An evaluation of Rea Vaya and Gautrain, its potentials and impacts on spatial and transportation planning in the City of Johannesburg

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PREFACE

This postgraduate research was carried out at the North-West University, Potchefstroom campus, under the supervisions of Prof. C.B. Schoeman of the Unit for Environmental Sciences and Management and Prof. I.M. Schoeman of Mathematics and Applied Mathematics respectively.

The research was conducted on the City of Johannesburg Metropolitan Municipality, the capital of the Gauteng Province of South Africa.

I, Adedayo Adegbaju do hereby declare that the dissertation with the title “An evaluation of Rea Vaya and Gautrain, its potentials and impacts on spatial and transportation planning in the City of Johannesburg” is my own work and has not been submitted at any University either in whole or in part.

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ABSTRACT

The unique urban contexts that emanated from the apartheid history of South Africa informed the transport landscape of the City of Johannesburg. Apartheid's divisive spatial planning and land use management policies promoted sprawling and separated labour from work. This was further exacerbated by poor funding of public transport and road designs that encouraged the use of private cars. The democratization of the country in 1994 was the beginning of a new phase in the history of the city. A new approach to policy formulations that entails the provision of public transport as one of the tools to end years of marginalization and inequalities was adopted by the national government. It soon became a policy direction that reflects in planning decisions of all spheres of government.

The Rea Vaya BRT and the Gautrain were respectively introduced by the municipal and provincial governments to demonstrate governments' commitments to the new policy direction. While the Gautrain was implemented to facilitate elite movement within Gauteng and to crowd investments and economic growths around station nodes; the BRT was provided for marginalized commuters in Soweto, to provide a sustainable alternative to the dominant minibus taxi. Although the two modes (Rea Vaya and Gautrain) have endured almost a decade filled with public sentiments and other issues, this research concludes that most of the challenges are associated with the country's historical context and the age of these transport systems.

The Gautrain has demonstrated that viable alternatives to the private car can be provided, with its satisfactory feedbacks from users; and some of its station nodes (Sandton, Rosebank and Pretoria) have showed promises of transit-oriented development, one of the project's key objectives. The other stations have been unable to stimulate growth due to reasons like non-implementation of their Urban Design Frameworks and lack of public sector investment required to attract private investors. The Rea Vaya, in its third phase of implementation, has been extended further north to Sandton in spite of both its inability to induce modal change and its low ridership figures. The research identifies factors like low peak to base ratio, pricing and the city's disjointed urban fabric as some of the reasons for its below average performance.

By drawing from the highlights and limitations, the study recommends that public transport provision should be institutionally integrated across and within spheres of government. Similarly, harmonization of the funding structure, better understanding of users' needs and travel patterns, underlined with continuity of policy direction and objectives will equally help to achieve optimum outputs.

Key words: Bus Rapid Transit, Gautrain, Rea Vaya, Transit Oriented Development, sustainable transport, spatial and transport planning.

OPSOMMING

Die unieke stedelike konteks wat voorgespruit het uit Suid Afrika se geskiedenis van Apartheid het die vervoer landskap in die stad van Johannesburg beïnvloed. Die Apartheid regering se verdelende ruimtelike beplanning en land bestuur praktyke het veroorsaak dat die arbeiders vêr van die werksgeleenthede af moes woon. Hierdie situasie was verder vererger deur swak befondsing van die openbare vervoer stelsel en pad ontwerpe wat die gebruik van privaat voertuie aangemoedig het. ‘n Nuwe fase in die geskiedenis van die stad het in 1994 aangebreek, met die bekendstelling van ‘n demokratiese regering in die land. Die nasionale regering het ‘n nuwe benadering tot beleidsformulering aangeneem in ‘n poging om jare se marginalisering en ongelykhede te beëindig. Die nuwe beleid het voorsiening gemaak vir openbare vervoer. Hierdie nuwe benadering word weerspieël in beplanning besluite op al die gebiede in die regering.

Die Rea Vaya BRT en die Gautrain is onderskeidilik deur die munisipale en provinsiale regerings bekendgestel om die regering se toewyding aan die nuwe beleid te demonstreer. Die Gautrain was geïmplementeer om beweging van die bevoorregte individue binne Gauteng te fasiliteer, sowel as om beleggers te lok en ekonomiese groei te bevorder. In teenstelling, die BRT maak vir die gemarginaliseerde pendelaars voorsiening deur ‘n volhoubare alternatief vir die dominante ‘minibus taxi’ te verskaf. Alhoewel die twee vervoer stelsels (Rea Vaya en Gautrain) vir amper 'n dekade lank publieke opinie en ander kwessies verduur het, kom hierdie navorsing tot die gevolgtrekking dat die meeste uitdagings verband hou met die land se historiese konteks en die ouderdom van hierdie vervoerstelsels.

Die Gautrain het bewys dat alternatiewe vir die privaat voertuie aangebied kan word, met bevredigende terugvoer van verbruikers; en sommige stasie-nodusse (Sandton, Rosebank and Pretoria) het beloftes getoon van transito-georiënteerde ontwikkeling, een van die belangrikste doelstellings van die projek. Die ander stasies kon nie groei stimuleer nie weens redes soos die nie-implementering van hul stedelike ontwerp raamwerke en 'n gebrek aan beleggings in die openbare sektor wat nodig is om private beleggers te lok. Die Rea Vaya, wat in sy derde fase van implementering, is verder noord tot by Sandton uitgebrei, ondanks beide die onvermoë om modale veranderinge te bewerkstellig en sy lae ruitersyfers. Die navorsing identifiseer faktore soos 'n lae piek tot basis-verhouding, prysvasstelling en die stedelike struktuur van die stad as 'n paar van die redes vir die ondergemiddelde prestasie.

Deur gebruik te maak van die hoogtepunte en beperkings, beveel die studie aan dat voorsiening vir openbare vervoer institusioneel oor die regeringsfere en binne die regeringsfere geïntegreer moet word. Net so sal harmonisasie van die befondsingstruktuur, 'n beter begrip van gebruikers se behoeftes en reis patrone, onderstreep met die kontinuïteit van beleidsrigting en -doelstellings, ook help om optimale uitsette te bereik.

Sleutel woorde: snelbusdiens, Gautrein, Rea Vaya, Transit georiënteerde Ontwikkeling, volhoubare vervoer, ruimtelike en vervoerbeplanning.

ACRONYMS

BEPP	Built Environment Performance Plan
BRICS	Brazil, Russia, India, China, South Africa
CBD	Central Business District
CoF	Corridors of Freedom
COGTA	Cooperative Governance and Traditional Affairs
CoJ	City of Johannesburg
CSP	Cities Support Programme
DEAT	Department of Environmental Affairs and Tourism
DPME	Department of Planning Monitoring and Evaluation
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
GCR	Gauteng City-Region
GCRO	Gauteng City Region Observatory
GDRT	Gauteng Department of Roads and Transport
GDS	Growth and Development Strategy
GHHTS	Gauteng Household Travel Survey
GMA	Gauteng Management Agency
GMS	Growth Management Strategy
GPG	Gauteng Provincial Government
HIA	Heritage Impact Assessment
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
IIMP	Integrated Infrastructure Master Plan
ITMP	Integrated Transport Master Plan
ITP	Integrated Transport Plan
ITS	Integrated Transport System
IUDF	Integrated Urban Development Framework
JDA	Johannesburg Development Agency
JnNURM	Jawarhalal Nehru National Urban Renewal Mission
JRA	Johannesburg Roads Agency
LGSETA	Local Government Sector Education and Training Authority
LRT	Light Rail Transit
LUM	Land Use Management
MTSF	Medium Term Strategic Framework

NATMAP	National Transport Master Plan
NDoT	National Department of Transport
NDP	National Development Plan
NEMA	National Environmental Management Act
NHHTS	National Household Travel Survey
NLTA	National Land Transport Act
NLTSF	National Land Transport Strategic Framework
NMT	Non-Motorized Transport
NPC	National Planning Commission
OECD	Organization for Economic Co-operation and Development
PRASA	Passenger Rail Agency of South Africa
PTMA	Public Transport Management Area
QoL	Quality of Life
REX	Regional Explorer
RSDF	Regional Spatial Development Framework
SACN	South African Cities Network
SAF	Strategic Area Framework
SAPOA	South Africa Property Owners Association
SDF	Spatial Development Framework
SITPF	Strategic Integrated Transport Plan Framework
SOE	State Owned Enterprises
SPLUMA	Spatial Planning and Land Use Management Act
SPTN	Strategic Public Transport Network
StatsSA	Statistics South Africa
TA	Transport Authority
TIA	Traffic Impact Assessment
TMR	Transformation, Modernization and Reindustrialization
TOD	Transit Oriented Development
UDF	Urban Design Framework
UDZ	Urban Development Zone
UN	United Nations
US	United States of America

DEFINITIONS

Glossary	Description
Apartheid Government	Policies and practices of racial segregation and discrimination as practiced in Southern Africa, which promotes inhuman acts committed for the purpose of establishing and maintaining domination by one racial group of persons over any other racial group of persons and systematically oppressing them (Assembly UG, 1973:2).
Bus Rapid Transit	A high-quality bus-based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service (Hook & Wright, 2007:11).
City-Region	An urban development on a massive scale: a major city that expands beyond administrative boundaries to engulf small cities, towns and semi-urban rural hinterlands, sometimes expanding sufficiently to merge with other cities, forming large conurbations that eventually become city-regions (UNICEF, 2012:2).
Compactness	"The characteristic of urban form (shape, density and land use) that reduces the overexploitation of natural resources and increase economies of agglomeration, with benefits for residents in terms of proximity" (UN-Habitat, 2015:1).
Corridors	Links between nodes, along which an increased intensity of development may be encouraged. They provide efficient access to a higher level of economic opportunities than would generally be the case in less structured space. They typically include public transport routes (DRDLR, 2011:4).
Environmental Management Framework	Part of the suite of integrated environmental management tools that can be used to support informed decisions regarding the management of impacts on the environment that arise out of human activities and developments (DEA, 2010:201).
Gauteng City-Region	An integrated cluster of cities, towns and urban nodes that includes Gauteng province and parts of at least three other provinces (Mpumalanga, North West and Free State) (Wray & van Olst, 2010:3). On the basis of functional considerations, the spatial configuration of the GCR appears to be polycentric (Wray, 2010).
Integrated Development Plan	A strategic planning instrument which municipalities must adopt to provide vision, leadership and direction for all role players in the development of a municipal area. It integrates plans and takes into account proposals for the development of the municipality; aligns the resources and capacity of the municipality with the implementation of the plan; and forms the policy framework that informs the annual municipal budget (SA

	2000 Section 25 [1]; DPLG, 2001:5).
Integrated Transport Planning	A process or framework that serves as a guide to gathering information about transport and analyzing it (IIEC, 1996). A framework for integrated transport planning consists of three main components: outcomes, guiding principles and planning process (Louw, 2003:3).
Integrated Urban Development Framework	The policy position of government that guides the future growth and management of urban areas. It promotes options for a more effective and efficient management of urban spaces and it plays a part in the NDP's aim of cities being the country's economic drivers through enhanced spatial efficiency and inclusion (SA, 2016:12).
Integrated Urban Development Framework Implementation Plan	It promotes the goals of the IUDF by providing strategic direction on what should be done, when and by whom (SA, 2016:13). It is reviewed every 3 years, to measure growth, as well as to readjust or reprioritize the programmes and projects.
Metropolitan area	It is defined as a geographical with a relatively high population density that is considered as a statistical area (UN-Habitat, 2017:4). In practice, it has statistical, technical, administrative and political meanings. In the same vein, the term "Greater" is often used to denote a metropolitan area.
Municipal Spatial Development Framework	A spatial component of the municipal Integrated Development Plan which makes provision for the basic guidelines for a land use management system for the municipality (SA 2000 Section 26e).
National Development Plan	It is a plan by the South African national government to eliminate poverty and reduce inequality by 2030 through facilitating an inclusive economy, building capabilities, enhancing the capacity of the state, and promoting leadership and partnerships throughout the society (SA, 2012:24).
Nodes	Areas where a higher intensity of land uses and activities are supported and promoted. In practice, a municipal area would accommodate a hierarchy of nodes that indicates the relative intensity of development anticipated for the various nodes, as well as their varying sizes and dominant nature (DRDLR, 2011:4).
Non-Motorized Transport	The transportation of passengers via human or animal powered means, including bicycles, rickshaws, pedicabs, animal-drawn carts and walking (UN-Habitat, 2013a:15). It is a means of transport that is free of all forms of energy combustion
Polycentric city	Polycentric city refers to the principle of developing multiple centers within a region to be complementary in role through city specialization (UN-Habitat, 2012:5).
Spatial Planning	Planning that enhances transformation of the physical and social space, and affects the distribution and flows of people,

	goods and activities through the articulation of political decisions and actions. It covers scales ranging from neighborhood, city/municipality, city-region/metropolis to national and supra-national/transboundary (UN-Habitat, 2015b:1).
Spatial Planning and Land Use Management Act	SPLUMA 2013 is a framework act for all spatial planning and land use management legislation in South Africa. It promotes consistency and uniformity in procedures and decision-making in this field. SPLUMA empowers municipalities as solely responsible for processing and dealing with land use applications and the appeals relating thereto. All municipalities must establish Municipal Planning Tribunals to decide on cases, with the Municipal Council dealing with appeals on decisions made by the Municipal Planning Tribunal (South African Planning Institute, 2015:1).
Sustainable transportation	"A transportation system that allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; – affordable, operates efficiently, offers a choice of transport mode, supports a vibrant economy; and limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and production of noise" (Centre for Sustainable Transportation, 2008:4-5).
Transit Oriented Development	Higher-density mixed-use development within walking distance of transit stations. It focuses on public and private development around transit stations to create neighborhoods where people can safely walk, live, work, shop and play (Center for Clean Air Policy, 2014:6-7).
Transportation Planning	It is defined as the improvement of synergy between land use and transportation system planning; promotion of the association between planning design and operation of transportation services; facilitation of a stable interface between transportation-related energy use, clean air and water; and the encouragement of alternative modes of transportation that will enhance efficiency, safety and high levels of mobility (USA Institute of Transportation Engineers, 2014:1).
Urbanization	The section of a country that is urban (UNICEF, 2012:1)
Urban agglomeration	'The population of a built-up or densely populated area containing the city proper, suburbs and continuously settled commuter areas or adjoining territory inhabited at urban levels of residential density' (UNICEF, 2012:1).
Urban core	It sometimes includes adjacent municipalities that developed during the same period as the core municipality. A core municipality usually includes the historical core. Generally, the urban core or the inner city is in the central municipality.

Urban density	Urban density in this research refers to the estimate of the urban unit of population and housing per unit area (neighborhood/city). The population density is measured as population per unit area while for built-up area density is measured as buildings or urban land cover per unit area (Banai & Depriest, 2014:7).
Urban Design Framework	A strategic planning tool that sets out an integrated design vision for the desired future development of urban places. It is a vehicle that helps a community to set an overall direction for a particular place or locality, and should be specifically adapted for that place (Victoria State Government, 2015:1-2).
Urban Development	It is defined as a planned and developed area within an urban area characterized by physical, socio-economic and institutional classifications (UN-Habitat, 2012:3).
Urban form	Urban form is a composite of characteristics related to land use patterns, transportation system, and urban design (Handy, 1996:152-153).
Urban resilience	Ability of an urban area/system to retain its original state after a shock.
Urban sprawl	The physical expansion of a city's built environment, which usually consumes adjoining rural areas. It reflects in car-oriented low-density areas, with a lack of access to basic services and infrastructure (UN-Habitat, 2015b:1).
Urban growth	Urban growth is the rate of growth of an urban population depending on the natural increase of the urban population and the population gained by urban areas through both net rural-urban migration and the reclassification of rural settlements into cities or towns (UNICEF, 2012:10).
Urban periphery	Urban periphery refers to any occupation on the fringes of the city which has neither a fully urban nor fully rural character – it is intimately connected with the city (UNICEF, 1998:10).
Urban segregation	Urban segregation is perceived as spatial separation of two or more groups, and it is measured in terms of the relative proportions of each group in the different neighborhoods of a city (Randon-Furling et al., 2018:2).
Urbanization rate	The increase in the proportion of urban population over time, calculated as the rate of growth of the urban population minus that of the total population (UNICEF, 2012:1).

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CHAPTER 1: INTRODUCTION AND BACKGROUND OF THE RESEARCH

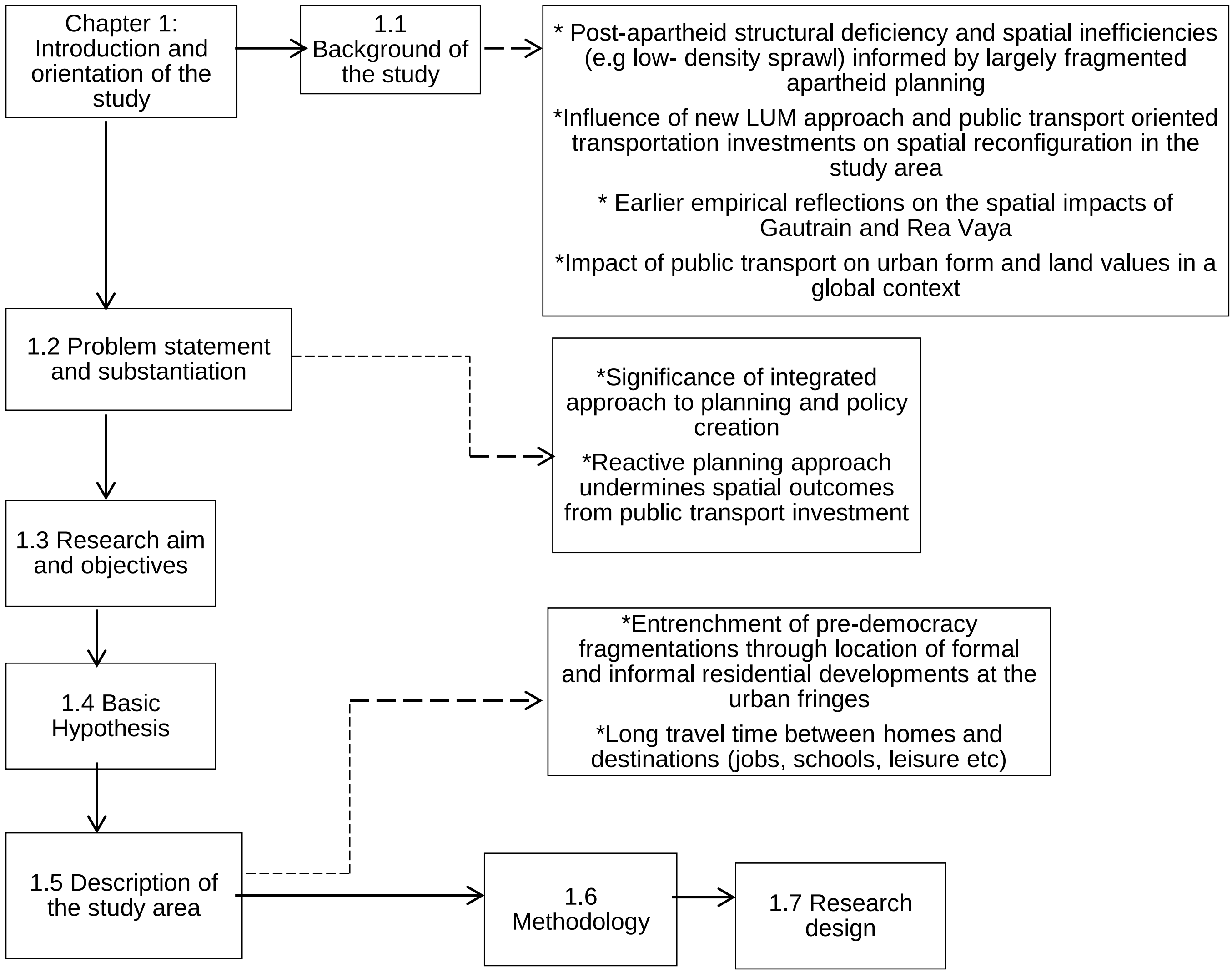


Figure 1.0: Layout and footprint of chapter 1

1.1. Background of the study

The transport landscape in South Africa during the white minority rule (apartheid) that pre-dates democratization in 1994 was characterized by dysfunctional public transport systems that moved non-white workers from sprawled black townships to places of employment and economic activities in the inner cities (Chakwizira et al., 2011:741-744; Weakley & Bickford, 2015:13; McKay, 2017:4-6). The public transport oriented townships were separated up to 25-30km (UN Habitat, 2013b:4) from activity nodes, and the metro rail was the first dominant node for residents of the townships in early Johannesburg (Czegledy, 2004:69; Chakwizira et al., 2011:741). This urban fragmentation is one of the ills of a non-democratic government's spatial system whose divisional policies promoted segregation and racial divisions across all facets of communal existence and interactions.

The system left behind a divided system of social exclusion, extreme job-housing mismatch and unavailability of social services required to live productively (Thomas, 2013:78). Donaldson, 2006, summarized the challenges presented to the post-apartheid government in 1994 as follows: “One of the greatest spatial challenges to overcome in the post-apartheid city is the inequality and spatial inefficiency caused by apartheid planning. Not surprisingly, a World Bank report of the early 1990s considered South Africa’s cities among the most inefficient in the world. Cities were (are) characterized by low-density sprawl, fragmentation and separation, all of these contributing to the dysfunctional structure where privilege was racially determined. Over a period of four decades, black South Africans were systematically marginalized, among others, in terms of accommodation, leisure, employment and transport. Structural deficiencies in the former apartheid city, resulting from segregation and low-density sprawl, created long-distance work-travel patterns (Donaldson, 2006:344).” In order to reinforce this perspective on pre-democratic South Africa, Figure 1.1 shows the fragmented land use pattern of the Pretoria-Witwatersrand-Vereeniging (PWV) region in the 1970s. It reflects a segregated urban landscape based on race, with non-white residents located at the fringes, far from work opportunities at the central business districts (CBDs).

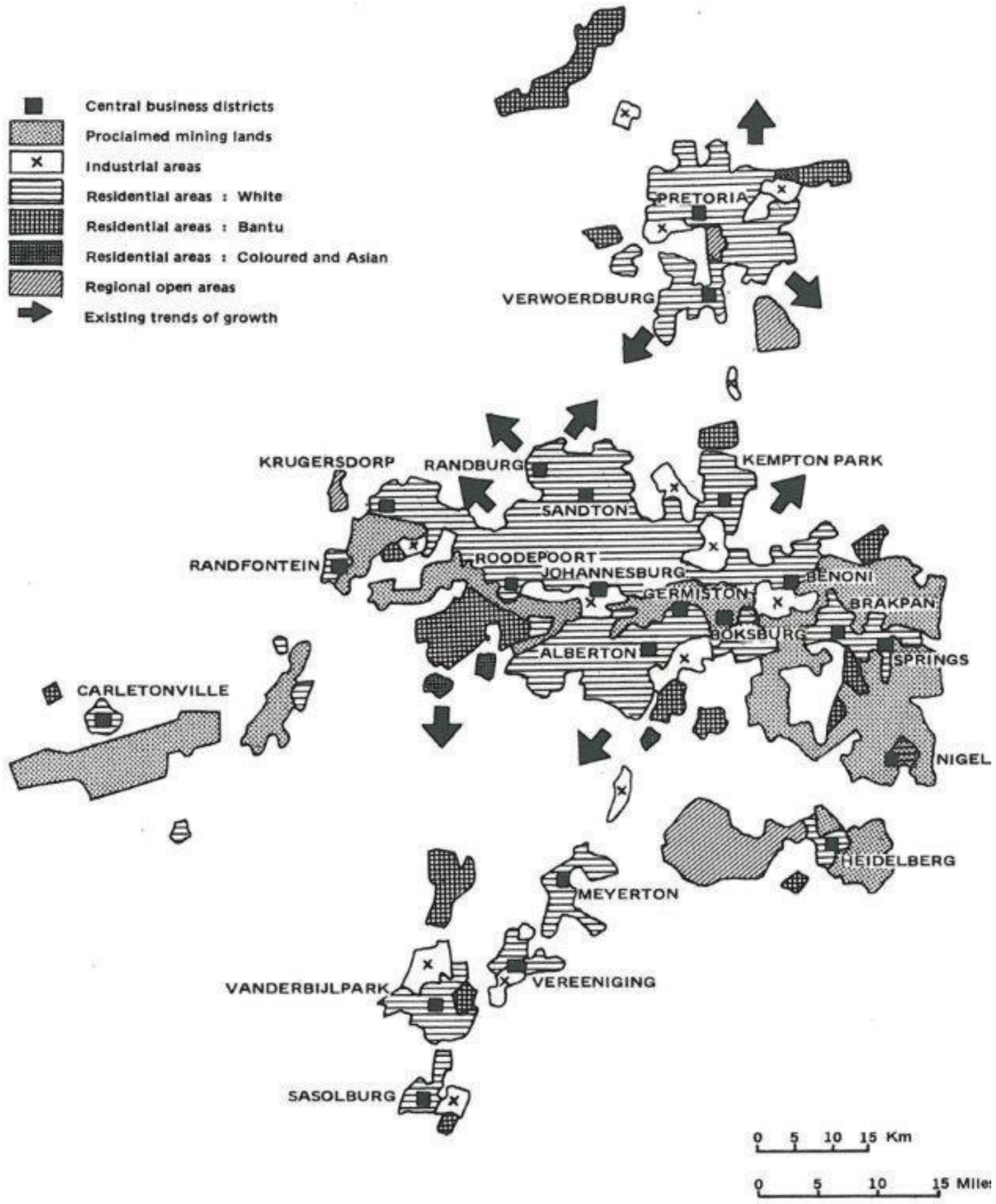


Figure 1.1: Pretoria-Witwatersrand-Vereeniging complex – urban land use (1973)

Source: Mubiwa and Annegarn (2013:20)

However, watershed events like democratization in 1994 and the hosting of the FIFA World Cup in 2010 have helped to spur spatial transformation and changed government's approach to transport provision (van der Merwe et al., 2001:1; Schoeman, 2009:1-9; Mabin, 2013:49; UN Habitat, 2013:50; Allen, 2013:406). In the case of Gauteng, the direct rail route between Johannesburg and Pretoria, developed on the western side of the N1, to complement the Pretoria-Witwatersrand-Vereeniging (PWV) Road Network had become impractical. Major developments had occurred on the eastern side, and the political administration installed in 1994 conceived a new rail route to link activities on the corridor (van der Merwe et al, 2001:1-2; Thomas, 2013:80). By the year 2000, the Gauteng Premier announced plans for the construction of a new rapid rail system that would restructure the PWV's urban form and make it more sustainable.

