text{km/h}$), its high-capacity competitive advantage is derived from coupling the coaches together.

At the low speed end, weakly positioned Metrorail applications are vulnerable. Firstly, if potential traffic is insufficient to support high axle load, then rubber tyred mass transit solutions suffice. Hence, BRT threatens rail's market share.

Secondly, automated rubber tyred guided vehicles emulate rail's high capacity by offering extremely short headways, i.e. virtual coupling. It is no surprise therefore that CoJ have started implementing BRT.

Contrary to Gautrain, that is positively influencing its environs by adding value through stimulating development around stations. This distinction between rail and road transport is crucial.

At the high-speed end, rail exploits its guiding genetic technology robustly, and to a lesser extent its coupling genetic technology. South Africa's topical debate and speculation is understandable, but much work remains before strategic direction can emerge.

Apart from alleviating the severe road traffic congestion as a result of urbanization, economic development will be stimulated by the rapid rail system and it will have distinct environmental advantages over other forms of transport.

In achieving the above, much of the increase will be to accelerate rolling stock upgrades and upgrade of the signaling and telecommunications system. A top priority of PRASA will be to explore ways of increasing the role of private sector funding, with special focus on recapitalization of the fleet and supply chain process.

6.5 Population growth

The analysis presented in Chapter 3 highlights the fact that there are several important implications emerging from the spatial planning forecasts covering housing and population growth. The relative shortage of suitable land in central Johannesburg and Pretoria means that the majority of new employment sites will be located elsewhere, thus reinforcing the current polycentric development patterns. The main out-of centre employment locations currently include Germiston, Kempton Park and parts of Soweto. Some of the future growth will be allocated to these areas, but other locations including Midrand and parts of Ekurhuleni will be affected by significant employment proposals. This type of spatial pattern will highlight the importance of delivering improved rail connectivity to these stations through a package of service changes. In addition, more convenient modal

integration will be essential to connect the railway stations with these development sites using minibus taxis, buses and other travel choices in order to widen the catchment.

It is also worth commenting on the distribution of future housing growth. Although the overall change in population for Johannesburg is limited, it is expected that a number of informal settlements will be consolidated to locations adjacent to rail corridors. This should help to boost the size of catchments accessible by rail. Other housing developments will inevitably exacerbate the existing crowding problems. Corridors where crowding problems are relatively modest will also be affected by the incremental changes in passenger demand and necessitate interventions which deliver capacity improvements.

6.6 Modal Choice

There are many factors that affect travelers' choices among available intercity travel modes. It is found that travelers make mode choices very differently depending on whether the trip is for a business or non-business purpose. Non-business travelers are highly sensitive to price and less responsive to travel time reductions, while business travelers place a high value on their time, and are, therefore, more responsive to travel time as a factor in mode choice. As a result, the High Speed Train (HST) service combination of higher fares than conventional rail in return for less travel time is much more appealing to business travelers than non-business travelers.

Considering the high price sensitivity of non-business travelers, many of whom currently travel by cars, HST is unlikely to succeed in capturing a major share of non-business travel, unless the consumer perception of HST travel can be shifted fundamentally in a positive direction. Diversions of travelers to/from O.R. Tambo International airport to/from HST would be significant, making the cross-modal policy implications of HST more serious.

CHAPTER 7

CONCLUSIONS and RECOMMENDATION

7.1. Conclusions

7.1.1 Overarching Spatial Objectives

Before considering the potential drivers of change which could affect the busiest public transport corridors, it is useful to review the strategic spatial objectives that will help to shape future housing and economic growth. A series of objectives have been developed and these comprise some important principles to shape the spatial development frameworks in Gauteng:

The promotion of land use densification to utilise resources more efficiently, including trends towards higher-density cluster or affordable residential development based on densities of 25 to 40 units/ha (net). It may be possible to further increase the intensity of urban development over time as urbanisation and population increases occur.

The integration of economically disadvantaged communities into the urban system, particularly those on the periphery of the system should be enhanced.

The promotion of viable public transport systems to reduce reliance on private cars and supported by a hierarchy of nodes to help improve linkages and connectivity.

Mass public transport should help to accommodate urbanisation trends and help shape more economically efficient spatial patterns with feeder services developed to widen the potential catchments.

The objectives set out in the Gauteng Strategic Public Transport Network generally support these overarching principles. However, lack of implementation continues to be a challenge. It is worthwhile noting the development concept for the plan and to assess its implications for the role of rail. Mass public transport is used as a

fundamental shaper of the urban logic with the existing rail systems and now, more recently, the BRT routes, forming the basis of the movement system.