Saff (1994:382); Beavon (2004) and Crankshaw (2008:1694) give an account of changes to the spatial configuration of the City of Johannesburg after 1994, with the racial integration of residents in similar income categories, supported by progressive land use management (LUM) practices. Although the spatial reconfiguration inaddition to the new LUM approach catalyzed desegregation and significant in-migration of non-white residents from the peripheries (Todes & Turok, 2018:12), policies that prioritized provision and funding of public transport were increasingly promoted by the national sphere of government (Bickford, 2013:8; Walters, 2014:2,5). Such policies include the White Paper on Transport Policy (1996), Moving South Africa, 1998 and the National Land Transport Transition Act (2000). At the same time, the unregulated minibus taxi industry increasingly replaced the heavily protected bus industry in Johannesburg (Walters, 2014:2).

The Rea Vaya BRT and Gautrain are two of the outcomes of these policies, and though they were both separately implemented by the metropolitan and provincial government (respectively) almost a decade ago, their responses to the apartheid separations appear to be a process that requires more time, if the desired spatial and commute transformation must be achieved. While the BRT was an upgrade on the Metro bus that is used by many low-income earners for intra-municipal commute, the Gautrain was developed to facilitate movement between Gauteng's three major metros (City of Johannesburg, City of Tshwane and City of Ekurhuleni).

Besides, in spite of the numerous challenges that Gautrain and Rea Vaya BRT have faced, it can be argued that such limitations cannot undermine their potential for gravitating Johannesburg's transport system towards sustainability. However, there is the need to learn lessons from their planning, funding, implementation, operations and performance measurements. Several authors (Ridgard, 2010:50-52; Gauteng, 2014:44-49; Mushongahande et al, 2014; Gotz et al., 2015:85-121; SAPOA 2016:15-23; GMA, 2017:12-15; Lombard et al., 2017:467-471) have documented their empirical findings on the system's interaction with the city and the region, using contexts like the neighborhood, nodes, property values and reduction of poverty and inequality. Ridgard (2010) asserted that property prices increased around station nodes at the planning and construction phases, similar to Mushongahande et al (2014); GMA (2017) and SAPOA's (2016) empirical confirmation of the increased property development and prices around Sandton, Rosebank and Pretoria stations, post-construction phase.

In terms of Transit Oriented Development (TOD) influence of the stations on their neighborhoods, Gotz et al (2015) were critical of the approach of using similar principles in preparing Urban Design Frameworks for the Gautrain stations in Johannesburg. The TOD concept can be related to the definition of the basic value of an investment by Mohring (1961). He argues that this "value – be it in highway or anything else – is the value of the resources it releases for other uses" (Mohring, 1961:244). Development is considered to be transit-oriented when it has a strong pedestrian orientation, with dense and mixed land use, and promotes multimodal transportation (Rodriguez et al., 2015:5).

According to Gotz et al (2015:93), the differing urban contexts of the Gautrain stations in Johannesburg were not incorporated in the preparation of the Urban Design Frameworks (UDFs), and this has resulted in Transit Adjacent Developments (Gotz et al., 2015). In terms of the impact of transport on spatial outcomes, Beavon (2003) highlights the contribution of transportation to the decline of Johannesburg's CBD. According to Chakwizira et al (2009:25), projects such as Gautrain reinforce apartheid's policies by promoting sprawls through providing subsidies for long distance travel. Weakley and Bickford (2015:45) conclude that the Rea Vaya BRT has enhanced mobility and accessibility for users in Diepkloof, Soweto. In ascertaining the influence of the BRT on urban form in the study area, Weakley and Bickford (2015:47) found that housing intensification began before the implementation of the BRT. Weakley and Bickford (2015) maintain that the Rea Vaya BRT is yet to stimulate any TOD inspired land development activity in the area.

In a global context, most empirical studies on the impact of public transit on urban form and land values were focused on heavy rail systems (Hess & Almeida, 2007:1043; Kilpatrick et al, 2007:304-307), because they confer the most significant accessibility benefits (Cervero & Kang, 2011:103). Most of these studies were done in the US, where most of the studies ignored the Rustbelt cities (faced with population and economic decline) and focused on thriving cities in the Sunbelt areas (Hess & Almeida, 2007:1042). Earlier studies on the impacts of bus transit on property values (Koutsopoulos et al., 1977:575; Knight & Trygg 1977; Cervero & Duncan, 2002) concluded that the modest gains conferred on properties was because most bus routes lack the permanence of fixed infrastructure (Dittmar & Poticha, 2004; Hess & Almeida, 2007:1043). However, recent empirical findings, especially in Asia and Latin America have ascertained that there are more promising gains in residential property price and corridor transformation associated with BRT systems. For example, Ottawa and Curitiba have demonstrated the immense potential of the BRT for large-scale urban transformation (Cervero & Dai, 2014:131). The BRT can induce similar land-use benefits as the rapid rail if transport and land-use planning are closely coordinated from the beginning (Levinson et al., 2002). In this regard, Gallivan et al (2015:24-25) argue that the land use planning element must be premised on a strong understanding of the land market. In this regard, the importance of pro-active planning to spur large-scale urban transformation by the BRT was reinforced by empirical evidence from Bogota (Cervero and Dai, 2014:133).

Based on the same perspective, the BRT in Beijing has stimulated property development on its corridor after 6 years of implementation. Rising values of properties adjacent to the BRT stations are associated with enhanced accessibility, a factor that has catalyzed high-density residential property developments on the BRT corridor (Deng & Nelson, 2013:111). The deduction made from Deng and Nelson (2012) is the potential of a full-featured BRT to attract residential properties around the stations, and the need for stronger public-private partnerships through efficient value-capture approach and incorporation of private developers at the planning stage. Ma et al (2013) also suggested the value capture approach in a similar empirical study on a corridor with the presence of the BRT and rail transit in Beijing. The study recommends the use of creative financing strategies like capitalizing the gains on properties adjacent to the rail stations. However, their conclusion was inconsistent with Deng and Nelson (2012), regarding the BRT's ability to attract property development. Ma et al (2013) conclude that the BRT is unable to spur property development, in spite of its ability to enhance accessibility for nearby residents.

Based on the above perspectives, it can be concluded that the deduction by Levinson et al (2002) is consistent with the account given by Ma et al (2013). This means that in order to strengthen the effects of BRT investments on land developments, future projects must incorporate planning interventions, which integrate station design and residential development in advance (Ma et al., 2014: 27-28).

Furthermore, Cervero and Kang (2011) further articulated the spatial influence of a BRT system in an empirical research on Seoul BRT. According to the research, Seoul's BRT induced land use intensification through conversions of single-family residences to multi-family apartments and mixed-use projects. Through addition of 70km dedicated median bus lanes, the bus operating speed was doubled (Cervero & Kang, 2011:115; Jun, 2012:87), leading to increased accessibility to properties on the BRT corridor. Most importantly, the spin-off effect is associated more with the reduction in travel time and the ease of transfer to the city's subway portal (Cervero & Kang, 2011:115). In Seoul, Cervero and Kang (2011) observed activity and land use intensification on parcels fairly close to BRT stops was generated over a 7 year period through conversions from single-family houses to multiple-family housing, condominiums and mixed land use (Figure 1.2).

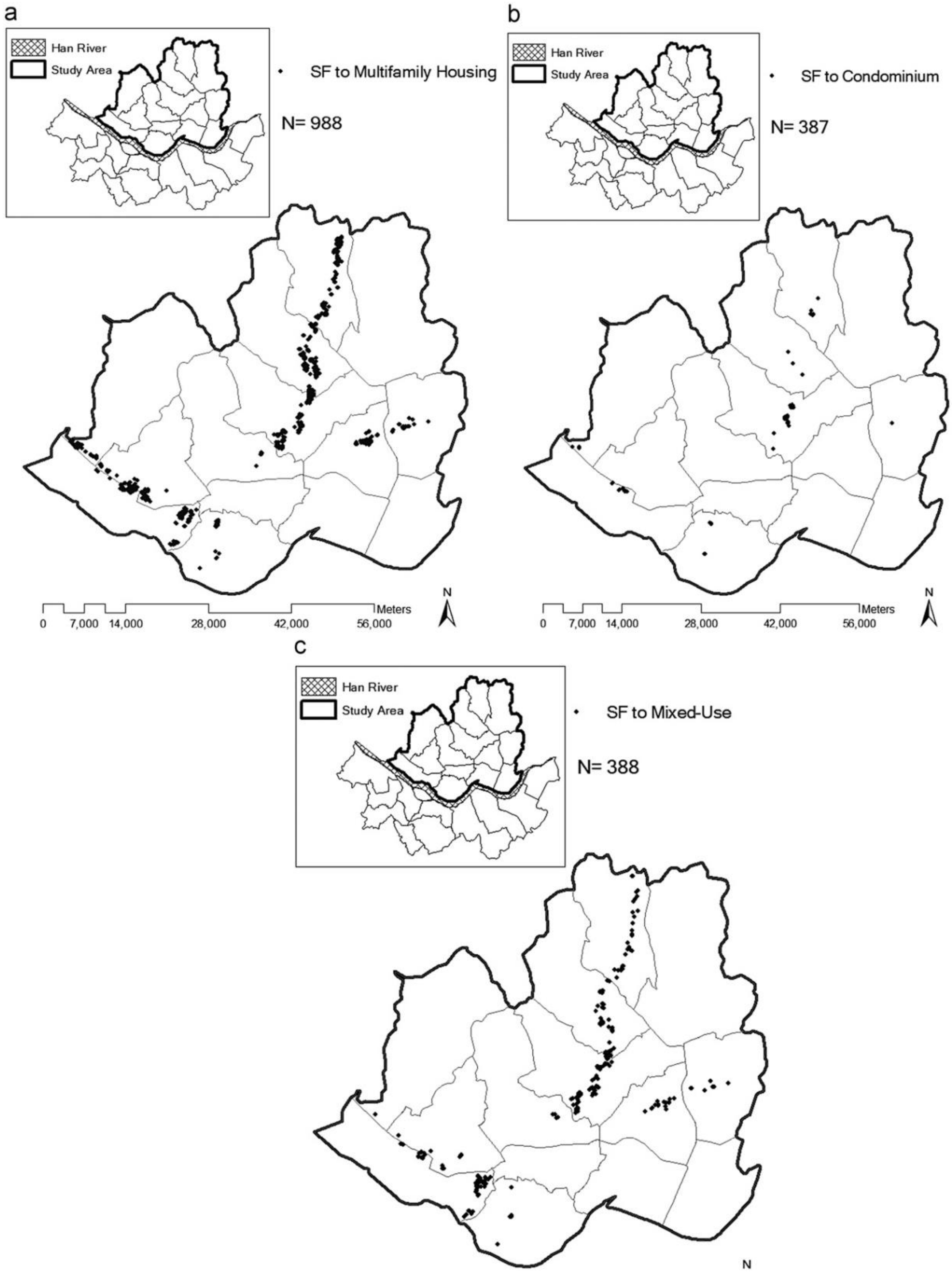


Figure 1.2: Location of converted single-family residential parcels in Seoul

Source: Cervero and Kang (2011:110)

However, further research by Jun (2012) used a different approach to evaluate the redistributive impact of Seoul BRT on employment and household (residential) location. It appears that firms are more sensitive to increased accessibility than households because firms gravitated more towards the BRT routes in the CBD and sub-centers when compared to household migrations using the same context. Jun (2012) concluded that Seoul's BRT acted as a counter-force to urban sprawl because it increased employment and household density in the CBD but depopulated the zones outside the BRT network (Jun, 2012:89-90).

In Bogota, Colombia, the BRT has catalyzed growth in residential and commercial properties density (Rodriguez et al., 2016), a change that occurred at the expense of existing public spaces, industrial and institutional land uses. Rodriguez et al. (2016:12-13) concluded that the BRT's potential for transit-oriented development is context dependent. The conclusion was based on empirical evidence from Bogota and Quito, with the use of contexts like the age of stations, before-and-after implementation periods, and comparison with non-impact zones (control zones). Most of the land use and development changes were private sector driven, but the stations with less land development activities were more transit-oriented relative to their surrounding built environment. A similar empirical study by Calvo (2017) revealed that proximity to the BRT stations induced price gains for residential and commercial properties in Bogota (Calvo, 2017:98). The findings by Rodriguez et al (2016) reinforce the argument by Levinson et al (2012) and Ma et al (2014) that planners and policymakers must become proactive in aligning developer interest (land-use planning) with the needs of the BRT system (transport planning) from the planning stage.

From the empirical findings above, it can be deduced that the propensity of a transit system to stimulate changes in urban form is premised on improved accessibility to the transit corridor. Accessibility increases with a reduction in the cost (money and/or time) of movement between two points (Giuliano, 2004:240). Conceptually, Rodriguez and Targa (2004) describe accessibility as having local and regional components. The local component measures the ease of physical access to a transit station or stop, while the regional component measures the transit's travel time to where passengers want to go (Rodriguez & Targa, 2004:596). Earlier empirical studies on the impacts of bus transit on land-use were inconsistent on its ability to stimulate property price gains and land development. Land development is best defined based on a city's context, but it refers to a "broad range of urban processes such as greenfield development, redevelopment, revitalization, regeneration and renewal" (Rodriguez et al., 2016:5). Another deduction from empirical literature is that residential and commercial land uses are the prominent land-use types attracted by transit investments, but as maintained by Giuliano (2004:244) and Rodriguez et al. (2016), the impact of transit systems on land-use remains an ongoing debate.

In addition, the potential of value-capture as a viable approach for reinvestment and profitability was articulated, with empirical evidence from the Hong Kong rail corridor, which is known as one of the few cities in the world where transit makes a profit (Cervero & Dai, 2014:137; Ma et al., 2014:27). Figure 1.3 is an illustration of the virtuous cycle from transportation planning and implementation to the reinvestments and future expansion that results from the capitalization of the gains from adjoining properties. Transit routes and stations must mutually co-exist with the adjacent areas to facilitate the best TOD outcomes; especially in the case of a BRT system, the interface must be consolidated at the planning phase, with inputs from all role players. While an implementation of the capitalization approach may promote division along income lines, because the low-income earners are excluded due to high property rentals (Rodriguez et al., 2016:13); it can be argued that this limitation may be mitigated by (i) underwriting the cost of providing affordable housing and shops to displaced residents and merchants (Cervero & Kang, 2011:116; Cervero, 2013:14), and (ii) a balanced portfolio of transportation improvements that prioritizes equal benefits to all socio-economic groups (Cervero, 2013:14).

In the same vein, the presence of complementary infrastructure (e.g. water and sewerage trunk lines) to support the growing densities around new transit stations was emphasized by UN-Habitat (2009:152-166); Cervero and Kang (2011) and Cervero and Dai (2014). This is consistent with a study by Todes (2012:162-163), in which he highlighted the need to link infrastructure improvement with urban growth and strategic spatial planning. In addition, strategic provision of a supportive non-motorized transport environment is essential for the best BRT TOD outcomes (Deng & Nelson, 2013:112; Cervero & Dai, 2014:134,137; Rodriguez et al., 2016:12).

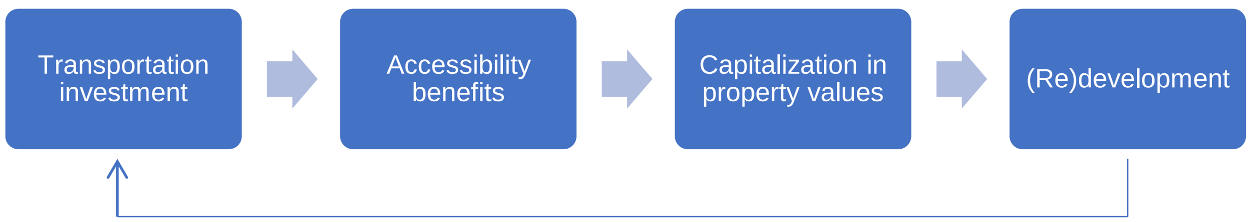


Figure 1.3: The BRT value-capture cycle

Source: Own construction (2018) adapted from Rodriguez et al. (2016:5)

Overall, the final deduction from literature that informs the focus of this research is the reactive approach that cuts across all the case studies. Planning, which in this context refers to spatial and transport planning should become proactively oriented, in order to optimize the potentials of a BRT system investment to stimulate urban transformation. It is further argued that the public sector's approach to transportation investments must change from using it to provide mobility solutions to catalyzing urban transformation. If sustainable BRT TOD outcomes must be achieved, the inputs highlighted in Figure 1.1 should be synergized, as conceptualized from the empirical and theoretical literature reviewed for this section. Interestingly, cities in both developed countries (Ottawa) and developing countries (Hong Kong, Curitiba) have pioneered likely outcomes driven by strategic inputs. However, there is no standard approach, but rather a context-dependent (Harumain & Morimoto, 2013:324) integration of the measures in Figure 1.4. Though researchers like Gallivan et al. (2015:24, 28) cautioned that significant land development changes are subject to the age of the transit system and the turnaround time for (re)development.

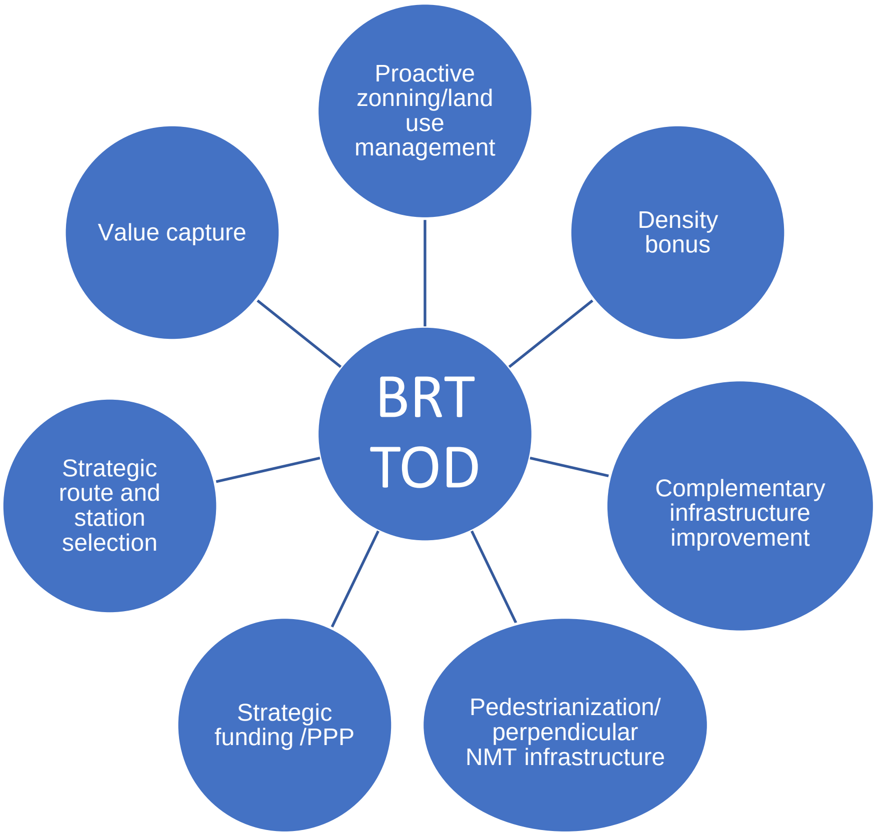


Figure 1.4: Conceptual BRT TOD inputs

Source: Own construction (2018)

From the foregoing, it might be tempting to align with the argument by authors like Muller (2004); Jordan and Infante (2012:537); Miranda and Siva (2012:143); Ratner and Goetz (2012:45); Cervero (2013:14, 20); and Rode et al (2014:32-33); that transport infrastructure largely informs urban form. There appears to be lingering equivocations in literature on the impact of transit systems on spatial outcomes, but empirical evidence has mostly reinforced the deduction that developing cities can be spatially (re)configured through strategic integration and incorporation of inputs by all role players at the planning (UN-Habitat, 2013b:48) and implementation stages.

1.2. Problem statement and substantiation

From many of the views explored, the interface between transport investments and the spatial impacts on the catchment area (route network) appears to be stronger for rail transit investments than the bus mode. Nevertheless, the BRT is cheaper and requires less residential and employment densities for optimal economic outcomes (UN-Habitat, 2013b:48). Empirical evidence has also supported the versatile and flexible nature of the BRT (Cervero & Dai, 2014:130-131). In spite of the deductions from literature on the need to integrate transport and land use planning at the planning stage of the public transport (transit) system, it appears that most times, policy development and planning are still carried out in silos (UN, 2016:20). The non-integration of policy creation and planning can undermine outcomes, but policy makers are most successful when they pursue an integrated approach (horizontally across sectors, institutions and modes and vertically among levels of jurisdiction and authority) (UN, 2016:20). In addition, there must be capacity building for implementation and a fiscal and financial system for efficient resource allocation.

Having made the deductions above, it implies that strategically planned urban transportation investments can generate outcomes with implications for urban transformation. Despite the on-going debate on transit impacts on land use, its other socio-economic impacts have also underpinned its relevance to the city discourse. The immense health benefits are informed by its ability to reduce traffic accidents and non-communicable diseases associated with the built environment (Dora et al., 2011:1-17; UITP, 2018:2). Policy approaches that incorporate the health benefits of public transport have recently underscored the significance of public transport investments. However, its relevance to the study focus is its ability to reduce urban sprawl and connect deprived areas to places of economic activities (UITP, 2018:2). This relevance is informed by the presence of deprived populations and spatial disparities in the study area, an outcome of its political past.

In this regard, one can argue from the perspective of the spatial mismatch and entrapment theory. According to this theory, those with the means for higher transport costs move to the suburbs, followed by the retail, other services and job opportunities. In addition to this, it appears that cheaper, more affordable housing are located in areas with poor transport connectivity and poor service provision, making it difficult for residents to access jobs (Titheridge et al., 2014:2). But it can be argued that a subsidy oriented public transport service could increase their access to jobs and other social benefits such as opportunities for healthier lifestyles and wider quality of life benefits (Lucas et al., 2008:45-51; Mackett & Thoreau, 2015:615). In this regard, integration of transport into packages of measures to reduce inherent social exclusions may be imperative, because it can be concluded that improvements to transport on its own will not reduce the social exclusion of the deprived populations (Mackett & Thoreau, 2015:615).

From the foregoing, it implies that this research is motivated by modern interest in the land use impacts of a transit system and the empirical evidence that suggests that in this regard, context-dependent, proactive and integrated planning can stimulate profound outcomes. The reactive approach to the spatial outcomes of transport investment, as identified from literature informs the objectives of this research. The focus is to limit the failure by role players to learn from existing transit system(s), in order to strategically incorporate lessons into future investment decisions. The study area is a good fit because the two transit systems are still at infancy, and findings on their impact(s) on transport and spatial planning will fill the knowledge gap created by the reactive planning approach.