7.1.2 Impact of Forecast Population Growth

The horizontal spatial extent of the urban system is kept tight and an urban edge is placed on outward sprawl. The intensity of urban development and the densities at which people are accommodated within the urban area are increased significantly through time as population increases.

The following summarises the implications for the main population catchments:

Johannesburg: There is a focus on locating new housing development close to existing Metrorail corridors as part of a strategy to promote infill development and densification along priority public transport routes. The additional demand will help to strengthen patronage on existing Metrorail corridors and create a framework to deliver service improvements. This growth in demand is likely to drive the need for new stations to serve emerging developments.

Furthermore, some housing development will be located adjacent to the proposed Gautrain and the proposed Bus Rapid Transit routes. Whilst some of the higher income households will be located in this area are remote from the Metrorail, the proximity to public transport corridors will be less important. These households will have higher levels of car ownership, so their likelihood of using Metrorail will be reduced.

Tshwane: Similar to Johannesburg, the population growth forecast is expected to be delivered on a number of corridors. Some of the housing development will result in strengthening the case for rail improvements on these corridors.

Ekurhuleni: There are four main locations for housing growth including Daveyton-Etawatwa, Tembisa, Katorus and Kwatsaduza. Most of these catchments are already served by Metrorail, but the extra passengers generated from the housing growth could necessitate further service improvements in due course.

7.1.3 Economic Activity and Employment

The discussion in Chapter 4 highlighted the importance of Gauteng's contribution to the overall economic position in South Africa and this trend is expected to continue.

About 58% of the population in Gauteng is economically active, and the delivery of various policy initiatives could help to further reduce unemployment rates in Gauteng.

If realised, these trends will lead to changes in the social structure of transport demand with a larger proportion of the travelling public being in a position to exercise choice about the transport mode they wish to use. A key challenge for rail will be to provide the necessary service level improvements to enable it to retain, and hopefully also to grow, its market share.

An analysis of the spatial distribution of economic activity confirms that the principal nodes are Tshwane CBD, the Johannesburg CBD and OR Tambo International Airport. Although the Johannesburg CBD has experienced a major slump in building occupancy rates in recent years, there is a renewed interest with major investment planned for the CBD. The majority of new property investment in recent years has been constructed in the central, northern and the north-western parts of the City of Johannesburg including Midrand, displacing sites at other locations.

Mixed-use developments are concentrated in the City of Johannesburg and the City of Tshwane and are located along main roads in high-income areas in these two municipalities (far removed from the rail infrastructure).

It is worth highlighting the polycentric development patterns. The analysis of the drivers of change strongly reinforces these outcomes. Retail and office activities are predominantly concentrated in the central parts, plus the south-eastern suburbs of Tshwane and in the central part and the north-western suburbs of Johannesburg. The areas east of Johannesburg and the western parts of Ekurhuleni are characterised by a high concentration of industrial uses. In Sedibeng, there are also concentrations of industrial areas.

7.2 Recommendations

7.2.1 Ensure long term viability of the public transport system

Transport infrastructure needs to be continuously maintained and as an integrated system, all components must work together for optimum effectiveness.

Figure 7.1 illustrates the modal efficiency^[75] in terms of the required viable operating environment for all modes and integrated land use and transport planning.

From a Socio-Economic and Environmental impact viewpoint, defined attributes of a sustainable transport system are consisting of sufficient fuel for the future, minimal pollution from that fuel, minimal fatalities and injuries from road based accidents and manageable congestion. PRASA can therefore, strengthen the commuter rail market share from the weakness of its Public Transport competitors.

Overall, the research demonstrates the future of commuter railway and its role to drive modal shift and to positively impact on a sustainable way of living. Even when opportunities are presented to develop integration between the railways and town planning, it has been difficult to secure equilibrium for any length of time, due to continuous shifts in political views and professional ideologies.

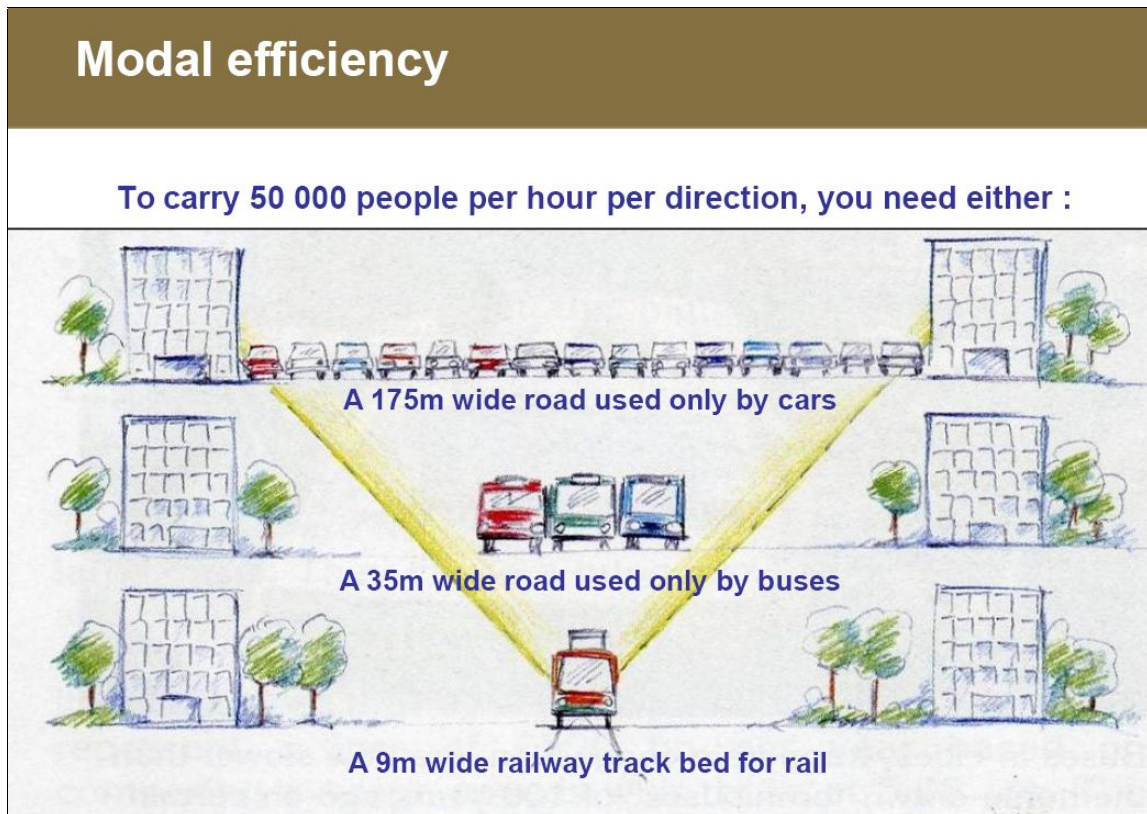


Figure 7.1: Modal efficiency

7.2.2 Policy Shift

The key to live-ability is managing land use and transport networks to maintain the highest level of access to communities, services and employment opportunities.

While there have been great strides since the end of apartheid, there remains significant, structural challenges that need to be addressed on the way ahead.

A primary and imperative aspect is the need to ensure more inclusive and sustainable economic growth for the future.

In order for a public transport (and rail in particular) to be effective and sustainable it is imperative that transport planners should take all the factors into account. More importantly, transport planning and spatial planning should be approached in an

integrated manner. These effects are notable but more needs to be done to curb the urban sprawl.

Apart from alleviating the severe road traffic congestion as a result of urbanization, economic development will be stimulated by the rapid rail system and it will have distinct environmental advantages over other forms of transport.

Figure 7.2 below provides principles to achieve the public transport supportive structure necessary for fundamental restructuring ^[76]. These principles seek to engage relevant stakeholders and provide a policy framework. These principles should be used as a point of departure to enable an sustainable public transport.