1.3. Research aim and objectives

The aim of the research is to contribute to the existing literature on the potentials and impacts of the Rea Vaya and Gautrain on spatial and transport planning in the City of Johannesburg.

The specific objectives are:

- To gain a thorough understanding of sustainable (public) transport system as it is practiced in some notable cities in the world, with emphasis on developing countries

- To gain insights into the interface of transportation planning, spatial planning and environmental management in the study area, with regards to their underpinning policy and legislative framework;
- To understand the study area (City of Johannesburg) in the context of the GCR

- To evaluate the impacts of the two public transport systems (Rea Vaya and Gautrain) on the City of Johannesburg's spatial and transportation planning

- To adopt this insight in making conclusions and recommendations that will have profound impacts, and engage in policy interface with relevant role players.

1.4. Basic hypothesis

The basic hypothesis of the study is to prove scientifically that:

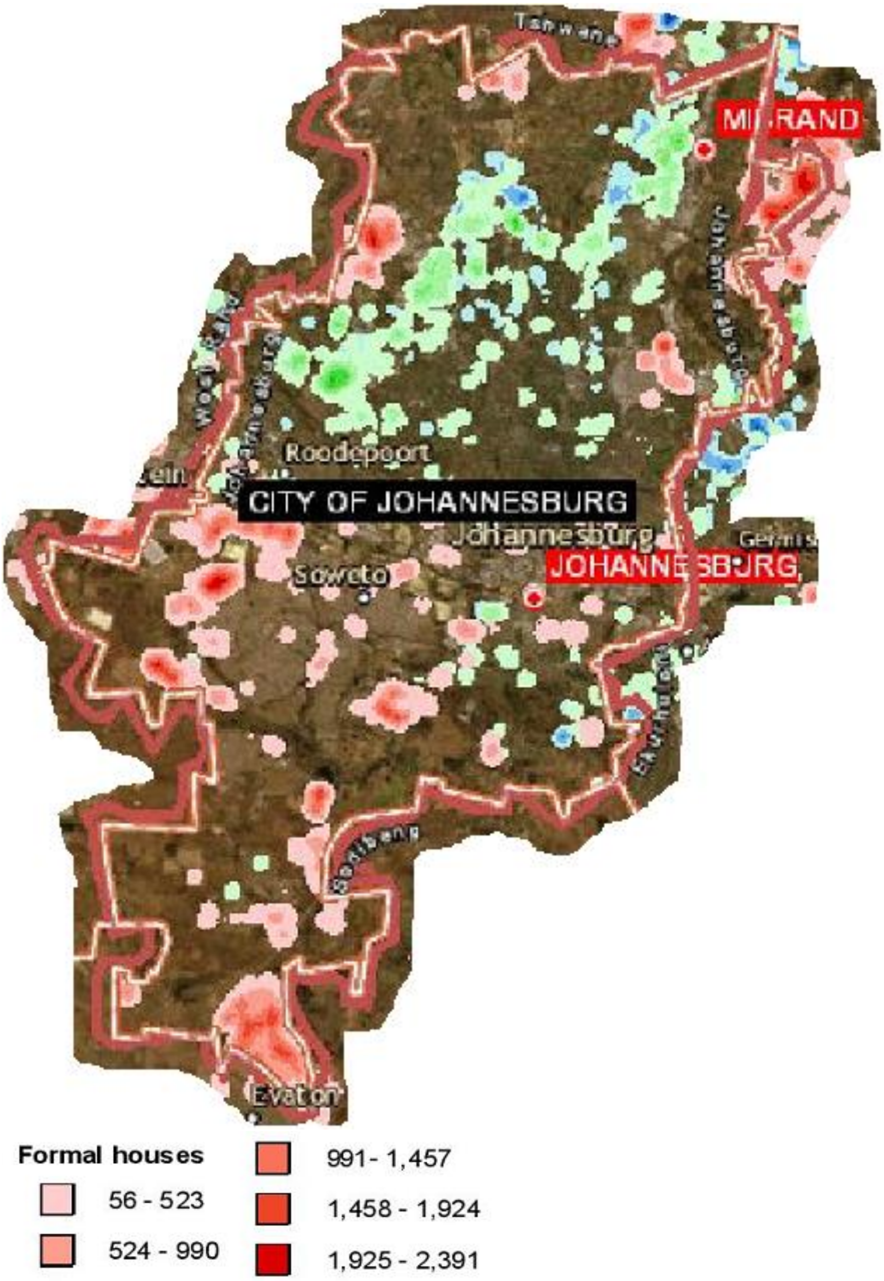
- The Rea Vaya BRT and Gautrain have not influenced residents' modal choices and travel patterns in the CoJ; and

- Outcomes have been influenced by the city's reactive spatial and transportation planning approach.

1.5. Description of the study area

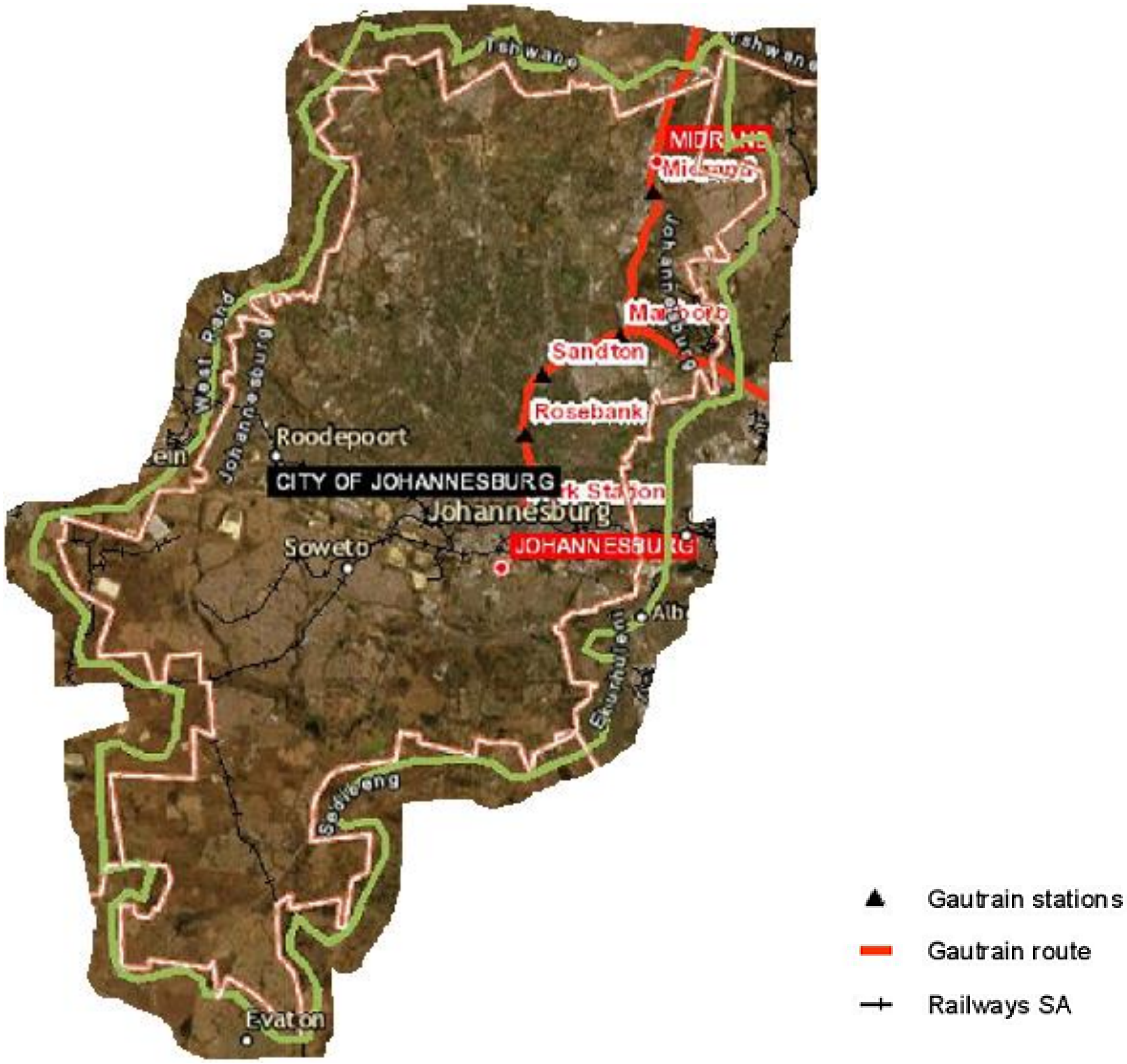
Johannesburg is located on the Highveld, a plateau region in South Africa, at an elevation of 1,750m. It is the capital of Gauteng Province of South Africa, the smallest yet most densely populated of the country's 9 provinces. Gauteng is currently home to 22.4% of South Africa's population and it is the province with the highest contribution to the nation's GDP (CoJ, 2011:38). Johannesburg has grown from an ordinary mining camp to become a global city. The city falls within the Gauteng City Region (GCR), a cluster of cities, towns and urban nodes that can be regarded as the economic heartland of South Africa. In terms of size, the city has an area of 1,645km^2, with 4.4 million inhabitants according to the 2011 census, comprising a total of 1.4 million households and an average of 2.8 persons per household (StatsSA, 2011).

With regards to urban classification in Gauteng, the townships and informal settlements remain at the periphery of the urban conurbation, and this has increasingly reinforced pre-democracy fragmentations. This is because most formal and informal residential developments that have occurred after 1994 have been at the urban fringes, as illustrated in Map1.1.



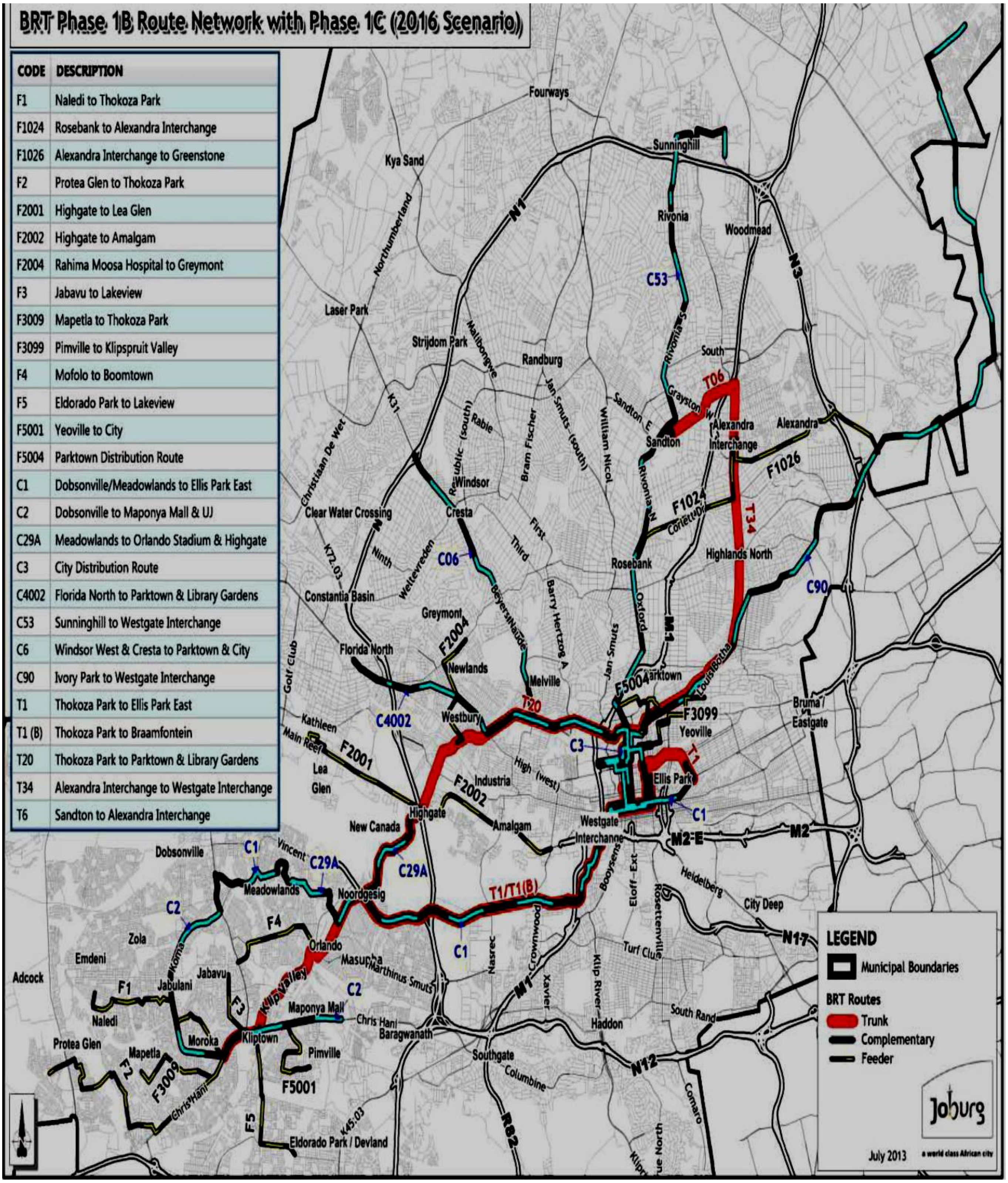
Map 1.1: Post-apartheid formal housing developments in Johannesburg (2001-2010)
Source: GCRO GIS viewer (2018)

Furthermore, the study area is informed by the catchment areas of the Rea Vaya BRT (with origin in Soweto) and the Gautrain route within the City of Johannesburg. Map 1.2a&b depict the route network of the Gautrain and the Rea Vaya BRT Phases 1A, 1B and 1C.



Map 1.2a: Representation of the study area (Gautrain route and stations in Johannesburg)

Source: GCRO GIS viewer (2018)



Map 1.2b: Representation of the study area (Rea Vaya routes)

Source: Source: CoJ (2013: 23)

The focus of this research is to evaluate the overall impacts and likely potentials of the Gautrain and the Rea Vaya BRT on spatial and transport planning in the City of Johannesburg. Vasconcellos, 2002; argues that in developing countries (such as South Africa), the primary focus should be on the relationship between transport and inequality. Everyone, regardless of social status should be able to move around the city safely, effectively and affordably.

Under the apartheid government, urban spatial planning in South Africa was influenced by the policy of racial segregation, pronounced mostly in the Group Areas Act (Act No.41 of 1950). Residential settlements for blacks and coloured folks were located away from city centres, and this meant they were far from job and economic opportunities. This implies that the cities were left with sprawling low-density areas without viable public transport systems. Over the years, this has created protracted spatial imbalance in major South African cities like Johannesburg, Pretoria and Cape Town. Residents endure long travel time between their homes and jobs, schooling, leisure and other socio-economic activities.

The Rea Vaya (Johannesburg) Bus Rapid Transit (BRT) was provided by the city to offer solutions to the mobility and accessibility challenges of residents in the periphery (Soweto) of Johannesburg, while the Gautrain is an initiative by the provincial government to reduce traffic congestion between Pretoria and Johannesburg, and to facilitate access to the OR Tambo International Airport. However, there has been limited empirical research on how these transport systems have influenced spatial and transport planning in Johannesburg. Theoretically, the impact is premised on the TOD abilities of the Rea Vaya and Gautrain. TOD principles were created out of a city's model of integration between transportation and land use planning. Therefore, the implementation of a BRT system in an urban setting can potentially influence existing spatial and land-use patterns, with the support of a deliberate, coordinated strategy (Fernandez-Maldonado, 2008).

In this regard, Chapman (2015:80) identifies the suburbs of Newclare and Sophiatown as early (prior to 1918) exemplars of TOD in Johannesburg. In contrast, as detailed in Beavon (2001), it can be argued that transport can equally contribute to nodal decline. Likewise, it can be deduced that the implementation of a BRT system may generate outcomes that are not in the direction of desired impacts. For example, in a study on the BRT system in Cape Town, Maunganidze (2011: 632) questions the degree to which the system provided for the travel needs of the poor. In another context, Van der Westhuizen (2007:338) provided a critical discussion around the justifications for the Gautrain project whose initial cost projections rose from R7 - R12 billion in 2002 to R20-R25 billion in 2005.

Van der Westhuizen maintains that the need to attract global capital investment to regions within the competition (Gauteng) was the political justification for the Gautrain (Van der Westhuizen, 2007:342-346). But it rather reinforced the spatial and socio-economic inequalities created by apartheid. By developing high-quality infrastructure for central locations, while neglecting the peripheries, the gap between the elite and the poor is further entrenched. This happens whilst residents of the peripheries, who require improved public transport (their main mode of transportation), remain spatially and economically segregated.

Hence, the selection of the study area is motivated by existing literature on the impacts of transit systems on urban form in South Africa.

1.6. Methodology

1.6.1. Literature and theoretical analysis

The study consists of two sections, namely theoretical founding and the empirical study. Essentially, the literature presents a theoretical analysis from supporting theories in planning and transportation and an assessment of case studies. This section is informed by applicable texts, journals, articles, and research thesis, as well as internet sources with relevance to the research theme. By drawing from contributions of academic and professional authors, the research seeks to make a case for mass transit mode and its interface with spatial planning and transport planning.

1.6.2. Empirical study

Several policy and legislative frameworks will be referenced to provide the legal framework for the interface between transportation planning, spatial planning and environmental management in South Africa. This includes national, provincial and municipal documents and legal instruments guiding planning and development in spatial systems. The research design is a case study approach. A case study approach is an intensive study of a single unit for the purpose of understanding a larger class of similar units (Gerring, 2004:341). In this regard, the focus is on the BRT system in a metropolitan context. In addition, the city is appropriate because results can inform similar planning inputs and outcomes from the other metropolitan municipalities in the country. In terms of research method, the triangulation method will be used. Trochim (2006:1-2) defines the triangulation method as a combination of various data collection methods. This involves the use quantitative and qualitative techniques based on purposeful sampling systems.

The use of interviews, questionnaires, field observation and databases such as REX, Quantec, StatsSA, GCRO Observatory, National and Provincial Household Travel Surveys and the Quality of Life surveys will provide the basis for data collection. Consequently, conclusions would be drawn from the integration of research findings, with recommendations provided on the future optimization of the city’s integrated transport plan and the interface of the two subject modes with transport and spatial planning. The data collection methods are represented with the template (Figure 1.5) below:

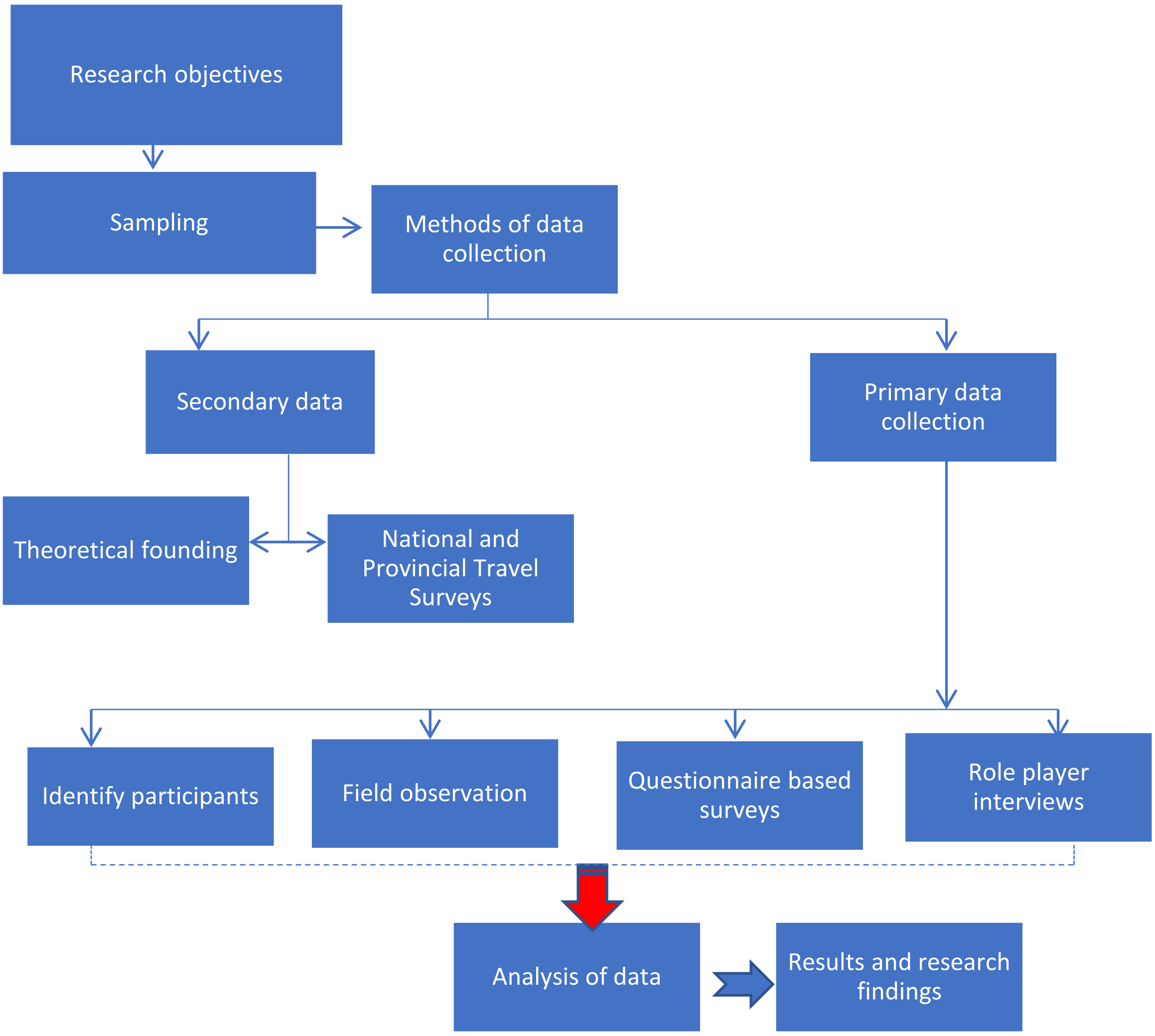


Figure 1.5: Data collection methods

Source: Own construction (2018)

1.7. Research design

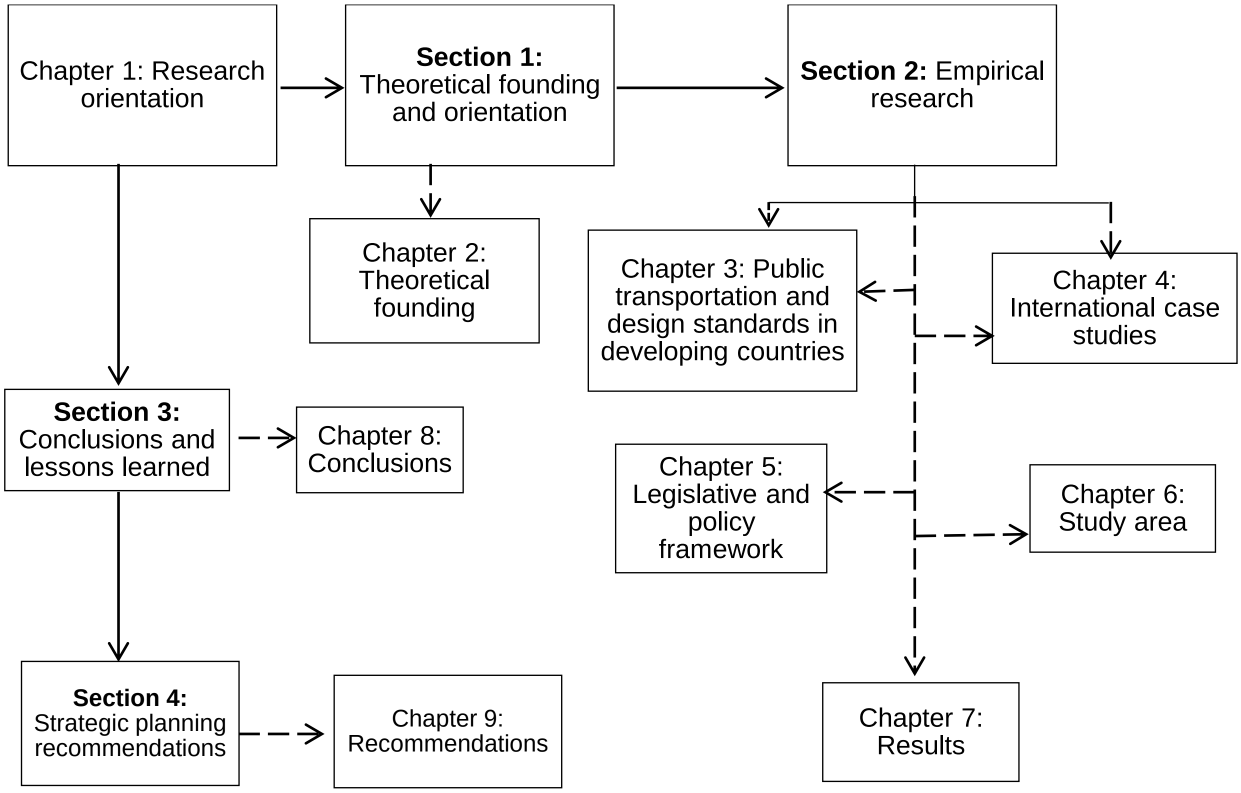


Figure 1.6: Layout of the dissertation

Source: Own construction (2018)

Chapter 1 included an introduction to the research theme and the development of research objectives. It also provided an overview of the research methods that will be used to achieve the research objectives. Finally, the significance of the study was highlighted.

Section 1: Theoretical founding and orientation

Chapter 2 is a review of the literature. It begins with a justification for spatial planning, especially on an urban scale, and provides insights on models and theories that informed the urban land use transport interaction. In the same vein, emphasis will be provided on the smart growth paradigm and the need to avoid the direct transfer of ideas and approaches from the developed countries to the developing countries. Finally, the review will reinforce arguments on the complexities underlining the land-use transport paradigm, with deductions on the imperatives of measuring the compact city approach against a base case scenario.

Section 2: Empirical research

Chapter 3 will explore the state of urbanization and urban transportation in developing countries, as well as the impacts of transportation on urban forms. In addition, the factors that determine the different outcomes from the point of view of developed and developing countries will be highlighted. In this regard, the significance of sustainable public transportation to promoting improved outcomes in developing countries will be underlined. This is followed by literature on the BRT and non-motorized transport (NMT), and a presentation of the design standards of the BRT system.

Chapter 4 presents international case studies on sustainable urban public transportation from developed and developing country contexts. The chapter will discuss the factors underpinning the success or failure of a BRT system, by highlighting them in the form of a conceptual framework. These themes are used to describe the case studies from Bangkok, Brisbane and Ahmedabad, and the significant lessons learned are provided.

In Chapter 5, the need for alignment of policy and legislative frameworks guiding spatial and transportation planning in South Africa is well articulated. In the same vein, the interface of these disciplines with environmental management is highlighted. This is followed by the complexities of integrating the three disciplines and the role played by SPLUMA (2013) and its Regulations.

Chapter 6 presents the study area with regards to its spatial form, modal preferences and its place in the context of the Gauteng City-Region (GCR). Consequently, the Rea Vaya and Gautrain are reported on and discussed, with a focus on their implementation, operations, limitations, expansion plans and users' satisfaction feedbacks.

In Chapter 7, data from interviews, questionnaires, databases and relevant travel surveys are synthesized to present a strong argument on the city's travel pattern, inter-municipal travels and respondents' institutional contribution to the research theme.

Section 3: Conclusions and lessons learned from the case studies and empirical research

Chapter 8 provides conclusions based on empirical findings from the research.

Section 4: Strategic planning recommendations

Chapter 9 will provide strategic recommendations.

CHAPTER 2: LAND USE, TRANSPORT AND THE THEORIES OF URBAN GROWTH

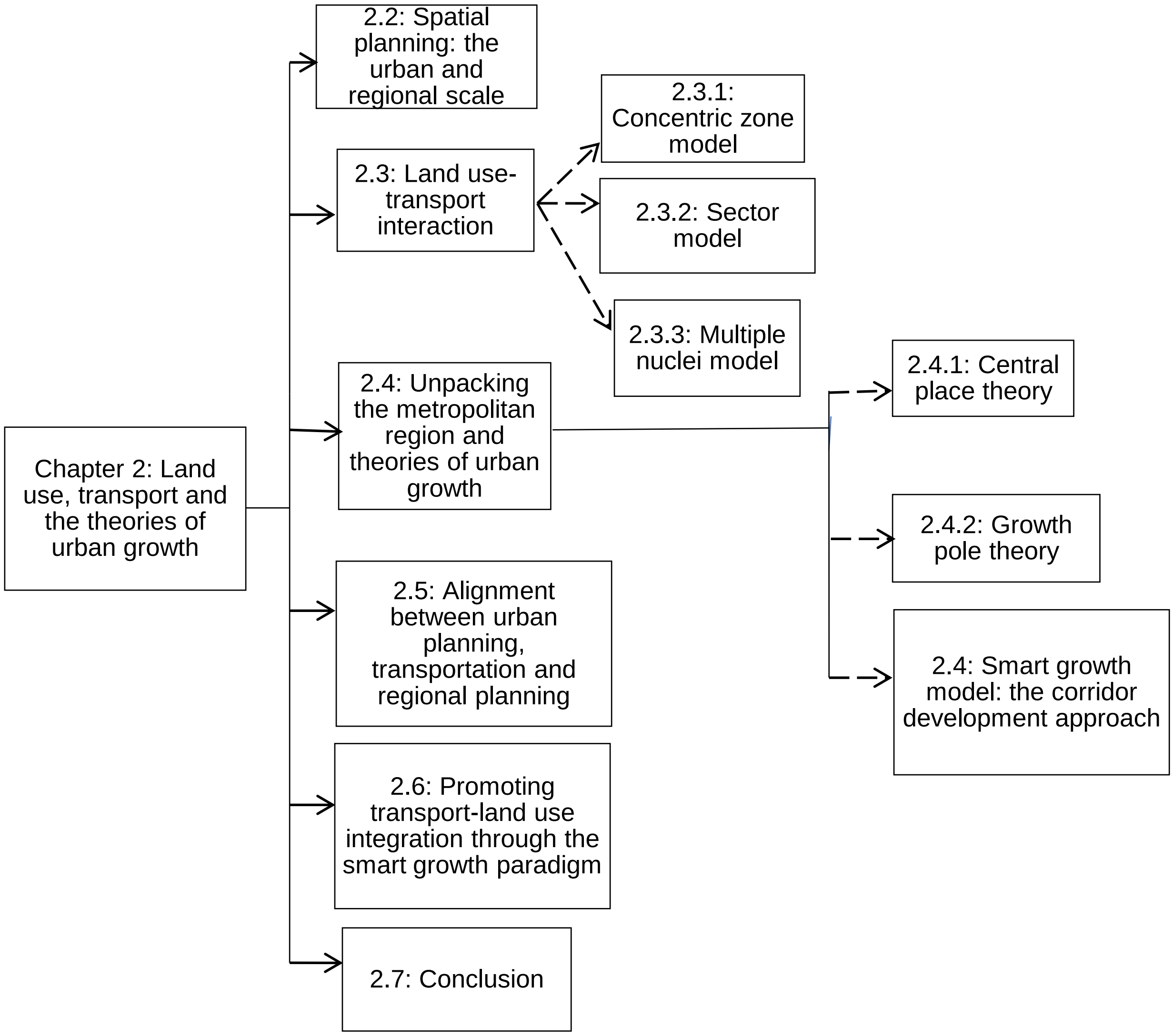


Figure 2.0: Layout and footprint of chapter 2

2.1. Introduction

The global population is projected to be increasingly concentrated in urban areas, with one in every three people living in cities with at least half a million inhabitants by 2030 (UN, 2018:1). However, in spite of the ongoing debate on how best to describe the geographical limits of a city, it can be deduced that cities refer places where large numbers of people live and work, while they also serve as the nucleus of government, commerce transportation and commerce (UN, 2018:1). As a result of the activities and interactions generated in cities, it appears that the outcomes may largely undermine or reinforce the overall process. For example, cities currently generate 80% of global Gross Domestic Product (GDP), with 35% of global GDP generated by the richest 100 cities.

But in developed and developing country contexts, the cost of increasing sprawls (dispersed urban form) continues to limit equitable public investments across sectors. In the US, for example, the annual cost of sprawl is estimated at $400 billion, and this largely results from higher costs on infrastructure, public services and transport (UN-Habitat, 2015:2). In order to adequately address these 21st century challenges in cities, there is the need to reinvent planning, a view that informed the development of the United Nations International Guidelines on Urban and Territorial Planning in 2015 (UN-Habitat, 2015:4). Although the local context and stage of development largely impact outcomes, however the urban strategies with good orientation on compactness and connectivity have largely induced more sustainable urban patterns and forms (UN Habitat, 2015:4). For example, the level of connectivity is implied by the amount of land allocated to streets. This averages 6-12% in cities of most developing countries, in contrast to an average of 29% in cities in developed countries (UN Habitat, 2015:4).

Based on these views, it can be argued that while there is no blueprint urban planning approach, planning and policy-making underpinned by spatial interventions facilitate coherence and integration of political and sectoral decisions. In practice, piecemeal sectoral projects and stand-alone private developments appear to have undermined long-term sustainable development objectives. As a result, it can be concluded that the harmonization and coordination of local and context driven spatial sector plans promotes coordination and efficiency (UN Habitat, 2015:4, 5).

2.2. Spatial planning: the urban and regional scale

Urban planning is both a technique and method of the observation and analysis of spatial, material and human reality. It is also a vision of what the city will be in the near and distant future (Fernandez et al., 2017:3). After the industrial revolution and the subsequent urbanization, the desire to re-create cities according to enlightened design principles gave impetus to urban planning (Fainstein, 2005:122; UN-Habitat, 2009:49; Agudelo-Vera et al., 2011:2302). Urban planning has been defined differently by several authors (Davidson, 1996:457; Hall, 2002:3: Wheeler, 2004:11; Agudelo-Vera et al., 2011:2296), the locus according to Fainstain (2005:122) is a “desired object” – a spatially coherent outcome that reacts to the present, incorporates role players and premised on socio-economic and environmental growth.

However, early urban planning failed to reflect on the process by which the ideal city was formulated (Fainstein, 2005:122). The master planning approach was dominant in Europe and North America until the 1970s (Todes, 2012:158) and it was imposed on countries in the global south (Watson, 2009a&b) through conduits like colonialism, market expansion, educational and scientific institutions and international development agencies and consultancies (UN-Habitat, 2009:9).

Urban planning in Africa was informed by long years of colonialism (Odendaal, 2012:174; Silva, 2012:155), and in spite of the changing contexts of most African cities, planning systems have changed little from the early master planning models (Watson, 2009:154). These cities persist with master planning because it serves the interests of the elites whose actions inevitably marginalize the poor (UN-Habitat, 2009:11) or because the city governments are incapacitated and overwhelmed by planning function (Odendaal, 2012:174). Watson (2008a&b) was critical of how the master planning adopted in the global south has reinforced poverty and marginalization.

Another similar pitfall that can be associated with the persistence of master planning in developing countries is higher crime rate because the poor will be willing to violate laws in order to survive (UN-Habitat, 2009:12). This is in contrast to the significant changes in approach that have occurred in the developed countries (UN-Habitat, 2009:11). While in many of the developed countries, the planning legislation has been revised several times in the last five decades, however change in developing countries has been limited by political bureaucracies and resistance to change (Silva, 2012:155).

According to Watson (2009:176), the master planning approach attempted to shape urban growth through physical plans showing the future layout of cities and the density and intensity of land uses. But its criticism stems from its inability to provide solutions based on the city's spatial and market context; its rigidity; the poor links to implementation (Watson, 2009:178; Todes et al., 2010:415; Todes, 2011:118) which is consistent with the process gap articulated by Fainstein (2005). In addition, it fails to consider the challenges of 21st century cities such as climate change, informality and oil dependence; and it lacks provisions for meaningful integration of role players such as residents (communities) and other stakeholders in the planning of urban areas (UN-Habitat, 2009:4). However, these 21st century challenges have shaped future urban planning trajectories (UN-Habitat, 2009:4).

The 2006 Vancouver Declaration highlights the importance of a new urban planning (Watson, 2009:153; Todes, 2011:116). Contemporary planning approaches emerged, with emphasis on areas like the link between planning, forms of urban development and sustainability. Planning has become more strategic and flexible, promoting participation and going beyond land use plans to incorporate sectors and institutions. According to Todes (2012:159), the new planning approach was linked to implementation through projects and budgets. In a description of the 21st century city as a just city, Fainstein (2005:126) highlighted the importance of participation by describing it as deliberative democracy. Fainstein (2005) asserts that urban planning under a deliberative democracy must promote affordable housing, the placing of community-based facilities for disadvantaged populations and the protection of the environment from toxic wastes. This is consistent with Raco's (2007:306) definition of a sustainable community.

Fainstein's (2005) assertion reinforces the strategic and integrated (sectoral and institutional) nature of contemporary urban planning approach. The description of governance as a means to an end – sustainability – was earlier articulated by Beauregard (2003:73) who maintains that a sustainable city is only realizable through an attentive government that relates with the concerns of all the people. But how do planners protect the interests of the three umbrella sectors – economic, environmental and social – which have emerged as the object of planning? In agreement with the perspectives by Fainstein (2005) and Beauregard (2003), Campbell (1996:297) further maintains that planners must strive to achieve a balance between the three goals of planning (Figure 2.1). It can then be argued that sustainability has since become the overarching framework for helping communities to recognize the link between economy, environment and equity (Berke & Conroy, 2000:31), although there is an ongoing conflict of interests between role players in the three sectors (Campbell, 1996:297-299).

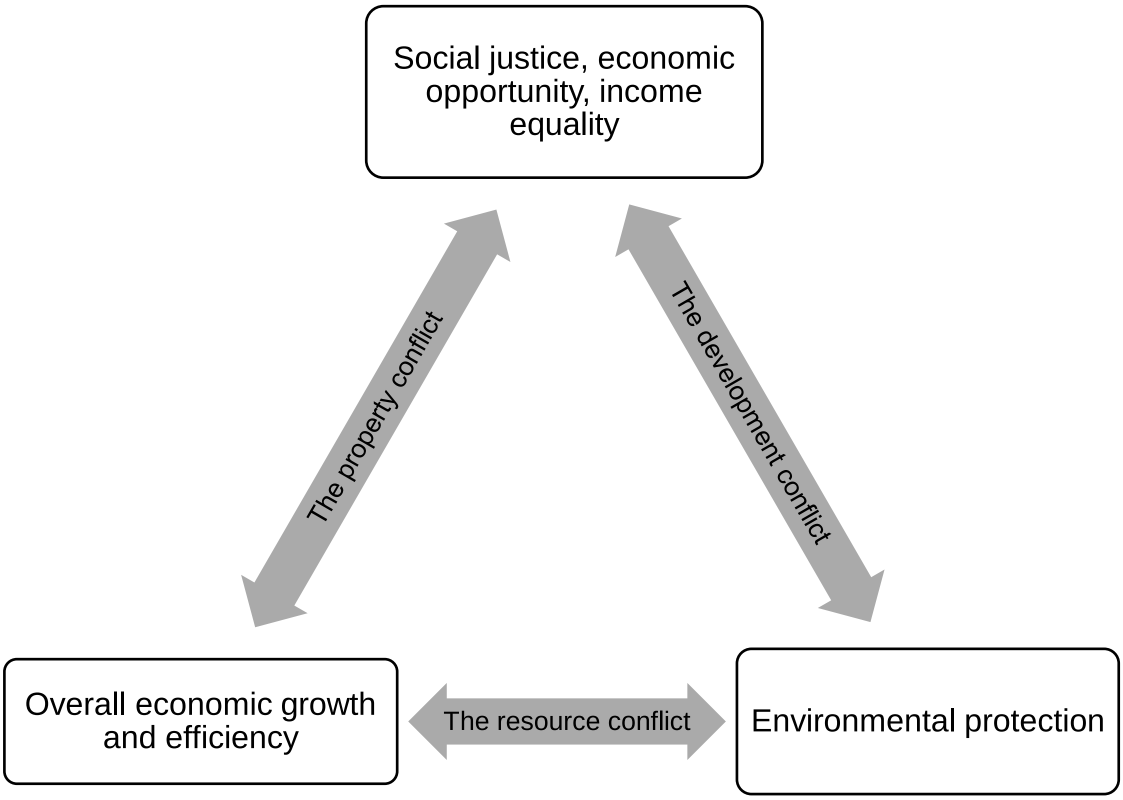


Figure 2.1: The triangle of conflicting goals for planning, and the three associated conflicts

Source: Own construction (2018) adapted from Campbell (1996:298)

In keeping a balance between the conflicting interests, Berke and Conroy (2000:22) argue that there must be coordination, negotiation and compromise. Against this background, it can be argued that there is no single blueprint of a sustainable city, but thousands of possible sustainable cities, for each city has unique historical, cultural, political and environmental circumstances (Basiago, 1999:145). For example, in linking the sustainability paradigm with the spatial form of European cities, much of the discussions converged on the ideal of the compact city, one that promotes social equity (Burton, 2000:1987-1988), ensures less use of energy for transport and in buildings and prevents loss of natural and agricultural areas (Naess, 2001; UN-Habitat, 2013:30).

It is argued that a compact city limits energy use through fewer travels and increased use of non-motorized transport (Newman & Kenworthy, 1989; Cervero, 1998; Naess, 2001:58; Jabareen, 2006:40; UN-Habitat, 2013:28-29; Rode et al, 2014:8-10). According to UN-Habitat (2015:2), urban compactness and greenhouse gas emissions are inversely related. For example, every 1% of growth that occurs in the city core instead of the peripheries, reduces generation of CO_2 per capita by approximately 5 million metric tonnes.

According to Schoeman (2014:6), the incorporation of sustainability into transportation planning promotes strategies that conserve natural resources, encourage alternative modes to single occupant vehicles and travel reduction. Concentrated housing to serve the high population densities will also reduce energy consumption and contribute significantly to the sustainability bottom-line. Empirical evidence from Oslo validates the assumption that high densities and proximity of activities reduce the need for travel (Naess, 1996; Holden & Norland, 2005:2156). For instance, Japan's urban areas are around five times denser than Canada's, and the use of energy per capita in Japan is around 40% of Canada's (Jordan & Infante, 2012:537). From a similar perspective, compact and connected urban form has increased accessibility and promoted low carbon, human-centered environments, with profound impact on the community's health (long term) in cities such as Seattle, USA and Brussels, Belgium (UN-Habitat, 2015:4).

In line with such empirical evidences, Naess (2001) advocated for contracted, area saving urban structures when compared to scattered and open patterns of urban development (Naess, 2001:507-511). While making the case for compactness, it is deduced that role players should ensure the modal change to mass transit, to safeguard against generating more pollution than alternatives like the polycentric urban form (Mindali et al, 2004:160; Gaigne, et al, 2012:133). This is because mass transit makes use of high-occupancy-vehicles (HOV), such as articulated buses and trains, and it reduces per capita transport related fuel consumption.

But the argument by Naess (2001) is one in a plethora of approaches to urban forms that best meet the requirements of sustainability, as well as those that enable built environments to function more constructively than they do. According to Jabareen (2006:38-39), these approaches have been addressed on different spatial scales, namely the regional and metropolitan levels; the city level; the community level; and the building level. However, the most desirable urban form in the context of sustainability remains an ongoing debate (Naess, 2001; Williams et al, 2000; Tomita et al, 2003). In line with the idea of no single blueprint sustainable city by Basiago (1999), Jabareen (2006:48) implies that an ideal sustainable urban form would be that which has a high density and adequate diversity, compact with mixed land uses, and whose design is based on sustainable transportation, greening, and passive solar energy (Jabareen, 2006:48).

Based on the views of different authors on the imperatives of contemporary spatial planning as against the traditional master planning, it appears the strategic nature of spatial planning capacitates it to provide for development and coordinate policies across sectors. Apart from providing a robust platform for entrenching sustainable and equitable socio-economic and environmentally sound development (Mashiri et al., 2017:146), spatial planning also promotes efficiency by limiting the duplication of effort by different departments and spheres of government (Stead, 2008:2). According to Friedman (2004), strategic spatial planning can be conceived as a long-range planning for territorial development that calls for new institutions of governance supported by a comprehensive and integrated approach (Friedman, 2004:52). And in contrast to the conventional master plans, strategic plans are reviewed regularly, and attention is paid to institutional aspects, financing and sequencing of development (Todes, 2012:402).

While underscoring the sustainability imperative of planning, Berke and Conroy (2007:23) opined that plans must link local to global concerns by acknowledging that community planning function within the context of global (and regional) environmental, economic and social systems. Therefore it implies that the imperatives of planning are informed by the local context and the submission that outcomes are integrated into larger scales, because for example, regional planning outcomes are generated by the inputs from the different jurisdictions. Therefore, the inference made from the above arguments is that the change of focus from master planning to spatial planning may significantly influence outcomes on a larger scale, because it is strategic, institutionally oriented, promotes sustainability and limits duplication. Figure 2.2 shows some of the elements of a compact urban form as deduced from the various views discussed above.

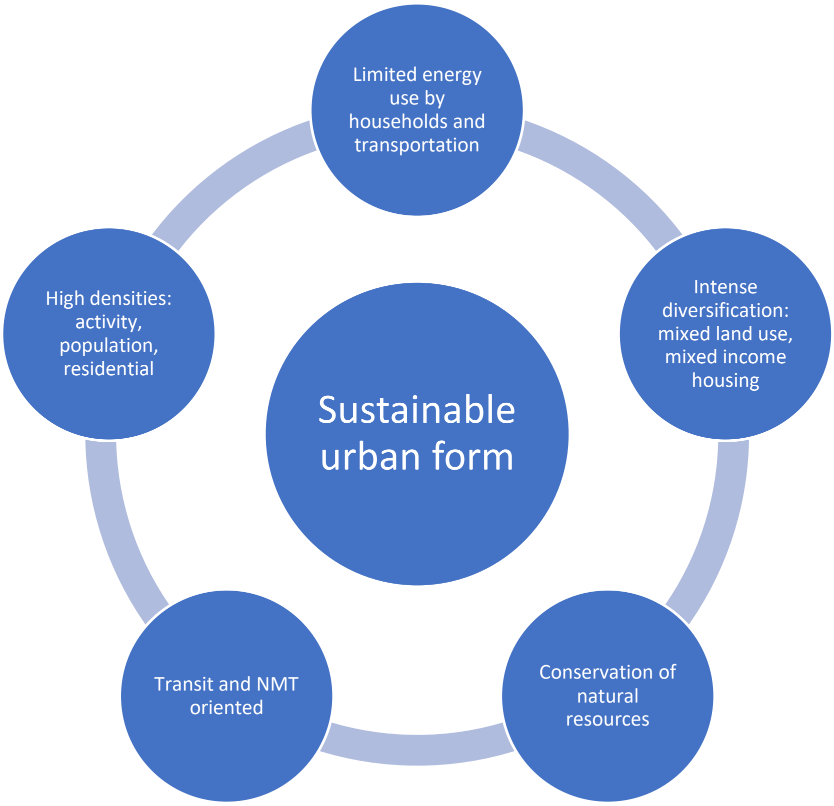


Figure 2.2: Elements of sustainable urban form

Source: Own construction (2018)

2.3. Land use-transport interaction

Consequently, the transport sector has been identified as the single most influential component of an urban form (Jabareen, 2006:40; Todes, 2011:125; Jordan & Infante, 2012:537; Todes, 2012:402; UN-Habitat, 2013:48; Newman et al., 2016:431). Urban form refers to the spatial imprint of an urban transport system as well as the adjacent physical infrastructures (Rodrigue et al, 2006:171). Although other infrastructure like water, sewerage and electricity can equally shape urban growth; their impacts are usually less obvious and often require large bulk elements that provide the capacity for growth in certain areas (Todes, 2012:402). Globally, a growing number of trips in urban areas are associated with rapid and expanded urbanization.

As a result, several urban spatial structures have thus emerged, but the developed world has responded to the growth in mobility by promoting automobility through the expansion of transportation supply and building new highways and/or transit lines (Rodrigue et al., 2006:177). For example, the dispersed urban forms of most Australian, Canadian and American cities are informed by their high level of motorization (Rodrigue et al., 2006:173). On the other hand, the dense urban cores of many European, Japanese and Chinese cities are a reflection of their historical pedestrian-oriented compact urban forms. It appears that urban forms vary according to the dominant mode of urban transportation.

In the same vein, transportation systems can influence urban form on different scales, but one of the most significant impacts has been the clustering of activities near areas of high accessibility (Rodrigue et al., 2006:179). According to Todes (2012:402), the importance of transport-land use links in shaping urban form has informed recent emphasis on transit-oriented development and the use of BRT systems within planning in many contexts. Since each type of land use has its own specific mobility requirements, transportation is a factor of activity location. Empirical studies on successful land use-transit integration (Cervero, 1998; Badoe & Miller, 2000:244-248; 2009; Ratner & Goetz, 2013; Hurst & West, 2014; Ferbrache & Knowles, 2017) have revealed the influence of transport infrastructure in shaping urban growth, but Godschalk (2000:20) maintains that it requires high levels of coordination and integration, as well as complementary policies (Badoe & Miller, 2000:248). While most developed countries like Australia have adopted this approach to planning, the limited institutional capacities, resource constraints and high degrees of informal urban growth in developing countries have inhibited its adoption (Todes, 2012:402; Rode et al., 2014:33).