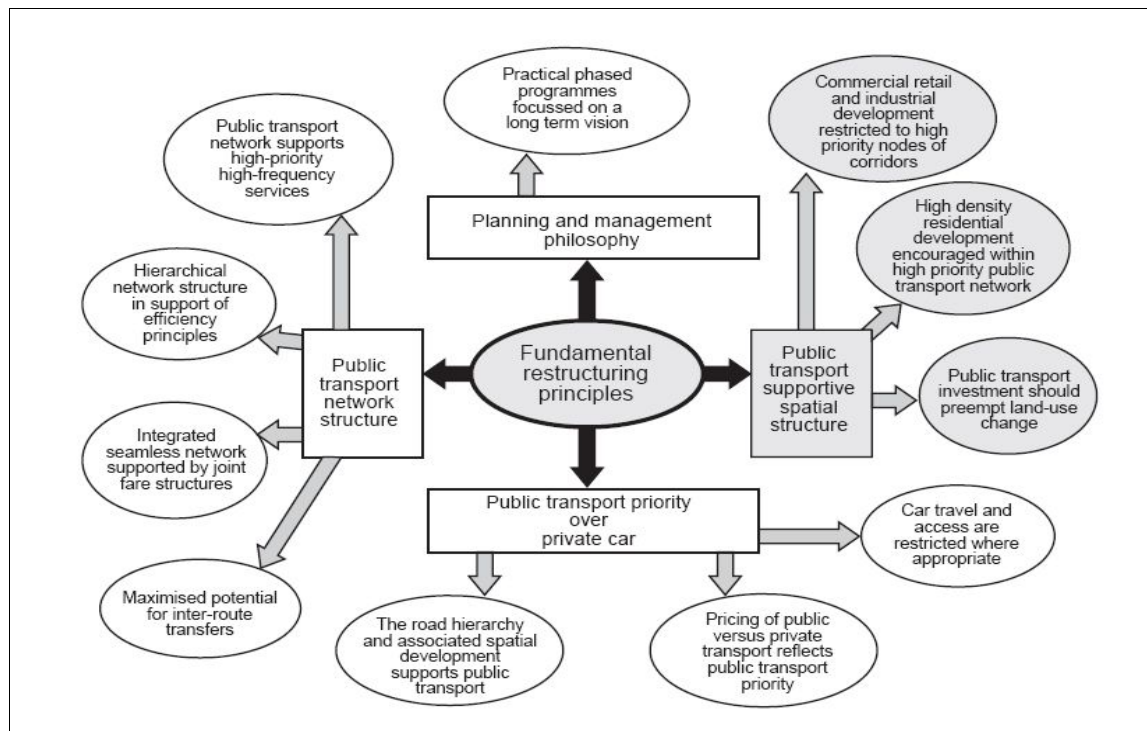


Figure 7.2: Principles to achieve the public transport supportive structure necessary for fundamental restructuring

As Gauteng's population grows, PRASA have to plan carefully for the commuters' future public transport needs. Across the country, many changes are occurring that will have a major impact on public transport system in the years ahead.

Urbanization in Gauteng is growing strongly, generating new demands for transport services within and between regions. CBD's outer suburbs are also growing rapidly, with more people needing to make trips across the metropolitan areas, instead of into the CBD. The population growth means that more people will rely upon public transport to move around. The growing number of cars on our roads is leading to greater traffic congestion and is starting to affect the live-ability of some local communities.

Strong economic growth across Gauteng means that people are making more trips and seeking greater mobility for personal, work and business reasons.

For PRASA to respond to the rapid urban growth in accordance with the proposed focus on high density corridors there is a need for consistency from Government to align transport and spatial planning policies and to significantly increase its investment in infrastructure, operations and new skills to further facilitate future growth in patronage and a sustainable service.

The impact of rapid urban growth on commuter rail is a public transport challenge. PRASA's long-term plan should be designed to address commuter rail issues and meet today's needs and tomorrow's challenges for the benefit of future generations.

REFERENCES:

1. DEMOGRAPHIA, (August 2008), Demographia World Urban Areas: 2025 & 2030 Population Projections, Planning Handbook.
2. PRASA: Corporate Plan (2010/11-2012/13)
3. Hlongwane, T.E. (2007), "Integrated Housing – Myth or Reality), University of Witwatersrand, Johannesburg. Dissertation
4. Turok, I. (1993), *Urban Planning in the transition from apartheid*. Strathclyde Papers on Planning
5. Todes, A. (2003) Housing, Integrated Urban Development and the Compact city debate, in Harrison, P., Huchzermeyer, M. and Mayekiso, M. (eds) *Confronting Fragmentation: Housing and Urban Development in a Democratising Society*, Cape Town, University of Cape Town Press
6. Comprehensive Integrated Transport Plan (CITP) Report. Nelson Mandela Bay Municipality, (2011-2012)
7. National Land Transport Act (NLTA) as promulgated in the Government Gazette No. 32110 on 8 April 2009
8. White Paper on National Transport Policy (1996). Department of Transport. South Africa,
9. Moving South Africa: (1998), Towards a transport strategy for 2020, Department of Transport, South Africa
10. South African State of the Cities Report, (2006:9)