According to Rodrigue et al. (2006:180), the highly complex transport-land use system involves several relationships between: (i) the transport system – that defines the level of accessibility; (ii) spatial interactions – that consider the nature, extent, origins and destinations of urban movements of passengers and freight; and (iii) land use – that considers the intensity of activities and their associated levels of mobility requirements. In line with the arguments above, various descriptive and analytical models of urban land use exist, and they all involve some consideration of the transport-land use link.

2.3.1. Concentric zone model

The concentric zone model provides a basis from which to describe the relationship between separate spatial outcomes. The model was developed by Earnest Burgess in 1923, and it outlines the use of urban land as a set of concentric rings, with each ring representing a specific socio-economic urban landscape (Harrison & Campbell, 2001:22; Rodrigue et al., 2006:182); as illustrated by Figure 2.3 below. In the concentric zone model, expansion occurs through a haphazard process in which the outlying zones are invaded by the innermost ones, in a continuous cycle of extension and retreat (Friedman & Weaver, 1979:60). According to Friedman and Weaver (1979:60), the model recognized the importance of transportation and mobility in the spatial organization of the different social classes in an urban area. The concentric zone model depicts the CBD as the most accessible location in the city, and this implies that it serves as an origin for major routes of transportation (Schrenk et al, 2011:212). According to Ratcliffe et al (2009:249), the concentric zone model underscores the significance of accessibility by highlighting development along transport corridors, with accessibility considered on the basis of time-cost. Therefore it implies that changes in transportation may stimulate changes in land use and land value.

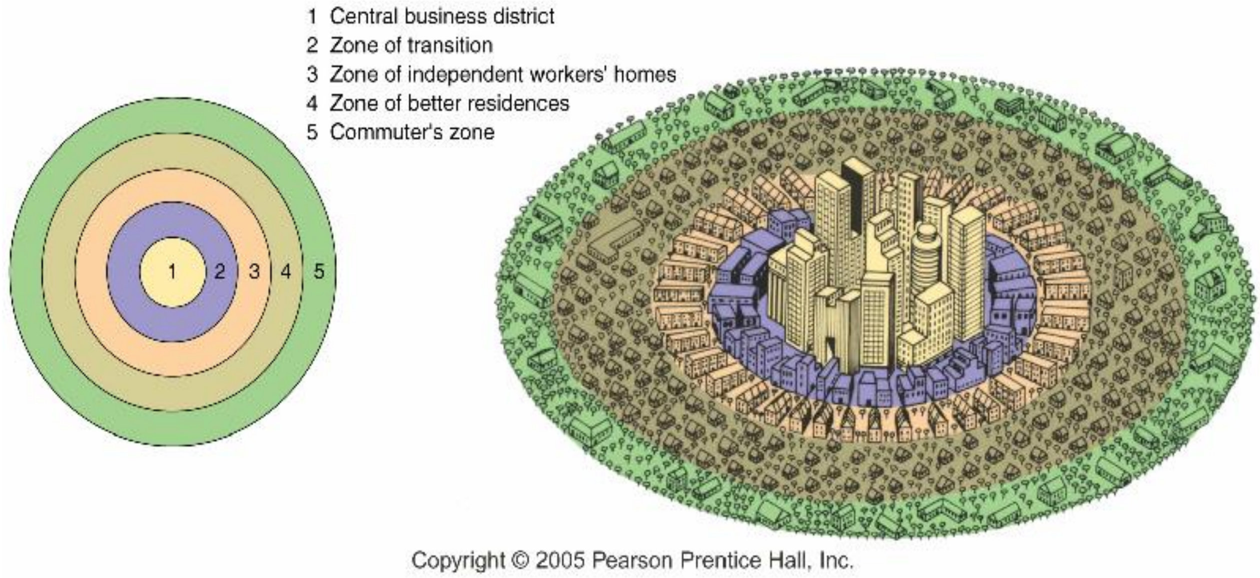


Figure 2.3: The concentric zone model

Source: Cities and Land Uses (2008)

The model was originally developed to present Chicago’s spatial form with regards to the usage of zones around the city, although its current spatial form is not similar to Burgess’ model (Peterson, 2004:13). The zones radiate from the city center, referred to as the loop, and they move outwards in a concentric pattern (Lewinnek, 2010:198). But in the real urban world, the concentric rings rarely link up to produce a complete ring around the city center (Harvey, 1996:5). Torrens (2000:14) criticized the concentric zone model for ignoring the influence of topography and transport systems on urban spatial form. Deak (1985:45) maintains that Burgess’ sociology background limits his perspective to social class and ethnic factors in ascertaining residential land use, while ignoring other land uses. In the same vein, much of the criticisms of the model were informed by its failure to sufficiently incorporate the apparent tendency for various land-use areas to expand radially along major transport routes (Friedman & Weaver, 1979:60).

Therefore, one can deduce that the concentric zone model promotes segregation and social inequities, without considerations for integrating transportation and residential land uses with other land uses. However, it is argued that there is no perfect model, since models are a simplified and generalized presentation of reality. Moreover, because the growth of many North American cities was informed by differences in race and social class, the model is perhaps a depiction of the historical growth patterns of these cities. In the words of Friedman and Weaver

(1979:58-59), the description of the concentric zone model is probably still the most concise explanation of the physical expansion of American cities to a metropolitan scale.

2.3.2. Sector model

Hoyt's sector model was developed in 1939 to address the factors overlooked by the concentric zone model (Friedman & Weaver, 1979:60). The sector model is premised on the recognition that transport axes, such as rail lines and major roads, guide development and thus transport has a directional effect on land use. Hoyt theorized urban growth as a star-shaped pattern of development (Hutchison, 2010:872) with similar types of land use extending outwards from the urban center along transportation corridors (Friedman & Weaver, 1979:61), following railroads, highways and other transport arteries (Squires, 2012:172); as shown in Figure 2.4.

According to Friedman and Weaver (1979:61), this was thought to be especially true for residential land use, with the direction of movement of upper-class residential areas influencing the axial growth trend of the whole city. Essentially, Hoyt observed that low-income households are located close proximity to railroad lines, while commercial land uses are found along business thorough fares (Harrison & Campbell, 2001:184). For example, Soweto, a peripheral area in the south-west of Johannesburg, has a population of over 1 million inhabitants, and it is located close to the old metro railway line.

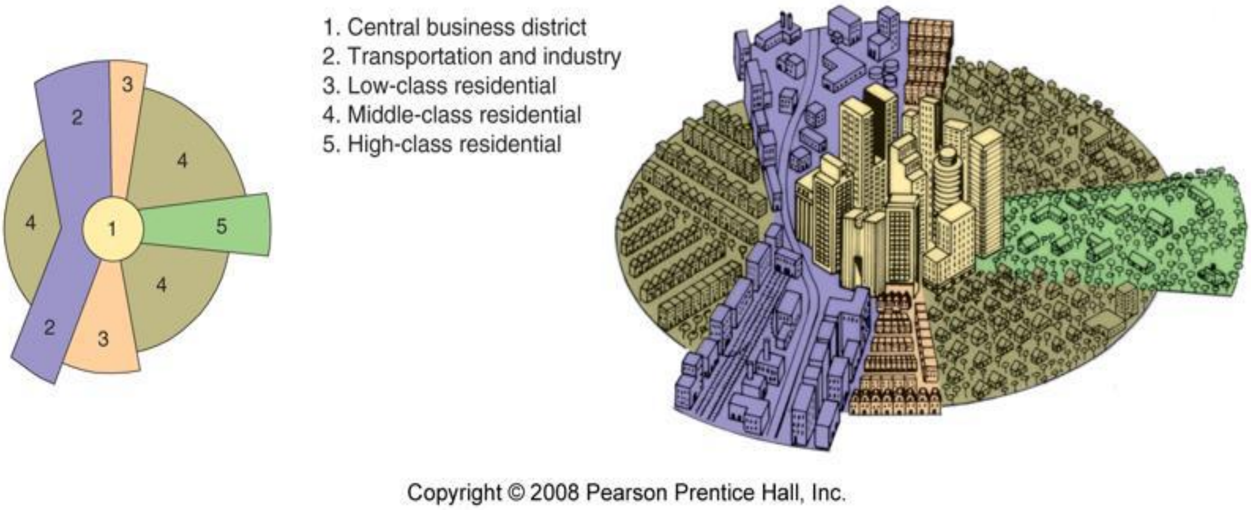


Figure 2.4: Hoyt's sector model

Source: Cities and Land Uses (2008)

Interestingly, the sector model identifies with the importance of providing limited transportation in urban areas, although it suggests that specialization of land uses takes place according to direction, rather than just distance from the location with highest accessibility (Tank, 1987:37). This implies that the model recognizes that residential locational decisions are linked to other factors besides accessibility.

It can be deduced that both the concentric and sector models are focused on the significance of accessibility to the CBD. However, they promote urban sprawl and fragmentation by separating land uses through the growth and expansion of zones. In addition, it is eminent that the two models are oriented towards a monocentric urban form, focused on the CBD, with distinct boundaries between the different residential land use zones; but such boundaries may not exist in reality.

2.3.3. Multiple nuclei model

The multiple nuclei model, proposed by Harris and Ullman (1945) is a hybrid of the concentric and sector models, with an integration of multi-nuclei which shows functional specialization (Friedman & Weaver, 1979:61; Rhind & Hudson, 1980:191); although Swanson and Kaplan (1994:362) argues that the model departs from the concentric model to suggest the complexities of larger urban (metropolitan) areas, with multiple land centers (Torrens, 2000:15), because of the view that a growth in private car ownership enhance high mobility.

As argued by Ruffin, (2012:14), the model recognizes that different activities demand diverse accessibility requirements. It is premised on the need for urban land uses to cluster around several nuclei rather than a single core (Murdie, 1974:110). Some activities cluster in certain areas because of the benefits of agglomeration, while others appear to repel each other, for example residential zones and industries. Its selling point is that it substantiates the fact that large metropolitan areas appear to be conurbations which have grown up around various centers or nuclei (Friedman & Weaver, 1979:61).

What differentiates the multiple nuclei model from the concentric zones and sector models is that it has several centers, through separation and dispersal of commercial activities (as in Figure 2.5). According to Schrenk et al. (2011:213), the larger cities develop suburban areas, with those that have reached a significant size beginning to function like smaller business districts. This implies that industries with similar land use and financial demands agglomerate, leading to multiples of such activity centers or nuclei (Squires, 2012:172).

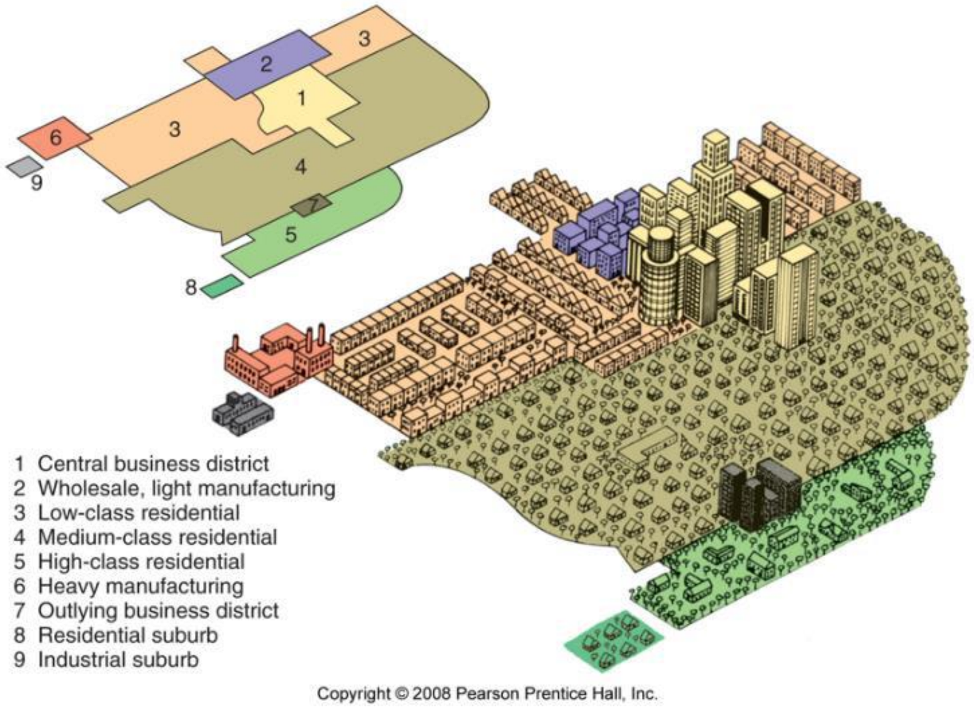


Figure 2.5: Multiple nuclei model

Source: Cities and Land Uses (2008)

Overall, the argument that early models on urban form do not support a compact, mixed-use and public transport oriented spatial pattern is reflected. Although the sector model recognizes the need for short distances between residential areas, non-motorized modes and other activities, it lacks the demand structure required for a high volume of public transport. The models promote segregation by creating unrealistic boundaries between different land uses, and separating low-income groups from the high-income groups.

It is also argued that the models were culture sensitive because they were developed on the basis of culture and behaviors of the population that the proponents attempted to present. For example, the concentric zone and multiple nuclei models were tailored after the growth of Chicago and similar North American cities, but may not be applicable to cultures outside that area (Dutt et al., 2008:293). However, the models remain relevant in literature because their elements can be universally found in modern metropolitan cities.

By building on the line of arguments above, it becomes imperative to acknowledge that planning transcends boundaries, and transportation plays a significant role in moving people and goods from origin to destination, and across jurisdictional boundaries. The growth of cities beyond their walls and jurisdictional boundaries, a process called "metropolitanization" (Healey, 2006:528), has informed the recent development of city clusters and large agglomeration. Agglomeration represents those concentrations or clusters that appear at the higher levels of geographic resolution. The clustering of agents of production and consumption generates a comparative advantage which often leads to cost reductions and enhanced utility (Mulligan, 1984:2). In addition, agglomeration is believed to promote creativity, innovation and the diffusion of new ideas and skills (Mulligan et al, 2012:411).

2.4. Unpacking the metropolitan region and theories of urban growth

According to UN-Habitat (2015:13), a metropolitan region is the spatial outcome of the economic and other interdependencies between the core and the peripheral. The region usually includes a number of independent local government jurisdictions; and there is a need for connectivity and regional transport to promote the development of these large agglomerations (UN-Habitat, 2009:34). Glasson and Marshall (2007:6) argue that the concept of regional planning is highly elastic because a region is determined by its historical and spatial context.

Although in practice, this elasticity is not absolutely without limit; it mostly refers to a scale below the nation state, and always to a scale above the municipal or communal government jurisdiction (Glasson & Marshall, 2007:8). A region is any area of subnational extent that is functionally organized around some internal central growth poles (Scott & Storper, 2003:580). According to Rodrigue et al. (2006:83), regions can be spatially subdivided into three basic components:

- A set of locations of specialized industries such as manufacturing and mining, which agglomerates based on location factors such as raw materials, labour, markets etc. These industries are often export-oriented and they are strongly responsible for regional growth
- A set of service industry locations, including administration, finance, retail, wholesale and other similar services, which forms an agglomeration of central places (cities) that provides optimal accessibility to labour or potential customers.
- A pattern of transport nodes and links, such as railways, roads, airports and ports, which service major centers of economic activity.

In light of this, the research attempts to depict regional economic growth through the central place theory and the growth pole theory. Of importance is the conclusion that these theories draw attention to how economic activity is organized across geographic space.

2.4.1. Central place theory

The central place theory has been critically debated since its creation by Christaller (1933) and Losch (1941) (Mulligan et al., 2012:407). Christaller depicted a region as a cascading system of central places, each surrounded by nested hexagonal market areas (Figure 2.6), with the most central location serving as the provider of all goods and services. Within the hierarchy, a central place on one level is able to provide goods and services specific to that level and all lower levels (Mulligan, 1984:4; Mulligan et al., 2012:408; Beguin, 1992:213). The theory highlights the significance of space in generating a trade-off between the economic advantages induced by the agglomeration of production and the transportation economies associated with a dispersion of production (Beguin, 1992:212). Christaller maintains that more types of goods will be clustered at the center as a result of cheaper and quicker transportation (Beguin, 1992:218). According to Dawkins (2003:155), the central place theory predicts that: (i) towns with similar size will be located roughly the same distance apart; (ii) there will be few large cities and many small cities dispersed throughout economic space; (iii) small towns exist to serve local customers while large cities serve local markets and customers from smaller towns.

The premise behind the notion of the central place theory is that the central places are centers of attraction to all factors of production, and they are able to spur agglomeration and economies of scale. Through a reduction of distances between producers and consumers, agglomeration is said to favour the development of central places (Beguin, 1992:222). Christaller's central places have been compared to nodal development, but Preston (1971:136-138) highlighted the essential difference by reflecting on their absolute and relative importance. Preston argued that centrality is focused on settlement size and the relative importance of settlements as regional centers, which translates to their role as providers of goods and services in excess of those demanded by the center's own inhabitants.

According to Preston (1971), Christaller defined the sum of the agglomeration of population (settlement size) and the central place as absolute importance, while the ability to provide for inhabitants of lower levels is regarded as relative importance. On the other hand, nodality is not relative because there is no emphasis on making provision for the residents outside the nodal area.

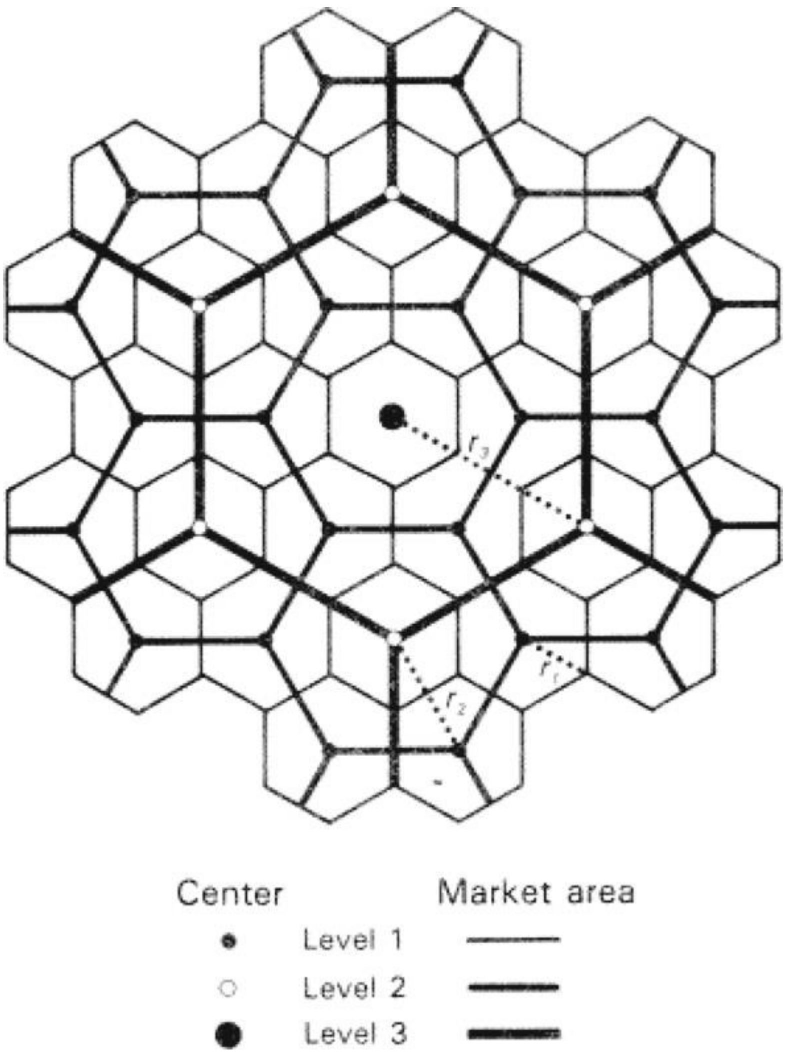


Figure 2.6: A typical central place theory hierarchy of hexagonal market areas
Source: Mulligan et al (2012:409)

Although the central place theory is focused on the distribution of economic activities over a geographic space, Christaller recognized the possibility of other influences besides the service principle, by asserting that the need for long-distance transportation cause centers to be aligned along main routes. Christaller believes that the influence of transportation is evident only in the development of rows of low-ranking centers on the main routes between higher centers (Brush, 1953:392).

The central place theory has been criticized for its rigid perspective (Parr, 1978:35; Dawkins, 2003) and ignorance of many important dimensions of regional economic growth (i.e. labour migration) (Dawkins, 2003:137); while Mulligan et al. (2012:426) and Parr and Denike (1970:585) observed that it lacks microeconomic foundations and general equilibrium approach. Beguin (1992:227) concludes that the central place theory is inconsistent because of Christaller's poor spatial economic background and over-reliance on economic factors. Derudder and Witlox

(2004:178) point to the shift from manufacturing based production to a knowledge economy, as well as the evolution of a network of world cities through globalization as occurrences outside the scope of Christaller's central place theory. Fujita et al. (1988:490) suggested the introduction of land market to address the spatial distribution that may be induced by increased demand from consumer clusters close to the new concentration of firms.

Incidentally, Losch (1954) expanded on Christaller's ideas by placing them in an economic context. Losch defines the optimal central place as the urban cog-wheel that has the highest diversity of market offerings for regional customers (Dawkins, 2003:155). Losch conceived a more realistic spatial division of labour to mitigate the rigid nature of Christaller's ideas (Mulligan et al., 2012:408).

On the basis of Christaller's viewpoints, the hierarchy of central places qualifies as an example of a polycentric region, although the influence of transportation on regional form is only reflected on routes linking higher centers. This stems from the assumption that the centers are places of economic activities where inhabitants (residents) meet to exchange goods and services. It is understood that transportation was seen either as a factor of production (by producers and suppliers) or as a factor that influence location and purchase decision by buyers, rather than emphasizing on accessibility as a tool for shaping the region's form.

2.4.2. Growth pole theory

Growth poles are centers of economic activities from which growth is spatially dispersed within a regional urban system (Srivastava, 2011:2). Originated by Perroux (1950), a growth pole referred to linkages between firms and industries. Propulsive or larger firms generate induced growth through inter-industry linkages as the industry expands its output (Dawkins, 2003:140). As conceived by Perroux, growth poles develop in an economic space which is defined without reference to geographic space (Gauthier, 1970:616; McKee, 2008:100). But authors since Perroux, especially Boudeville (1966) and Friedman (1972) have attempted to improve on Perroux's ideas by incorporating space into the concept of a growth center. For Boudeville, development can be viewed from three types of geographic space: homogeneous, polarized and programmed or planning space (Boudeville, 1961:8-16).

Homogeneous geographic space translates to a maximum internal homogeneity of all elements over the uniform region. Polarized space focuses on the linkages that exist between points distributed in geographic space and the interaction associated with those linkages. Finally, Boudeville defines a region from the point of view of specific planning goals. A planning or programming region is a geographic space organized for the realization of the objectives of a planning or political authority. On the other hand, through the center-periphery model, Friedman highlights the role of innovation and social relations in distributing growth over a geographic space. Such social relations entail a stable interface between the local leadership and the dependents (residents). Friedman links economic development to the emergence of a hierarchy of cities of the Losch type, with size and unstable labour mobility determining the rate of growth (Gauthier, 1970:618).

From the viewpoint of the central place theory, Gauthier (1970:616) maintains that the growth pole is compatible with the hierarchies of central places. According to Gauthier, 1970, the propulsive (larger) industries that create economic growth poles have a geographic location in growth centers which are the larger, more functionally complex centers in the urban hierarchy. The hierarchical nature of the growth poles is reinforced by the words of Perroux (1970); “growth poles do not appear everywhere at the same time, they become manifest at points or poles of growth, with variable terminal effects on the whole of the economy” (Mckee, 2008:100).

However, it appears that the emergence of the facilitative business services such as accounting, banking, legal assistance and various forms of consulting provided assistance to a business clientele already in place at the leading firms and propulsive industries (McKee, 2008:101). The growth of the service sector is attributable to the increased geographic size of markets, innovations in transportation technology and the rise of multinational corporations (Noyellle & Stanback, 1984:3). Transportation, communications and advertising are seen as other significant service sectors that facilitate the inter-industry linkages responsible for growth expansion (McKee, 2008:103). Unfortunately, such expansions in a free enterprise economy sometimes lead to urban centers in dire straits after having hosted and lost growth poles as a result of new directions in the economy and location of new leading sectors elsewhere.

McKee (2008:104) suggests that diversification coupled with the assistance of various service activities may lessen such adverse effects. In a similar vein, Parr (1999:1255-1256) opined that the expansion of firms at the growth pole, supported by regional transport improvements (Gauthier, 1970:618) may limit the growth of firms and households located at the hinterlands. Parr’s (1999) argument is consistent with the observation by Dawkins (2003:140) that growth pole policies were abandoned in the 1980s because they failed to induce speculated growth of lagging regions.

In a similar argument, Richardson (1981:275) maintains that growth centers have failed to diffuse development intra-regionally; and in most cases, policymakers frequently abandon the strategy because they lack the tenacity and courage to achieve results.

From the various reflections on the role of transportation in early regional economic development, emphasis was on transportation cost as a factor in locational decision-making

(Hotelling, 1929; Weber, 1929; Christaller, 1933; Losch, 1954; Gauthier, 1970; Friedmann & Alonso, 1975; Scott, 1983:7; Krugman, 1991; Fan et al, 2000). It can be argued that locators will always seek to mitigate the costs of distance by adopting locations that reduce linkage length as far as possible. Implicitly, suppliers will want to locate close to buyers in order to maximize demand, and buyers will want to locate close to suppliers in order to minimize cost, insurance and freight (c.i.f.) prices (Scott, 1983:7).

In Weber's (1929) view, transportation costs of firms are influenced by weight and distance. Weight-losing firms – where the raw materials are heavier than the final product – will locate near input sources while weight-gaining firms will tend to locate near consumer markets. Friedman and Alonso (1975) reflected on the implications of multiple raw material sources, irregularly shaped transportation networks and market areas on optimal plant location. In this regard, Krugman (1991) defines his core-periphery model as one where all manufacturing is located in the core and all agricultural production is located in the periphery.

It can be argued that the core-periphery model makes provisions for multiple raw material sources because it is an agglomeration of nodes defined by their contribution to the final outcome. However, the changing patterns of accessibility induced by regional transportation improvements must be consistent with the objectives of the regional plan for development (Gauthier, 1970:616-617). It is deduced that a careful and realistic analysis of the likely external effects of all growth and investment decisions at the regional planning stage, underlined by an understanding of the functioning of a regional space economy can mitigate most unwanted outcomes (Parr, 1999:1256, 1265).

Regional planning involves an integration of existing elements and the dynamics and procedures that must be synergized regionally to facilitate anticipated outcomes (Bryson & Roering, 1996). These outcomes are economic (increased productivity), environmental (adaptation to climate change impacts and reduction in energy use) and social (promoting territorial cohesion and complementarities in both growing and declining areas) development (UN-Habitat, 2015:2); and they can be enhanced by agglomeration and urbanization (Scott & Storper, 2003:581).

From the foregoing, it can be concluded that the central place and growth pole theories were informed by the distribution of economic activities and outcome over a geographic space. While interactions between economic activities largely determine spatial and transportation outcomes, it is argued that their alignment with environmental management was largely overlooked. But it appears that this concern is accounted for by the smart growth model.

2.4.3. Smart growth model: the corridor development approach

According to Daniels (2001:277), the smart growth model has proven through empirical evidence from Maryland that regional expansion caused by population growth can be contained. The smart growth promotes compactness and reduces the cost of public services, sprawling and land consumption. But the state must ensure integration of plans (land use patterns, transportation and infrastructure) between communities by enacting ordinances that promote efficiency and development. Godschalk (2000:20) opines that these integrated plans should be reviewed for consistency by regional agencies and subjected to approval through cross-acceptance by local governments.

In most cases, regional integration of plans demands disintegration from sector priorities in order to be able to see an issue from the angle of the interrelation of activities in the region (Healey, 2006:539). But institutional barriers in countries where investment resources and regulatory powers are concentrated at the national level, as seen in England and Northern Ireland, can inhibit regional integration (Healey, 2006:539). To mitigate such outcomes, Godschalk (2000:20) advocates for regional empowerment to promote public transportation, provision of region-wide infrastructure, fair-share housing and open space.

Furthermore, Friedman (2004) highlighted the significance of focusing on planning to produce outcomes through changing paradigms and the creation of new institutions. Because of the usual disconnect between the pace of actual events and the time it takes to produce the planning blueprint, emphasis must be shifted away from plans to scenarios. Essentially, he argued that published plans are used by politicians to provoke public sympathy and to induce support for funding from the private and public sector (Friedman, 2004:54, 56). The argument by Friedman (2004) for a paradigm shift is consistent with the call for a shifting and re-shaping of convictions by Healey (1997:244-245). However, Friedman (2004) further reflected on the collaborative and network planning components of the conventional strategic planning process.

Contemporarily, Forster (2006:178); Filion and Kramer (2011); and Botha (2017:48-50) made a case for the use of nodal and corridor development as the tools for achieving regional planning outcomes. This approach is consistent with Schoeman's (2014:5) argument that the integration of transportation and spatial planning with functions like land use, economic planning and development can be achieved through approaches like densification, as well as nodal and corridor development. The significance of transportation in linking growth poles within a corridor is further underscored by its ability to enhance accessibility.

Since the peripheries are only integrated after the core had been developed (Srivastava, 2011:2), accessibility induced by densification and public transit (different modes) infrastructure appears to be a good catalyst for distributing growth (Marrian, 2001; Kramer, 2009:518). By investing in rapid transit, especially in outer suburbs which are sites for future nodes, the region can limit the influence of the private car by trips from the suburbs on the pedestrian and public transport oriented inner nodes (Fillion & Kramer, 2012:2253). Soria Y Mata's linear city (Ciudad Lineal) model was an example of corridor development centered on transport infrastructure, and it has informed many regional plans which have advocated some sort of linear extension of large cities based on infrastructure (Priemus & Zonneveld, 2003:168). By drawing on the Netherlands experience, Priemus & Zonneveld (2003:173) identified three distinct meanings of the corridor development model:

- The corridor as an infrastructure axis, defined in terms of traffic engineering
- The corridor as an economic development axis, where spatial outcomes of functional economic activities are strongly determined by the infrastructure network
- The corridor as an urbanization axis, where the infrastructure network guides future location of residential and work activities

However, it is assumed that these models can exist exclusively or as a combination of models. For example, India's Delhi Mumbai Industrial Corridor is a 150km wide, 1,500km long corridor served by a multi-modal high-speed freight corridor that amalgamates 9 industrial zones, 3 ports and 6 airports over 6 Indian states (UN-Habitat, 2013:50).

It can be deduced that such spatially balanced development is associated with polycentric settlement systems, whose main elements are metropolitan areas, city regions or super-agglomerations (Godschalk, 2000; Daniels, 2001; Scott & Storper, 2003:581; Cohen, 2006:67; Forster, 2006: 178; Sykora, et al, 2009:234; UN-Habitat, 2015:2). The city regions are regarded as the locomotives of their national economies because of their intense economic activities, innovation and productivity (Scott & Storper, 2003:581). By concentrating most human activities in territories, the balanced polycentric development attempts to pluralize choices for individuals, households or economic subjects in terms of access to jobs, services, knowledge, and so on, within an interrelated system of local, regional and national tiers of urban centers (Sykora, et al., 2009:235). There is a growing preference for models that combine nodal development premised on public transport (transit). This according to Filion and Kramer (2011:2238) is attributed to the ability of the nodal perspective to stimulate substantial urban structure and transport change.

In Australia, all five metropolitan areas adopted similar planning policies informed by the three principles of 'containment, consolidation and centers'. While the centers concept promotes polycentricity, with nodes well served by public transport and adjacent high and medium density housing; urban containment and consolidation attempts to cluster urban growth through higher densities, modal shift to public transport, less energy consumption and limiting urban expansion (by using urban growth boundaries) to preserve surrounding ecosystem (Forster, 2006:178-179). Although the regional policies imperatives seem well-intended, Forster (2006) was critical of their rigid and utopian nature, and their departure from the complexities in the evolution of Australian cities (Forster, 2006:180).

While being critical of the density corridor approach, Filion and Kramer (2012) maintain that limitations like frequent NIMBY (not in my backyard) assaults associated with the wider coverage area, institutional capacity and the need to sustain interest of the development industry could hamper its implementation. The authors strongly made a case for the nodal strategy for transforming from the dispersed to the concentrated urban form. In a Canadian context, the six largest metropolitan regions have shown unanimous support for the intensification and reduced dependence on cars, a measure of the influence of the smart growth and sustainability message on their urban planning imperatives. Nodal development is prominent in metropolitan plans in Canada because of its high inner synergy potential, simpler institutional requirements – which enable numerous jurisdictions to develop their own suburban downtowns (outer nodes) – and the general ease of implementation (Filion & Kramer, 2012:2250-2253).

It can be deduced that a growth node is the smallest unit of the corridor and the nodes may grow naturally based on their different economic dynamics. These dynamics can be reproduced in locations with similar context, resulting in new growth poles within a region; thereby justifying the use of nodal development as a regional planning tool. In addition, the intersection of different movement networks can also induce nodal growth because they create opportunities for people, goods and services to develop and interact (Schweitzer, 2009:422). Botha (2017) opines that different nodes may be created as a result of different reasons and functions within a region, generating a nodal hierarchy. Meanwhile, a corridor is a linear spatial element consisting of two or more nodes connected by at least one mass public transport route, which may be fed by supporting feeder routes (Marrian, 2001:7). Figure 2.7 depicts the string of beads concept, which reinforces the deduction by this study, by suggesting that nodes and sub-nodes occur along the main movement channel (Warnich & Verster, 2005:344). The higher density areas around nodes represent the different infrastructure that the corridor generates.

From the foregoing, it can be concluded that corridor development is essential to projecting the theme of this study. According to Marrian, (2001:12) and Warnich and Verster (2005:345), "the activity/development corridor is a conceptual frame in which a certain desired relationship between land use, economic activity and traffic movement/flow is articulated through essential elements such as a major transport route, public transport modes, linkages between nodes and sub-nodes, intense mixed-use development, intense human interaction, availability of services, and public investment in adjacent vicinities of the corridor." In addition to the views on promoting corridor development through alignment of land use, economic activity and traffic flow; Jordaan (2003) pointed out that environmental management should be incorporated into a planning process that identifies the implication of each discipline before addressing and integrating them into the corridor design guidelines (Jordaan, 2003:9).

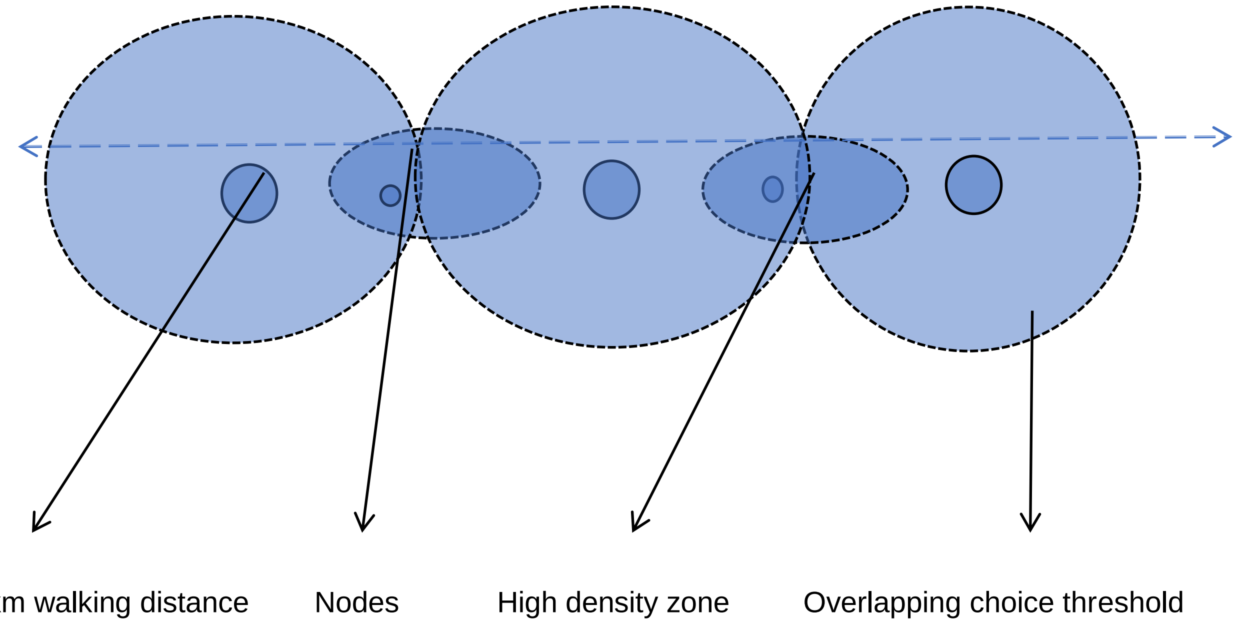


Figure 2.7: String of beads concept

Source: Own construction (2019) adapted from Warnich and Verster (2005:344)

It can be concluded that regional or metropolitan development can be premised on the establishment of integrated nodes and corridors, by using the smart growth perspective. Although, there have been arguments in literature (Priemus, 2001; Priemus & Zonneveld, 2003; Forster, 2006; Healey, 2006; Filion, 2009; Sykora et al, 2009:235-237; Filion & Kramer, 2012) in this regard, it appears that enhancing the pre-conditions summarized in Table 2.1, as adapted from Marrian (2001) can reinforce the conclusion by this study.

Table 2.1: Pre-conditions for corridor development

Pre-conditions / requirements		Description
Economic	Pre-existence of economic viability	Area must have: (i) pre-existed strong economic growth; (ii) potential and strong effective demand for further mixed use development; (iii) free of inhibitors
	Economic sense	Economic feasibility with the ability to offer investors satisfactory cash return on their investment, relative to competing opportunities
	Critical (competitive) economic mass	Corridor-locations must either match the other localities attributes or provide a unique absolutely overwhelming attribute
Organizational/institutional	Integrated and coordinated governance	Vertical and horizontal integration across spheres of government and non-governmental role players responsible for land use policy and management; transportation planning and infrastructure investment; and maintenance. There may be need for institutional transformation, especially at the local governments, because they are most intimately responsible for the corridors
	Enforcement/implementation	Corridor plans must be implemented and enforced with incentives and coercion depending on the operating environment
	Capacity	All role players must be adequately capacitated
Physical	Connectivity between nodes	Strong functional links must exist between nodes to facilitate movement and interaction in a corridor
	Promotion of multi-modal transportation	Existence of multi-modal transportation is essential to provide alternatives for users
	Efficient feeder system	A feeder system with provision for all modes is necessary for optimization of the main routes on the corridor
	Regional/metropolitan focus and accessibility	Corridors must be attractive and linked to the wider metropolitan area by public transport.

	Land for low cost housing	Publicly owned or acquired land must be provided for low cost housing and economic activities
Behavioral	Cooperation and culture of public transport use	All parties involved must be firmly committed to the ideal, supported by wide usage of public transport
Political	Political will	The corridor vision must be acceptable to politicians in all spheres and in all sectors of government
Perceptions	Good image	Public perception by residents, media and potential investors is essential for best outcomes
	Integrated plan and planning	An integrated approach to land use and transportation must be adopted. Emphasis is on a metropolitan-wide integrated planning process and institution to oversee the implementation
	A total onslaught	The entire metropolitan area must become public transport oriented
	A broad mix of intensive land use	Intensively mixed (residential and commercial) land use is essential for the delivery of best TOD outcomes
	An action plan with a time frame	A programme of action with definite time frames indicating exactly when transportation and other infrastructural investments in the corridor will be made is crucial for investor confidence
Plan and planning requirements	Zoning stability	Private investors must be assured of the medium to longer time zoning situation in a corridor

Source: Own construction (2018) adapted from Marrian (2001:7-10)

In light of the above, it can be deduced that corridor development is hinged on top-down and bottom-up integrated transport and land use planning underpinned by institutional capacities and competencies with a strong orientation for implementation and adequate knowledge of the respective operating (regional) environment. Corridor development links transportation, land use and environmental planning, and it may serve as a contemporary regional planning tool. Metropolitan planning organization (MPOs) can play a leadership role in this regard, through their long-range planning and programming activities (Williams & Marshall, 1996:11).

Perhaps an understanding of the evolution of metropolitan planning will provide insights on the connections between transportation, land use and environmental outcomes on a regional scale. The rapid growth, overcrowding and service demands of industrial cities in the 19th century led to modern metropolitan planning, underlined by region-wide governmental structures. Britain responded by creating institutions such as the London Metropolitan Board of Works (1855), while the U.S. cities created single-purpose regional districts such as Boston's Metropolitan Sewerage Commission (1889) (Wheeler, 2000:135). Meanwhile, the more specific City Beautiful plans of the 20th century stressed the creation of civic spaces, boulevards, neoclassical monuments and regional park systems – aesthetic and recreational amenities which were lacking in the 19th century industrial city.

In the case of Australia, colonial legacies from the 19th century vested the powers for the planning and supply of metropolitan infrastructure in the state government authorities (Searle & Bunker, 2010:164-165). Metropolitan planning was further influenced by the introduction of the automobile in the late 1910s and 1920s, by incorporating automobile-oriented ideas like regional highway systems, inwardly focused suburban neighborhoods and dispersal of industry into centers throughout the region.

After World War 2, metropolitan planning thrived in Britain and continental Europe, with the need for postwar reconstruction combined with social democratic politics. For example, metropolitan spatial planning approaches like the finger plans – channeling development along transit lines – were adopted in Copenhagen and Stockholm. With these plans, the central governments attempted to shape the spatial form of the metropolitan region, to save open space and limit growth, and to coordinate land development with public transportation (Wheeler, 2000:136). At the same time, the U.S. experienced rapid growth in automobile use, widespread suburbanization and a vast increase in federal spending for transportation investments, leading to a need for regional modeling of travel behavior (Johnston, 2004:116).

However, contemporary regionalism is confronted with dilemmas like jurisdictional fragmentations; political conflicts; entrenched power interests; institutional fragmentations in transportation and land use management (Wolf & Fenwick, 2003:123) and tax base disparities. Conversely, by arguing from a sustainable planning perspective, Wheeler (2000:137) concludes that integrating land use, transport and environmental management through approaches like the smart growth and the new urbanist design can promote regional planning imperatives on a metropolitan scale.

From the various reflections on the emergence of metropolitan planning in the developed economies, one can conclude that it was informed by economic growth, politics, post-World War 2 reconstruction and rapid motorization. It appears that the increasing automobile orientation induced dispersed urban developments which due to their sprawled nature catalyze the need for planning on a regional or metropolitan scale. It can therefore be concluded the automobile, as well as institutional role players in most developed economies were responsible for the development of metropolitan planning.

2.5. Alignment between urban planning, transportation and regional planning

Transport is the means by which: people travel to work, play, shop or business; raw materials are conveyed from the land to a place of manufacture or usage; and goods are moved from the factory to the market place and from the staff to the consumer (O'Flaherty, 2006:2). The purpose of transportation, therefore, is to facilitate the movement of freight, people and information from a certain point (origin) to another (destination). The spatial separation of human activities creates the need for travel, and this serves as the underlying principle for transport analysis and forecasting (Dieleman & Wegener, 2004:309). Therefore, transport is significant to the structure and organization of space and territories, although this impact varies according to the level of development (Rodrigue et al., 2006:3). The impact of transportation improvements on urban development is perhaps one of the most important, and contested concerns in contemporary metropolitan transportation planning (Giuliano, 1995; Cervero & Landis, 1997; Goldman & Deakin, 2000:60; Handy, 2005; Waddell et al, 2007:382; Colonna et al, 2012:84; Golub & Martens, 2014:11).

Regional transportation plans, such as the ones prepared by Metropolitan Planning Organizations in the U.S. often ignore this feedback effects, thereby jeopardizing the project and plan evaluation. In spite of this practice gap, it can be concluded that there is a very high degree of mutual influence between the evolving urban form of a metropolitan area and its transportation system (Waddell et al., 2007:383). One could never hope to understand the changing spatial structure of a metropolis without understanding its movement patterns. Accessibility is the underlying factor of this relationship (Banister, 1999:319; Papa & Bertolini, 2015:81), and it is regarded as the potential for interaction (Hansen, 1959), or the ease of connection between places. According to Banister and Lichfield (1995:12) and Straatemeier (2008:128), this potential for interaction is influenced by the quality and quantity of the transport system (depicted by travel time or the costs of reaching a destination) and the qualities of the land use system (qualities of potential destinations).

The accessibility of places has a major impact upon their land values (Hanson, 2004:5; Rodrigue et al., 2006:11; Dieleman & Wegener, 2004:315) (and hence the use to which the land is put), and the location of a place within the transportation network determines its accessibility (Hanson, 2004:5). Interestingly, the final aim of both transportation and land use is to answer the needs of human beings, whose habits, behavior and later culture and identity are shaped by the processes of transportation and land use (Colonna et al., 2012:85). Theoretically, it is argued that people locate their houses and their workplaces by trading off housing and commute costs (Giuliano, 1995:3), such that they are willing to pay more for housing that minimizes their commute, while on the other hand some may be willing to pay less for housing associated with farther commute (Handy, 2005:149), mostly based on their income levels. According to Rodrigue et al (2006:11, 86-87), locational decisions are taken in an attempt to minimize transport related costs.

In a metropolitan context, the role of transportation in transforming the urban form is an ongoing debate. It is argued that historical factors greatly inform differences in urban form and density. In a global context, European cities are much more compact than their U.S. and Australian counterparts (Rodrigue et al., 2006:173) because, according to Dieleman and Wegener (2004:316), ‘they are much older and partly developed in an era when the streetcar and private car were not yet invented”. As maintained by Newman & Kenworthy (1996:2) and Dieleman and Wegener (2004:309), the evolution from the dense urban fabric of medieval cities – where almost all daily mobility took place on foot – to the vast expansion of modern metropolitan areas was facilitated by the railway and in particular the private car.

In this regard, earlier descriptions of the evolution of the U.S. metropolis linked it to a framework of four transportation eras (Adams, 1970). According to Adams (1970), each growth stage reflects a particular movement technology and network expansion process that shaped a distinctive pattern of intra-urban spatial outcomes:

i. Walking-Horsecar Era (1800-1890)

ii. Electric Streetcar Era (1890-1920)

iii. Recreational Automobile Era (1920-1945)

iv. Freeway Era (1945-present)

The freeway era spawned the automobile-oriented and polycentric metropolis (Baum-Snow, 2010:382; Newman et al., 2016:436) and an increase in local resistance, as well as higher construction costs induced by the need to conform to stricter environmental regulations (Muller, 1995:82). Handy (2005:149) maintains that during the freeway era, growing incomes informed automobile dominance at the metropolitan level, and this was accompanied by a reduction in travel costs. The automobile created decentralization and catalyzed lower population densities (between 10 and 20 people per ha.) through the expansion of cities (Newman & Kenworthy, 1996:4).

Consequently, urban systems in dense and productive regions like the northeast of the U.S. became structured and interconnected by transport networks to the point that it was considered as the Megalopolis (one vast urban region) (Rodrigue, 2006:23). Although the growing private car dominance and its associated urban spread became a global phenomenon, its impacts were felt locally. This concern informed the devolution of transportation planning from central governments to a regional scale (Lee and Rivasplata, 2001:59). Meanwhile, evidence from metropolitan Los Angeles and Houston had revealed that building new highways does not improve traffic flow (Muller, 1995:82).

Therefore, metropolitan transportation planning has evolved from primarily focusing on highway constructions in pre-1950s United States (Dickey, 1983:2), to more comprehensive approaches informed by concerns for social and environmental aspects of transportation, as well as citizen inclusion in transportation decision-making process (Dickey, 1983:7; Goetz et al, 2002:90). This new approach provided a basis for the introduction of new public mass transit systems like the heavy-rail, electric-train systems in metropolitan San Francisco, Washington D.C., Cleveland, and Atlanta; the less expensive light-rail trolley lines at San Diego, Buffalo and Portland (Oregon); and major bus systems improvements at Indianapolis, Detroit and Dallas. But Muller, 1995:83 argued that the increasingly dispersed travel pattern of the low-density automobile-oriented suburbs of these regions continue to limit the market share of these transit systems.

In Europe, post-World War 2 urban development led to decentralization (population and employment) of major cities in Britain and the Benelux countries (1950s), Germany and Scandinavia (1960s) and finally France, Italy, Spain and Portugal (1970s and 1980s). The decentralization of employment gave impetus to the transfer of journeys from public transport to the private car. The increasing private car dominance facilitated further decentralizations, massive growth of suburban activity and higher suburb-to-suburb commuting (Hall, 2003:79).

Globally, the links between transport and development on a regional scale are evident from the impacts of major transport infrastructures like rail links, airports and ports on local traffic, employment and the local economy. Their presence influences the location decisions of complementary firms and industries, a multiplier effect of such regional transport investments (Banister & Lichfield, 1995:3).