11. General Household Survey, Statistical Release P0309.3, Statistics South Africa
12. General Household Survey, (May 2010), Statistics South Africa P0318, Statistics South Africa
13. Mid Year Population Estimates, (2006), Statistic South Africa
14. Travel Patterns, TIP Technical Documentation, Technical Appendix T19: (June 2008), Department of Science and Technology, Department of Engineering, University of Pretoria (Unpublished documentation)
15. Yuriy Lozynskyy, (2010): "Transport scenarios in Gauteng province: Status quo and perspectives" EnerKey Transportation Seminar 2010, University of Johannesburg (Unpublished documentation)
16. City of Johannesburg Integrated Transport Plan (2003/2008)
17. City of Tshwane Integrated Transport Plan (2006-2011)
18. South African Rail Commuter Corporation: Rail Plan Report (2006)
19. Mbeki, T. (May 21, 2004), Address To The Joint Sitting of Parliament of the Republic, South Africa
20. South Africa Yearbook available from [http://www.gcis.gov.za/docs/publications/South Africa Yearbook](http://www.gcis.gov.za/docs/publications/South%20Africa%20Yearbook). (Accessed 25th May 2011)
21. Economy Overview, available from; <http://www.statssa.gov.za>. (Accessed 14th April 2011)
22. Economic Growth, available from; <http://www.reservebank.co.za>. (Accessed 5th May 2011)

23. Budget-Treasury department, South Africa, available from; <http://www.finance.gov.za>. (Accessed 14th April 2011)
24. Gauteng Employment, Growth and Development Strategy for 2009-2014 (GEGDS)
25. Unemployment rate, available from; <http://www.dti.gov.za>. (Accessed 5th May 2011)
26. Fishlow, Albert, (1965). *American Railroads and the Transformation of the Ante-Bellum Economy*. Harvard University Press, Cambridge, MA.
27. Chandler, Alfred D., (1965). *The Railroads, the Nation's First Business*. Harcourt, Brace & World, Inc., New York
28. Collins, William J., (1999). Labour mobility, market integration, and wage convergence in late 19th century India. *Explorations in Economic History* 36
29. Metzger, Jacob, (1974). Railroad development and market integration: the case of tsarist Russia. *The Journal of Economic History* 34
30. Metzger, Jacob, (1984). Railroads and the efficiency of internal markets: some conceptual and practical considerations. *Economic Development and Cultural Change* 33.
31. Fogel, Robert W., (1964). *Railroads and American Economic Growth: Essays in Econometric History*. The Johns Hopkins University Press, Baltimore.
32. Summerhill, William R., (2005a). Big social savings in a small laggard economy: Railroad-led growth in Brazil. *The Journal of Economic History* 65.
33. Summerhill, William R., (2005b). *Profit and Productivity on Argentine Railroads, 1857–1913*. Department of History UCLA (Mimeo), Los Angeles.
34. National Strategic Sustainable Development (NSSD): (2006), South Africa

35. International Monetary Fund (IMF), 2007
36. Geurs, Karst; Zondag Barry; de Jong, Gerard and de Bok, Michiel. (2010): "Accessibility appraisal of land-use/transport policy strategies: More than just adding up travel-time savings" :Transportation Research Part D: Transport and Environment, Volume 15, Issue 7, October 2010
37. Public Transport, available from; <http://www.gautrain.co.za/>. (Accessed 22 April 2011)
38. Metrorail Regional Train Operations Department
39. Gauteng Metrorail, Commuter Rail Census, (2007)
40. Gauteng Spatial Development Framework (GSDF) (2000)
41. Behrens, R. and Wilkinson, P. (2003) Housing and Urban Passenger Transport Policy and Planning in South African Cities: A Problematic Relationship? in Harrison, P., Huchzermeyer, M. and Mayekiso, M. (eds) Confronting Fragmentation: Housing and Urban Development in a Democratising Society, Cape Town. UCT Press
42. Charlton, S. and Kihato, C. (2006) Reaching the poor? An analysis of the influences on evolution of South Africa's housing programme, in Pillay, U., Tomlinson and Du Toit, J. 88 (eds) Democracy and Delivery: Urban Policy in South Africa. Human Science Research Council Press
43. Fujita, M., (1989), "Urban Economic Theory: Land Use and City Size". Cambridge University Press, Cambridge
44. Atack, J., Margo, R.A., (1998). Location, location, location! The price gradient for vacant urban land: New York, 1835–1900. Journal of Real Estate Finance and Economics 16 (2)