By drawing from Muller’s (1995) argument, it becomes imperative to consider the likely outcomes of new regional transport investments. For example, in metropolitan areas with well-developed transportation systems, large investments on transportation improvements may only have a marginal effect on accessibility (Banister & Lichfield, 1995:5; Giuliano, 1995:6; Wegener, 1995:159; Vessali, 1996:98). As maintained by Banister and Lichfield (1995:4), where local benefits of major transport improvements (high-speed rail links) in such metropolitan areas are found, they are very highly localized and in small scale. Although accessibility appears to be the most appropriate measure of benefits from regional transportation plans and investments (Hansen, 1959; Giuliano, 1995; Hanson, 2004; Martens, 2012; Martens et al., 2012; Golub & Martens, 2014); it can as well lead to a more dispersed urban form if it is increased in the entire metropolitan area (Dieleman & Wegener, 2004:315). In the words of Banister (1995:279), “it is only in the developing countries (such as South Africa) that the changes in accessibility resulting from investment in new infrastructure will have a major impact on regional and local development”.

In this regard, it is essential to evaluate all likely impacts, including those that could affect other areas, groups or time periods (Litman, 2015:6). However, using empirical evidence from Tokyo, Wegener (1995:159) argues that exceptions exist in regions (developed countries) where accessibility remains a scarce commodity in spite of improvements to the already existing extensive transport networks. In Tokyo, accessibility – informed by rail travel time to Tokyo Station – remains a key determinant of all location and travel decisions because employment is still highly centralized and central parking is highly unaffordable (Wegener, 1995:159).

Similar to the above line of argument, the locational decisions of households and firms in the U.S. and European Union (EU) are becoming increasingly unaffected by transportation because of innovations like telecommuting (as well as teleshopping) and the growing dominance of information based firms, whose locational considerations are not influenced by the need for physical access (Giuliano, 1995:6; Bannister, 2003:12-13; Dieleman & Wegener, 2004:313). Although there is empirical evidence to link the location decisions of firms and industries to regional transport innovations like the European high-speed rail network and the Channel Tunnel, because they stimulate agglomeration economies of certain locations and reduce transport costs (Bannister, 2003:12); additions to such extensive networks make more industries footloose and reduce the potential of such additions to influence locational decisions (Banister & Lichfield, 1995:5). As argued by Banister and Lichfield (1995:5), likely reductions in transport costs may be absorbed through higher profits or rents, or through higher wages, or lower prices to the consumer.

On the other hand, by incorporating the environment into the growing concern on the impact of transportation on urban development (Wheeler, 2000:135), the policy context for metropolitan transportation planning in the United States took a new approach (Waddell, 2002:297). In this regard, legislations like the Clean Air Act Amendments (1990), the Intermodal Surface Transportation Efficiency Act (ISTEA; 1991) and later the Transportation Equity Act for the 21st Century (TEA-21; 1998) were introduced to integrate metropolitan land use, transportation and environmental planning (Paaswell, 1995:36; Newman & Kenworthy, 1996:11; Wheeler, 2000:136; Waddell, 2002:297; Karner, 2016:47); to increase public involvement in planning decisions (Handy, 2008:115); and to give powers to the states and local governments through the MPOs, to conduct metropolitan transportation planning on a regional bases (Goetz, et al, 2002; Wolf & Fenwick, 2003:123). Metropolitan Planning Organizations (MPOs) were created as regional transportation planning agencies with a federal mandate of coordinating federal transportation programmes within metropolitan regions.

In the United Kingdom (UK), these concerns were addressed by the Departments of the Environment and Transport in the mid-1990s, through policy aims that: reduce growth in the length and number of motorized journeys; encourage alternative means of travel with less environmental impacts; and reduce the reliance on the private car (Newman & Kenworthy, 1996:11; Banister, 1999:315-316). It is argued that planning decisions such as these policy aims can play a major role in reducing the levels of traffic growth. With emphasis on using travel pattern – reduced travel (shorter trip lengths) and fewer cars (by promoting public transport and green modes) – to promote balance, Banister (1999:316-319) identifies three key relationships between land use and transport:

- Higher development density can significantly reduce average trip length, car dominance and distance travelled.
- An increase in settlement size can induce shorter trips and higher use of public transport
- Location of activities (households, firms, shops etc.) can equally influence trip lengths and travel times. Locational decisions must be integrated to provide for the needs of each sector, while there must be a simultaneous provision of facilities and services to facilitate the desired reduction in trip length.

Policies that synergize incentives and restrictions have become standard practice in many European countries. Incentives are in the form of promotion of higher-density mixed-use development and environment-friendly modes such as public transport, cycling and walking; and restrictions are measures that limit urban sprawl through stricter land-use control and on car driving through speed limits, parking restrictions and higher fuel taxes. According to Wegener (1995:160), countries like Netherlands, Britain, Germany and the Scandinavians, with strong interventionist planning system have been more successful in integrating land use, transport and environmental concerns through clustering new towns around commuter rail stations.

From an integration perspective, Dieleman and Wegener (2004) summarize the likely outcomes of a smart growth oriented land use transport interaction as highlighted in Table 2.2.

Table 2.2: Theoretically expected impacts of smart growth oriented land use and transport inputs

Direction	Factor	Impact on	Expected impacts
Transport → Land Use	Residential density	Trip length	A mixture of higher residential and workplace density leads to shorter trips if at the same time travel costs are increased
		Trip frequency	Little impact. If destinations are shorter, trips are shorter and more trips are made
		Mode choice	More cycling and walking trips will be made if trips become shorter as a result of the outcome under trip length
	Employment density	Trip length	Clustering workplaces in few employment areas increases average trip lengths. But a balance of workplace and residential densities in the area leads to shorter work trips only if travel becomes more expensive.
		Trip frequency	If origin and destination are closer, trips are shorter and more trips are made.
		Mode choice	Concentration of workplaces in few employment areas reduces car use if supported by efficient public transport. More walking and cycling trips are made only if trips become shorter.
	Neighborhood design	Trip length	Attractive public spaces and a variety of shops and services induce more local trips.
		Trip frequency	Reduced distance between origins and destinations induces more trips.
		Mode choice	Pedestrianized street layout with cycling lanes lead to more walking and cycling.
Transport → Land Use	Accessibility	Residential location	Locations with good accessibility to workplaces, shops, education and leisure facilities are more attractive for residential development. Improving accessibility locally changes the direction of new residential development, improving accessibility in the whole urban area leads to more urban sprawl.
		Industrial location	Locations with better accessibility to motorways and railway freight terminals are more attractive for industrial development.

		Office location	Locations with better accessibility to airports, high-speed rail railway stations and motorways are more attractive for office development.
		Retail location	Locations with better accessibility to customers and competing retail firms are more attractive for retail development.

Source: Dieleman and Wegener (2004:314)

2.6. Promoting transport-land use integration through the smart growth paradigm

Based on the above reflections, it may be imperative to understand how conventional regional transportation planning has evolved in the face of the broader metropolitan planning challenges. For example, how have planners been able to integrate transport, land use and environmental management objectives into the regional planning processes? Currently, metropolitan transportation has transformed from focusing on supply (i.e. siting facilities to meet projected demands) towards a more integrated system- and demand-management perspective (Zegras et al, 2004:4).

In the views of Straatemeier (2008:127), the different concerns faced by urban transportation planning are a reflection of the much broader debate on the role of planning in an increasingly more complex institutional context and market-oriented society. And by exploring the possibilities of using accessibility as a regional transportation planning framework, especially at the policy design phase, Straatemeier (2008:135-136) concluded that planning for accessibility can induce a paradigm shift from planning for transportation network efficiency to a focus on the network position and development potential of places in the urban network. This interprets to an integration of transport and land use at the policy development phase, with a premise on strategically enhancing accessibility for people and places.

From a similar viewpoint, the deliberate coordination of transportation planning and land use through growth management strategies appears to limit or direct growth in an effort to end urban sprawl, limit automobile dependence (Newman & Kenworthy, 1996), as well as to control the scale and timing of development (Wolf & Fenwick, 2003:124-125). Growth management strategies are premised on a close coordination of transportation plans with land use policies and programmes. In this regard, new urbanism and smart growth – specific forms of growth management that promote compactness – have been widely advocated for addressing growth in metropolitan areas (Newman & Kenworthy, 1996; Williams, 1999; Godschalk, 2000; Wheeler, 2000; Daniels, 2001a & b; Ewing et al, 2002; Wolf & Fenwick, 2003; Dittmar & Ohland, 2004; Dieleman & Wegener, 2004:308). Smart growth is an urban growth management approach that promotes the integration of transport and land use at the planning and implementation stages.

According to Litman (2015:35), smart growth provides two primary resource savings: (i) it reduces per capita land consumption, and (ii) it reduces the distances between destinations – which reduces the cost of public infrastructure and services, improves accessibility, and reduces per capita vehicle travel. It is an anti-sprawl policy (Handy, 2005:147; Dieleman & Wegener, 2004:316-317) that leads to outcomes such as: revitalized urban communities; repopulation of central cities; redevelopment of brownfield areas; housing affordability; more social equity (Litman, 2018:42) and less racial and socio-economic segregation; reduced travel demand and shorter travel distances; more biking and walking; cost savings on infrastructure such as road water and sewer infrastructure; preservation of farmland and open space; and environmental protection and improved health.

Against this background, Litman (2015:34) acknowledges that there are internal and external costs, as well as benefits of smart growth. For example, some of the costs include higher land unit costs, more compact housing with less private open space (lawns and gardens), reduced privacy, higher crime rates, and increased exposure to noise and air pollution. But he (Litman, 2015:34) argues that the implementation of comprehensive smart growth policies can minimize and offset many of the impacts (costs). For example, traffic and parking management strategies can reduce congestion problems. By categorizing costs and benefits of smart growth as either internal (borne by the smart growth residents) or external (borne by other people) as highlighted in Table 2.3, Litman (2015:36) concludes that smart growth policies that promote compact development may seem undesirable from a neighborhood (local) perspective but desirable from a regional perspective.

Table 2.3: Costs and Benefits of smart growth

	Internal (To smart growth residents)	**External (To other people)**
Benefits	i) Increased accessibility leading to reduced travel time and money costs. ii) Improved mobility options, which reduces non-drivers' independence and economic opportunity, and reduces. drivers' chauffeuring burdens iii) Less total vehicle travel and congestion costs. iv) More affordable housing options (townhouses, apartments, etc.). v) Increased economic resilience.	i) Open space preservation (farm and natural lands). ii) Reduced public infrastructure and service costs (roads, utilities, emergency and transit services, etc.). iii) Reduced congestion and crash risk imposed on other people. iv) Reduced healthcare and disability costs. v) Increased local economic

	vi) Increased traffic safety. vii) Improved fitness and health.	productivity and development. vi) Reduced overall crime rate. vii) Reduced fuel consumption and pollution emissions.
Costs	i) Higher unit land prices. ii) Less private greenspace (lawns and gardens). iii) Less privacy. iv) Increased local social problems (poverty and crime). More exposure to some pollutants.	i) Increased costs of infrastructure like curbs and sidewalk. ii) More local traffic and parking congestion

Source: Litman (2015:36)

However, the smart growth or compact city policy has been highly debated (Handy, 2005), because some authors have questioned its ability to enhance the quality of urban life (Breheny, 1996; Gordon & Richardson, 1997; O'Toole, 2000; Schwaen et al, 2004:598), while others believe it is an excuse by affluent communities to hamper immigration of low-income households. Cox (2003) and Melia et al (2011) claim that by increasing density, smart growth increases traffic congestion and air pollution. Other critics claim that smart growth reduces housing affordability by reducing urban land supply (Cox, 2003b) and that it undermines consumer preferences by forcing people to single-family homes and private vehicle travel, thereby making consumers worse off (Orski, 2003; Kotkin & Cox, 2013). But smart growth proponents like Litman (2015:42) and Litman (2016) maintain that critics are often biased, misrepresent issues and purposely limit the scope of their arguments by using selected examples and information, while ignoring alternative perspectives and information.

As a result of the ongoing debate on the acceptability of smart growth, it is argued that both perspectives must be incorporated into future theoretical and empirical imperatives, in order to optimize outcomes. Furthermore, it can be deduced that careful and proactive integration of land use, transport and environmental considerations through policy approaches like the smart growth management can facilitate a cohesive regional development on a metropolitan scale. Although it is doubtful that all the highlighted outcomes would accrue only from compact city (land use) planning, the price for inaction or continued sprawling, especially for developing countries appears not to be a better alternative. It is further argued that historical and differing urban contexts and operating environments (Pojani & Stead, 2015a) must be incorporated into smart growth or compact city decisions, as seen in empirical evidences from Europe (The Randstad in the Netherlands) and North America (Portland, Oregon) (Dieleman & Wegener, 2004: 317-321).

By drawing from the above reflections on the smart growth imperatives, it is argued that metropolitan planning must facilitate the integration of transport and land use, underpinned by the alignment of policies and role players, and environmental considerations of the impacts of all anticipated outcomes. For example, in their survey on the extent to which regional transportation planning agencies (MPOs) in the U.S. consider land use factors in their planning processes, Wolf and Fenwick (2003) identified three factors that compel the role players to integrate the two disciplines. The MPOs' processes were mostly influenced by: environmental pressures – in terms of complying with the federally imposed clean air standards and other regulations concerning wetlands and water quality; state laws – in terms of ensuring alignment with regional or state policies and plans; and action by MPO staff and political leaders – by prioritizing interactive and proactive land-use and transportation planning (Wolf & Fenwick, 2003:129-130). These findings are consistent with the conclusions by Goetz et al. (2002), who found that effective leadership, staff competence and credibility, development of a regional ethos and integrated land use planning are among the factors responsible for successful MPOs.

However, it can be deduced that in practice, the transportation-land use relationship seems more complex than it appears (Handy, 2005:163; Litman, 2016a:52). Rather than a simple linear relationship between transportation investments, land development patterns, and travel patterns, Handy (2005:163-164) asserts that what exists is a system of endogenous relationships between transportation and land use, and countless exogenous factors like: the influence of attitudes and socio-demographic characteristics on travel patterns, impacts of land use policies on land development patterns, and political interference in transportation investments decisions (Figure 2.8). In a similar research, Vessali (1996:98-99) highlighted the availability of developable and easily assembled land as a powerful exogenous factor that determines the scope of land use impacts from new transport developments.

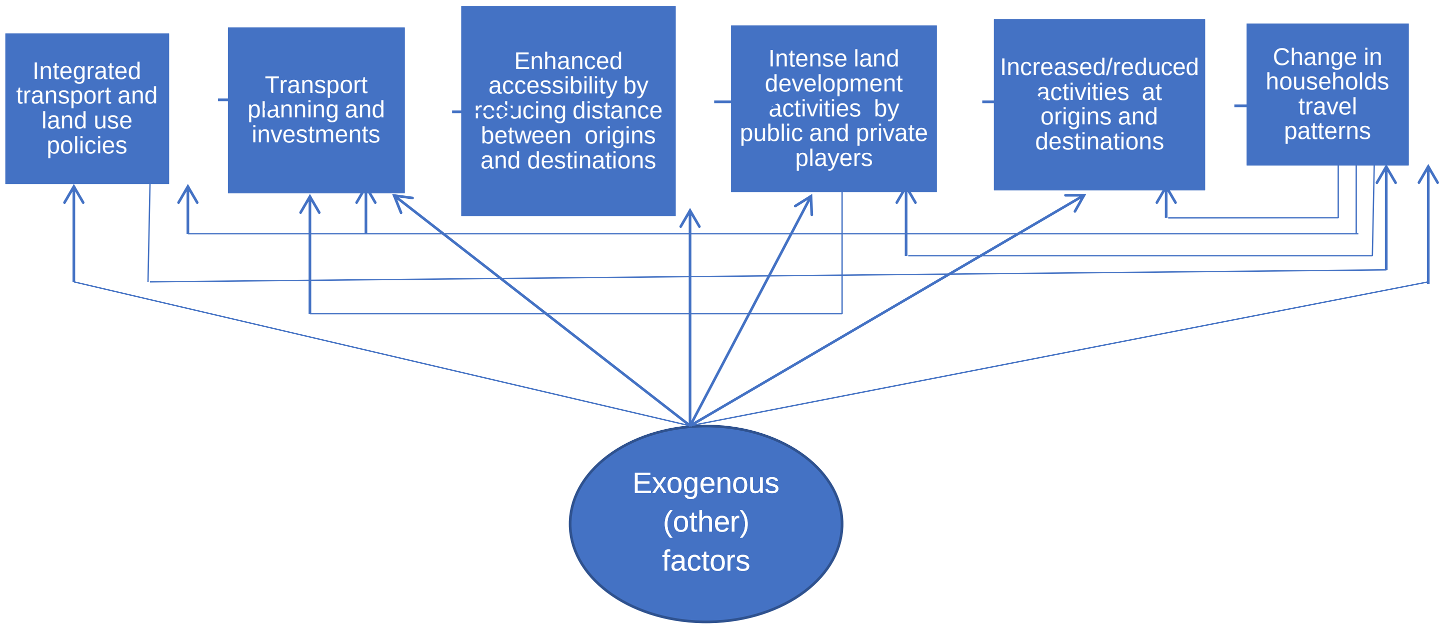


Figure 2.8: Complex links between transportation and land use

Source: Own construction (2018)

Todes (2008:11) points out that a successful land use-transport planning is contingent on good analysis of demographic, housing and employment trends and projections; underpinned by funding and pricing, as well as strong champions and agencies for coordination. According to Todes (2008:11), widespread acceptance and buy-in, reinforced by the consistent use of the plan in decision making at all levels, are equally essential.

This implies that the smart growth is a complex growth management system that requires historical data and reliable future predictions to justify policy, planning and investment decisions with net positive impacts, when compared relative to other alternatives. However, it can be difficult to predict the exact impacts of a particular transportation and/or land use policy or project (Handy, 2005:164; Litman, 2015:12), but it is essential to consider the more local impacts (Litman, 2015:6). According to Litman (2015:12), land use models can predict some but not all impacts. Analysis may therefore require professional judgment (Litman, 2015:12), as well as a synergy of views from all local and regional role players in communities where there is a need to establish that the problems of sprawl and automobile dependence are sufficiently large relative to the possibility of justifying smart growth efforts (Handy, 2005:12).

Therefore, it can be concluded that a more comprehensive analysis of all impacts, which includes a definition of the base case (conditions that would occur without the proposed policy or project) can facilitate the integration of transportation and land use planning, while it equally promotes transport decisions that provide for land use objectives, and land use decisions that support transport objectives.

2.7. Conclusion

Urban planning has evolved from the traditional production of blueprints to the strategic integration of sectors and institutions. Although this change is inspired by frequent revision of planning legislations in developed countries, outcomes in developing countries are however informed by bureaucracies and resistance to change (Silva, 2012:155). It was argued that the land-use transport interaction informed early urban growth models such as the concentric zones and the sector model.

The study promoted the smart growth/new urbanism approach because of its impact on resource conservation and entrenchment of sustainability. The implication for the research theme is the reduction of sprawling, reinforced by improved accessibility through the provision of mass transit. This facilitates regional/metropolitan growth, which is largely entrenched by nodal and corridor development. Although the complexities involved in the land use-transport interaction was highlighted, it was argued that the cost and benefit should be articulated by considering the likely outcomes against the base case scenario.

CHAPTER 3: PUBLIC TRANSPORTATION IN DEVELOPING COUNTRIES: ITS SYSTEMS AND DESIGN STANDARDS

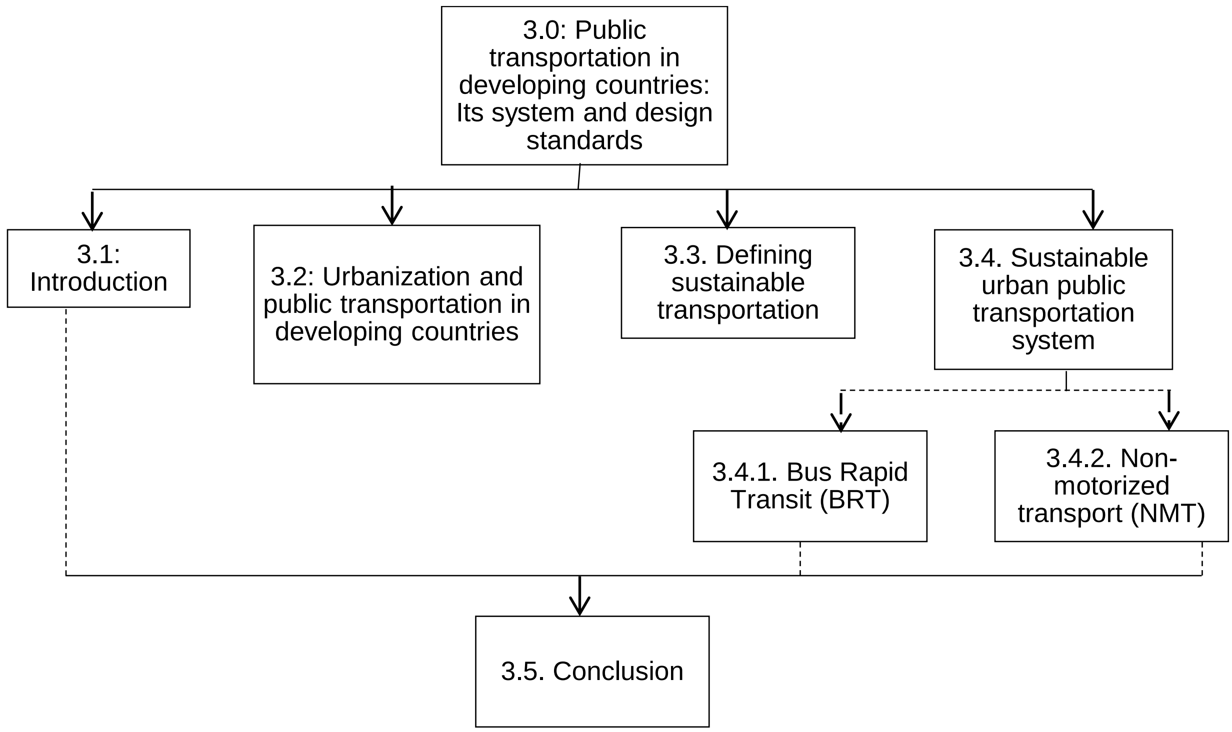


Figure 3.0: Layout and footprint of chapter 3

3.1. Introduction

The urban transport sector is an essential part of spatial planning, and its significance is reinforced by the implications on the residents, especially the poor (Cruz, 2011:6; World Bank, 2013:6). Since levels of income significantly influence urban transport options, the poor and the lower middle-income class are the largest users of public transport and non-motorized transport (NMT) (Mahendra, 2016:10). For example, in Buenos Aires, Argentina, 45% of train users about 38% of bus users belong to the lower to upper middle-income class brackets. In a developing country context, the implication may be increasing users of public transport and NMTs, because its rapid urbanization is inversely related to economic growth (Mahendra, 2016:3). The problem is exacerbated by growing but disparate incomes in most developing countries (Cruz, 2011:2). As a result, the motivation is to correctly decide for whom transport systems should be designed and managed. It thus implies that decision makers largely have to choose between unmanaged motorization and sustainable transportation, which promotes equitable access to quality public transport and NMTs (Cruz, 2011:10).

3.2: Urbanization and public transportation in developing countries

According to the United Nations, 55% of the world's population currently resides in urban areas, and this has been projected to reach 68% by 2050. Globally, the growth in urban population is driven by overall population increase, high urban-rural growth differentials (Richardson, 1981:267) and the upward shift in the percentage of people living in urban areas; but most of the urbanization leading to more megacities will occur in the developing regions (Cohen, 2006:63-64; Stucki, 2015; UN, 2019:2; UN, 2018:4-5). While 81% of the world's current megacities (cities with 10 million inhabitants or more) are located in the less developed regions (global south), nine of the ten cities projected to become megacities between 2018 and 2030 are likewise located in developing countries (Figure 3.1) (UN, 2018:5).