45. McMillen, D.P., (2003). The return of centralization to Chicago: using repeat sales to identify changes in house price distance gradients. *Regional Science and Urban Economics* 33(3).
46. Markowitz, H., (1952). Portfolio selection. *Journal of Finance* 7 (1).
47. Muth, R.F., (1969). "Cities and Housing". University of Chicago Press, Chicago
48. Christaller, W., (1933). *Central Places in Southern Germany*. Prentice Hall, Central Places in Southern Germany, London
49. Papageorgiou, G.J., Casetti, E., (1971). Spatial equilibrium residential land values in a multicentric setting. *Journal of Regional Science* 11.
50. Odland, J., (1978). The conditions for multi-center cities. *Economic Geography* 54 (3).
51. Sivitanidou, R., (1997). Are center access advantages weakening? The case of office commercial markets. *Journal of Urban Economics* 42 (1).
52. Heikkila, E., Gordon, P., Kim, J.I., Peiser, R.B., Richardson, H.W., Dale-Johnson, D., (1989). What happened to the CBD-distance gradient? Land values in a polycentric city. *Environment and Planning A* 21.
53. Ogawa, H., Fujita, M., (1980). "Equilibrium land use patterns in a non-monocentric City", *Regional Science and Urban Economics* 20 (4).
54. Wieand, K., (1987). An extension of the monocentric urban spatial equilibrium model to a multi-center setting: the case of the two-center city. *Journal of Urban Economics* 21.
55. White, M.J., (1988). Location choice and commuting behavior in cities with decentralized employment. *Journal of Urban Economics* 24 (2).

56. Sasaki, K., (1990). The establishment of a sub-center and urban spatial structure. *Environment and Planning A* 22.
57. Helsley, R.W., Sullivan, A.M., (1991). Urban sub-center formation. *Regional Science and Urban Economics* 22 (3)
58. Yinger, J., (1992). Urban models with more than one employment center. *Journal of Urban Economics* 31 (2).
59. Sasaki, K., Mun, S.-I., (1996). A dynamic analysis of a multiple-center formation in a city. *Journal of Urban Economics* 40 (3).
60. Gordon, P., Richardson, H.W., Wong, H.L., (1986). The Distribution of Population and Employment in a Polycentric City: The Case of Los Angeles. *Environment and Planning A*. 18.
61. Gordon, P., Richardson, H.W., (1996). Beyond Polycentricity: The Dispersed Metropolis, Los Angeles, 1970–1990. *Journal of the American Planning Association* 62 (3).
62. Yiu, C.Y., Tam, C.S., (2004): “A review of recent empirical studies of property price Gradients”. *Journal of Real Estate Literature* 12 (3).
63. Anas, A., Arnott, R., Small, K., (1998). Urban spatial structure. *Journal of Economic Literature* 36 (3).
64. Clapp, J.M., Rodriguez, M., Pace, R.K., (2001). Residential land values and the decentralization of jobs. *Journal of Real Estate Finance and Economics* 22 (1).
65. Garreau, J., (1991). *Edge City: Life on the New Frontier*, Doubleday & Company, New York.
66. Andrulis, J., (1982). Intra-urban workplace and residential mobility under uncertainty. *Journal of Urban Economics* 11.

67. DeSalvo, J.S., Eeckhoudt, L., (1982). Household behavior under income uncertainty. *Journal of Urban Economics* 11.
68. Turnbull, G.K., Glascock, J.L., Sirmans, C.F., (1991). Uncertain income and housing price and location choice. *Journal of Regional Science* 31
69. Turnbull, G.K., (1995). *Urban Consumer Theory*. The Urban Institute Press, Washington, DC.
70. Papageorgiou, G.J., Pines, D., (1988). The impact of transportation cost uncertainty on urban structure. *Regional Science and Urban Economics* 18.
71. Turnbull, G.K., (1991). The spatial demand for housing with uncertain quality. *Journal of Real Estate Finance and Economics* 4.
72. Yiu, C. Y., (2010): "A spatial portfolio theory of household location choice": *Journal of Transport Geography* 19.
73. Williams, R. (2007). *The Sustainable Transport and Mobility Handbook Vol. 1*
74. *Public Transport Strategy (2007 – 2020)* Department of Transport, South Africa
75. Peter Sieburg – (28th May 2009) Presentation on "Guest of the PMSA Young Project Managers Group" Bombela TKC (unpublished)
76. Shaw, A (1998). Fundamental restructuring of the planning management and operation of urban public transport networks. Report No CR 98/018. Division of Roads and Transport Technology, CSIR, Pretoria.