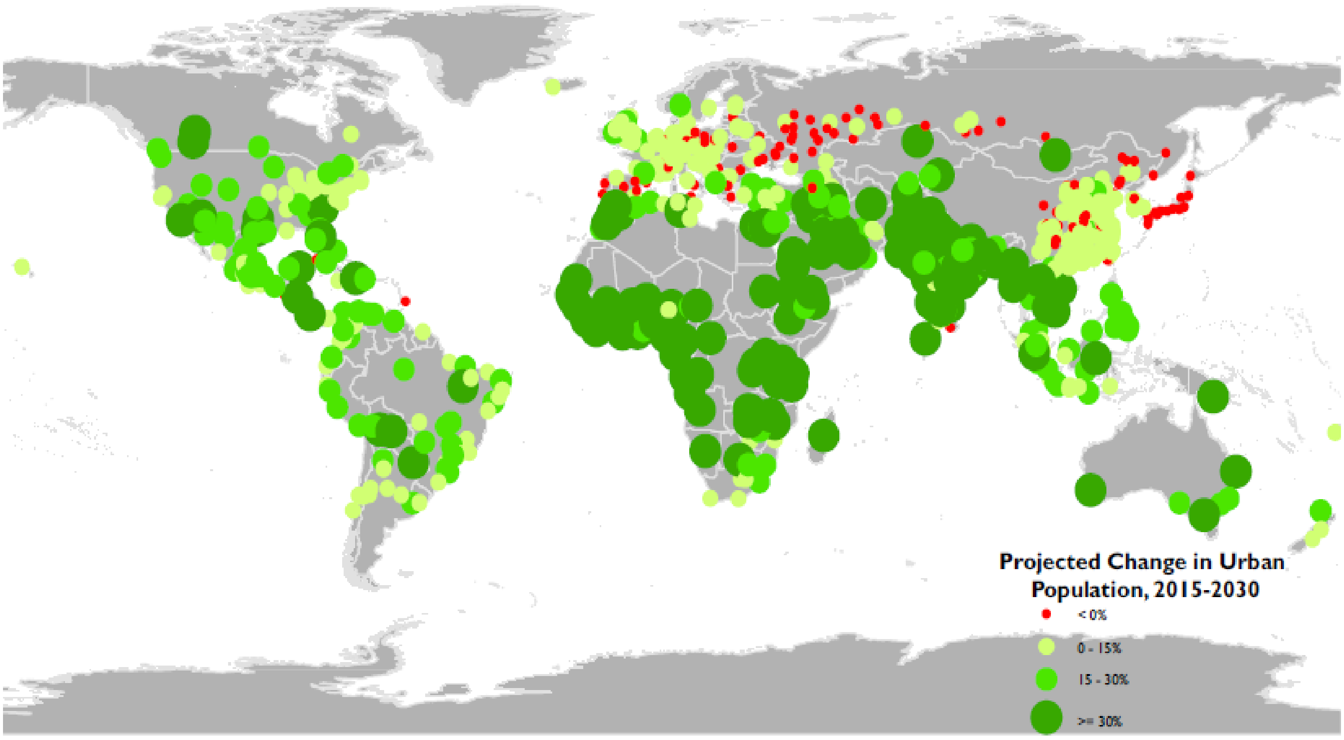


Figure 3.1: Projected urbanization from 2015-2030

Source: Mahendra (2016:2)

In spite of the significance of transportation to the rapid urbanizations (Cervero, 2014:175; Berg et al., 2017:465), there exists a stark contrast between the relatively immobile developing regions (third world) and the highly mobile advanced economies (Hilling, 2003:1). Currently, many of the urban transportation problems affecting developing countries are informed by historical shortcomings in form of human and financial resource constraints, and recent worldwide trends – automobile dependence (da Silva et al., 2008:350; UN-ESCAP, 2016).

The transport landscapes in most developing countries are characterized by increasing congestion, declining mobility (Gakenheimer, 1999:672); traffic injuries and fatalities, environmental pollution and the mobility problems of the poor, as in the case of Africa, China and India (Pucher et al., 2005:185-186; Pucher et al., 2007:380; Kumar & Barrett, 2008:1); as well as human and resource constraints required for upgrades, poor infrastructure maintenance and lack of capacities to meet present needs and future demands (Hilling, 2003:2). With respect to the interface between urban form and transportation, the suburban fringes are usually unplanned or haphazardly developed, with inadequate provision of roadways for buses and non-motorized transport (Pucher et al., 2005:186). Integration of land use and transport planning has increasingly failed at all spatial levels, from city wide strategic planning to street design (Stucki, 2015:12). In Africa, land use-transport integration remains elusive because transport providers continue to see transportation as a means to enhance mobility, and not as an opportunity to modify the urban form (Stucki, 2015:13). It appears that the lack of integration is largely induced by factors such as misaligned sectoral plans, conflicting government policies as well as resource constraints, in terms of people, institutions and financing (World Bank, 2013:8; Mahendra, 2016:11).

Based on the various reflections, it is deduced that urban transport problem in developing countries is informed by historical inadequacies – institutional, preferences, income inequalities, financing, knowledge gap – or increasing absence of initiatives and synergies to stimulate similar outcomes as generated in developed countries. According to Gakenheimer (1999:673), the following characteristics are responsible for the differences in transport outcomes between a developing and a developed city:

i. Rapid pace of motorization – this is mostly observed in Asia, and it leads to enormous congestion because related systems such as transportation facility capacity and urban structure adjustments are unable to keep up.

ii. Higher travel demand relative to the provision of facilities – growing congestions and high latent demand for travel are the outcomes of higher motorization relative to highway expansions. Only a few exceptions exist in the rich Gulf States and cities where increasing motorizations has not yet caught up with capacity, due to very low initial motorization rates.

iii. High modal share of public transit – with the exception of China, urban vehicular trips in much of the developing world are dominated by public transit (75%). However, in most settings, conventional automobile orientation, political and institutional complexities hamper growth and improvement.

iv. Urban structure incompatible with motorization – for example, the urban form of most Chinese cities, as well as Bangkok, Hanoi and Jakarta (Newman et al., 2016:435) appears to be more transit friendly, as against their rapid growth in automobile use.

v. Stronger land use-transportation relationship – construction of new highways has a higher marginal impact in a developing city context because there are fewer high-speed roads. The new freeways provide more comparatively attractive access than in the developed city, where peripheral access is high in every direction. In addition, governments in developing cities have considerable influence, current or potential to guide land use into mobility-friendly forms, because metropolitan governance as in China and Korea is less fragmented and decision making is easier than the highly fragmented metropolitan regions of developed countries.

vi. Irregular response to impacts of new construction – for example, air pollution is a matter of intense concern in cities like Bangkok, while there is very little attention in others like Cairo.

vii. Fewer legal constraints on the use of new technologies – innovation is more feasible in developing cities because the introduction of new technologies is less problematic. For example, introducing driver advisory functions in developed cities is more problematic because of the fear of legal suits.

viii. Very limited agreement on planning approaches – developing cities lack structures that incorporate professionals (e.g. planners and engineers) involved in dealing with urban transportation problems. They seldom borrow professional perspective from elsewhere, with role players that have conflicting interests and mostly uncommitted.

ix. Capital is scarce and operating subsidy difficult to sustain, and this leaves high net expenditures for urban transport.

x. Local transportation development is more centralized in the hands of a few elites – because government and funding is more centralized and provisions are hardly made for community participation in decision making.

As maintained by Hilling (2003:2) and Stucki (2015:12), Africa remains the area with serious under- provision of transport because existing systems are unable to meet the increasing travel demand generated by rapid urban growth. For example, in 1996, 12.1% of the total world population resided in Africa, but they were served by 3.5% commercial vehicles and 2.0% passenger vehicles of the world’s total vehicle population (Hilling, 1996:2). But there is an increasing advocacy for a global paradigm shift towards the design of more compact cities based on the inter-mixing of land uses that prioritize sustainable transportation, such as public transport and non-motorized transport (Cervero, 2014:175).

With a focus on public transport provision in developing countries, the once regulated transport industries became deregulated post-1980s, or in other cases, the regulatory regimes were liberalized through a mixture of privatization and commercialization (World Bank, 1994). For example, in South Africa, the once regulated and heavily subsidized commuter bus industry was deregulated in 1986, with the legislation of the White Paper on National Transport Policy (Walters, 2014:2). This led to the legalization of the 16-seat minibus taxi industry, as well as subsequent loss of business in the bus industry, because of intense competition from the unregulated taxi industry. Although the reason for deregulation was to promote competition, reduce public transport subsidies and improve resource allocation (World Bank, 1994); the results have been variable (Sohail, et al., 2006:5). Meanwhile, most recent interventions by providers of public transport in developing countries have shifted focus from transport infrastructure to the implications of transport provisions to overcome poverty and inequality, in the form of improved health and well-being, the environment, and people's access to employment and livelihoods (Sohail et al., 2006:5).

It can be argued that the change in approach by the developing countries was induced by concerns for social, economic and environmental impacts of the transportation sector. In this regard, concerns for the environmental implications stimulated a global debate because of their large populations, as well as a rapid increase in ownership and use of private cars (Gakenheimer, 1999:680), underpinned by rising per-capita incomes. For example, transport development in China and India, which are the world's most important developing countries, has global implications due to their rising energy use, informed by growing automobile dependence (Pucher et al., 2007:380). Collectively, the two countries had more than 2.4 billion inhabitants in 2005, accounting for 37% of the global population, while the total number of motor vehicles has roughly tripled since in India and increased tenfold since 1990 in India and China respectively, (Pucher et al., 2007:379-380).

In the words of Pucher et al (2007), 'the worldwide concerns about energy shortages, air pollution and climate change are increasingly focusing on transport developments in China and India'. There are fears that rising motorization levels in the two countries will largely elevate their contributions to air pollution, greenhouse gases and energy use, thereby offsetting the modest reductions achieved in more affluent developed countries.

However, the socio-economic impacts of transport developments in developing countries were localized to make provisions for universal accessibility, social equity and reductions in transport costs. According to Sohail et al. (2006:5), 'deregulation was initiated as a tool to improve access for the urban poor through the provision of low cost methods of transport that are better and able to respond to consumer needs, and a variety of services with different qualities and fares'. Incidentally, the change in paradigm observed in developing countries can be said to be a global concern, with recent pressures to develop sustainable transportation systems in modern cities of the developed world (Kennedy et al., 2005:393; Jones et al., 2013:2).

According to Kennedy et al. (2005:394) and Rodrigue et al. (2006:192), these concerns in the developed world was informed by the rapid growth of sprawling, and automobile dominance, leading to reduced quality of life from vehicle emissions and congestion. As corroborated by Haghshenas and Vaziri (2012:115), the problem of the automobile and its environmental impact has become a major issue in all metropolitan regions of the world. In order to transition from current unsustainable practices (dispersed urban form, automobile dependence, complex urban systems and fragmented decision makers) of most urban regions in developed countries, Kennedy et al (2005) suggest the use of region-specific performance measures that can be used to define sustainability objectives. Gudmundsson and Hojer (1996) and Kennedy et al (2005) identified the universal components of these sustainability measures as:

- Accessibility;
- Health and safety;
- Cost effectiveness;
- Impacts on competitiveness and generation of wealth;
- Consumption of natural capital;
- Production of pollutants (local and global); and
- Impact on distribution of quality of life

From the foregoing, it can be concluded that rapid sprawling and private car dominance are universal factors that have undermined the shift to sustainable transportation. Rapid motorization leads to higher congestion, which limits accessibility by damaging the viability of public transport (May, 2013:172). Nevertheless, context-based solutions that are orientated around socio-economic and environmental themes such as increased accessibility and acceptable pollution limits may generate sustainable outcomes from urban transportation. In essence, sustainable transportation planning focuses on access or reduction of exclusion, it is people oriented, local in scale and promotes the integration of different modes (Kwok & Yeh, 2004:923; Inturri et al., 2011:26).

It can therefore be deduced that sustainable transportation planning implies planning for accessibility. This new paradigm shift to promoting accessibility, rather than mobility can be reinforced by avoiding long and unnecessary motorized travel, shifting the movement of people and goods to most efficient modes, and improving the technology and operational management of transport services (Dalkmann & Brannigan, 2007:5,8). These measures are consistent with the views of Litman (2003:1), who argues that accessibility may be improved with strategies that reduce the need to travel, such as land use management and improved communications.

3.3. Defining sustainable transportation

Litman (2007:10-11) defines sustainable transportation system as one that:

- Allows the basic access needs of individuals and societies to be met safely, and in a manner consistent with human ecosystem and health, and with equity within and between generations;
- Is affordable, operates efficiently, offers a choice of transport mode, and supports a vibrant economy; and
- Limits emissions and wastes within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and production of noise.

In another context, sustainable transportation is defined as 'the provision of services and infrastructure for the mobility of goods and people, needed for economic and social development and for improving quality of life and competitiveness. These services and transport infrastructure provide safe, reliable, economical, efficient, equitable and affordable mobility, while mitigating the negative impacts on health and the local and global environment, in the short, medium and long term without compromising the development of future generations" (Hidalgo & Huizenga, 2013:67). It appears that sustainable transportation is founded on sustainable development principles that ensure present needs are met, without prejudicing the ability to meet future needs. For example, a sustainable transport system is one that supports a competitive economy and balanced regional development, as well as promotes equity within and between successive generations (ADB, 2010).

With regards to the sustainable development principles, the World Bank (1996) views sustainable transport as one that promotes economic and financial (cost) effectiveness, environmental imperatives such as pollution, land use, energy consumption and wildlife; and social equity (safe and adequate service to all segments of the society). In practice, however, the sustainability of an urban transportation system may be determined by its contribution to residents' quality of life, its resource (physical and natural) efficiency, its provision for externalities and social equity (Sinha, 2003:333).

However, it can be concluded that there is no blueprint definition of sustainable transportation (Steg & Gifford, 2005:60; Bakker et al., 2014:342), but it appears that the common goal is to ensure that current and future economic, social and environmental considerations are incorporated into decisions on transportation activities (Jones et al., 2013:2; Cervero, 2014:179-

181). In reality, it is essential that sustainable transportation indicators are adopted to evaluate the outcomes of inputs and practices towards sustainability. According to Sinha (2003:334-335) and Litman (2007:11, 14), indicators are things that we measure in order to evaluate progress towards goals and objectives; they determine how things are perceived and what receives attention. However, there is the danger of generating sub-optimal outcomes by using indicators that are orientated towards a certain activity or option at the expense of others.

Therefore, it is usually best to carefully select a balanced set of indicators that are case-specific, with integration of economic, social and environmental objectives (Litman, 2007:14, 15). Likewise, Steg and Gifford (2005:66-67) emphasize the need for making provisions for public participation in the process of transitioning to sustainable transportation. This is because different urban contexts generate differing outcomes, and public sentiments are informed by the net impact on quality of life.

As highlighted in Table 3.1, a sustainable transportation indicator set must at least reflect different levels of social, economic and environmental impacts from the decision making processes, the travel effects and the intermediate impacts to the ultimate outcomes.

Table 3.1: Sustainable transportation impacts

Economic	**Social**	**Environmental**
Traffic congestion	Equity/fairness	Air pollution
Infrastructure costs	Impact on the mobility of disadvantaged residents	Climate change
Consumer costs	Human health impacts	Noise and water pollution
Mobility barriers	Community cohesion	Habitat loss
Accident damages	Community livability	Hydrologic impacts
DNRR	Aesthetics	DNRR

DNRR = depletion of non-renewable resources
Source: Litman (2007:11)

According to Dalkman et al (2007), sustainable transport solutions can be categorized into three main areas:

- Transport avoidance – through proper land use and transport planning can reduce the demand for mobility while increasing mobility access;
- Modal shift to more sustainable models – promoting the use of low carbon mobility by influencing decisions on mobility options that are more sustainable, such as public transportation, walking and cycling;
- Transport efficiency – through the deployment of technologies, driving behavior and standards on fuel efficiency

Based on the above views on sustainable transportation, it can be deduced that an integrated network-based public transport system can provide an impetus towards the promotion of sustainability. According to Fouracre et al (2003:299) and Hensher and Golob (2008:501), large metropolitan areas with growing populations, private car induced pollution and congestion have increasingly recognized public transport as a key springboard for a sustainable future. However, Goldman and Gorham, (2006:262) underline the significance of policy guidance in addressing sustainability issues in general. It thus implies that policy formulations and implementation are essential parts of the sustainable transportation process.

3.4. Sustainable urban public transportation system

Urban public transportation includes both transit and para-transit categories, since both are available for public use (Vuchic, 2002:4). Also regarded as collective transportation, public transit provides publicly accessible mobility over specific parts of a city, and its efficiency is premised on transporting large numbers of people and achieving economies of scale (Fouracre et al., 2003:299). Although informal modes like microbus and minibus services are able to transport fairly large numbers of people, and they are dominant in most developing countries because of a lack of affordable and accessible transit systems; they are regarded as unsustainable because they can also worsen traffic congestion and air quality (Cervero, 2014:178).

It can be argued that public transit use is largely contingent on urban population density, or more specifically, activity density – population and jobs (Sinha, 2003:338; Kwok & Yeh, 2004:923). This is because it benefits from economies of agglomeration associated with high densities and from economies of scale linked to high short distance travels. This implies that transit systems are less efficient in urban areas with low densities and low mobility demands informed by dispersed urban forms. It may be more capital intensive to develop public transit under such conditions. However, it is essential to establish if high densities and high demands due to shorter trips are enough for optimal outcomes from a public transit system. Are there likely system concerns or operational factors with similar influence on the overall outlook and output of the system? To address these concerns, it is imperative to understand the basic elements, operations and functioning of transit systems.

According to Stucki (2015:4), a transport supply system typically includes infrastructure (fixed installations), vehicles and operations. In terms of service provision, Vuchic (2005:3) maintains that transportation offered to passengers is usually referred to as service, while operations cover system management, scheduling, and functioning from the operating agency's point of view, as well as the enabling environment, such as financing, legal frameworks and policies (Stucki, 2015:4). Table 3.2 highlights the components of a transit system:

Table 3.2: Components of a transit system

Basic operating elements	Features	Description
Transport supply system		Typically includes infrastructure (fixed installations), vehicles and operations.
Transport infrastructure		Includes linear installations (such as roads and railways) and terminals (such as railway stations, bus stations and trucking terminals).
Transit line		Infrastructure and service provided on a fixed alignment by vehicles or trains operating on a predetermined schedule.
Transit route		Often synonymous with transit line, but with reference to overlapping lines, rather than major metro or regional rail lines.
Transit network		A set of transit lines that connect with or cross each other, with provisions for integration to enhance passenger convenience and operational efficiency.
Line length		The one-way distance between the two terminals along the line alignment.
Network length		The total length of all alignments served by one or more lines.
Total route length		Sum of all line lengths, regardless of whether they operate alone or overlap with other lines.
Transit right-of-way (ROW)		The strip of land on which a transit line operates. It usually refers to the facility used exclusively by transit vehicles, as well as the numerous physical forms a transit line may follow, from street to fully controlled elevated structure or tunnel. However, the most important ROW feature for transit operations, performance and cost characteristics is the degree of its separation from other modes.
Transit stop/station		A location along a line at which transit vehicles stop to pick up or drop off passengers.
Transfer stations		Joint stations for two or more lines (modes) at which passengers can transfer between lines.
Terminals		End stations on a transit line, but it is sometimes used for major transfer stations.
Fleet		Refers to transit vehicles, bus and rail. Rail cars and rolling stock are two specialized terms often used for rail modes.
Modes		Traditionally, transit modes are categorized according to technology and the degree of separation from traffic.
Metro system		A heavy rail system, often underground in central areas and above ground at more peripheral locations, with fixed routes, services and stations. Transfers between lines or to other components of the system (mainly buses and light rail) are made at connected stations.
Bus system		Operates on scheduled fixed routes and stops serviced by multiple-passenger vehicles (45-160 passengers). Services are often integrated with other heavy systems, mainly metro and transit rail, where they act as feeders.

Transit Rail system		It can be in the form of streetcars (tramways) used in central areas or commuter rail, used to service peripheral/suburbs.
Paratransit system		A flexible system that is privately owned by informal operators. They are common in developing countries and they include small to medium capacity vehicles (motorcycles, taxis, shared taxis, mini-buses and vans).
Taxi system		Privately owned cars or small vans offering on-call, individual demand-response system.
Technology		Mechanical features of their vehicles and travel ways.
	Support	Rubber tyres on roadways, steel wheels on rails.
	Guidance	Usually by the drivers, guideways or mechanically.
	Propulsion	In the form of Internal Combustion Engine (ICE), special magnetic forces, propeller and others.
	Control	The means of regulating the travel of one or all vehicles in the transit system.

Source: Own construction (2019) as adapted from Vuchic (2002:5); Vuchic (2005:3-5); Rodrigue et al (2006:54, 149, 171, 187-188).

Essentially, the overall quality of a transit system largely depends on the economy and state of development of the city and/or country. Most often, a traveller has to use a combination of modes to complete a journey, and the ease of integration between and within modes is integral to successful transit systems (UN-ESCAP, 2016:4).

Against this background, it is important to examine the efforts by developing countries to transition to sustainable transportation practices. For example, China is playing a significant role in promoting the use of clean, energy efficient, and environmentally friendly vehicles. Through advancements in technology and government's desire to clean up the environment and reduce the country's dependency on oil, the Chinese automobile industry is increasingly gravitating towards energy efficient vehicles. For example, vehicles using alternative fuels, especially LPG and CNG, increased from 5,000 in 1998 to 80,000 in 2000, and filling stations increased from 40 to 228 in the 12 pioneer cities for clean vehicle demonstration (Gan, 2001:8).

In addition, the country has aggressively implemented BRT systems in more than 10 cities, adding BRT lanes at a faster rate than any part of the world over the past 8 years (Cervero, 2013:6). On the other hand, with nearly 30 metro systems, China's Shanghai and Beijing metros, each longer than 500km are the longest in the world (Kai et al., 2016:2). However, the transition to sustainable road transportation system in China is not without barriers, most of which are institutional (Gan, 2001:10).

In the same vein, Brazil is shifting towards sustainable urban transportation through initiatives driven by the national government (da Silva et al., 2008:351). The country's new approach promotes the provision of public transportation and transfers the mandate for its creation to the municipalities.

While generalizing the challenges militating against sustainable transportation planning in developing countries, Sietchiping et al (2012:185); Jones et al. (2013) suggest that the use of conventional processes and erroneous transfer of automobile oriented planning approaches from Western countries are largely impacting on anticipated outcomes.

The authors (Jones et al., 2013) maintain that these planning approaches are usually lacking in the evaluation of alternative modes in an integrated manner. As a result, transport development in developing countries has increasingly failed to comprehensively consolidate sustainability concerns because the alternative modes are often considered in isolation. However Gakenheimer (1999:685) maintains that in spite of the lingering debate on knowledge and policy transfers from the developed to the developing countries, three key lessons on mobility and motorization can be learnt by the developing world.

Gakenheimer (1999:685) surmises that knowledge on technology, institutional management and general experience can benefit the developing countries, although there must be provisions for their differing contexts. Based on these views, Pojani and Stead (2015b:7786) opine that in order to mitigate against unproductive policy transfers, developing countries must consider examples of transport solutions from both developing and developed contexts, as according to Cervero (2014:177,183) some of the most efficient and cost-effective public transport systems have been developed in Latin America. For example, the very successful Transmilenio BRT in Bogota has incorporated bicycle paths, improved pedestrian facilities, and significant restrictions on private car use (Pucher et al., 2005:197). In the same vein, some major cities of the Asia-Pacific region (Beijing; Hong Kong, China; Seoul; Singapore and Tokyo) have successful transit systems that can serve as exemplars to other cities in the process of transitioning to sustainable transportation (UN-ESCAP, 2016:4).

It thus implies that an understanding of the local context (land use-transport), underpinned by technology, institutional stability and approaches that limit private car dominance are essential for promoting sustainable transportation outcomes in developing countries. For example, adequate knowledge of the apartheid inspired land use-transport context of the City of Johannesburg, supported by a synergized land use-transport institution, as well as innovations like Intelligent Transport System (ITS) equipment, cleaner vehicles and strategic promotion of public transport and non-motorized transport can facilitate a transition to sustainable transportation practices. Based on the foregoing, it can be argued that the theme of the study is focused on the city’s two formal transit systems and their interface with spatial and transportation planning. As a result, it is essential to gain a perspective by synthesizing existing literature and state-of-the-art of the BRT and non-motorized transport.

3.4.1. Bus Rapid Transit (BRT)

The BRT is a high-quality, efficient mass transport mode that provides capacity and speed comparable with urban rail (light and heavy rail), though at a much lower price (Cervero, 2013:1; Wood, 2014:1238; Carrigan et al., 2013:5; Mallqui & Pojani, 2017:254; Gauthier & Weinstock, 2010:318). According to Pardo (2010:11), the BRT has become popular in recent years due to its moderate cost of implementation, relatively short implementation time, high quality of service, and capacity to move large numbers of passengers. It implies that the BRT is a cheaper alternative to the urban rail system, in spite of their functional similarities as mass transit modes. In the words of Rizvi and Sclar (2014:194), BRT technology is particularly suitable for developing countries because of its low capital costs, flexibility, and potential for integration with non-motorized transport facilities.

Empirical evidence on the passenger capacities of the BRT reveals that the range of systems varies from high capacity to relatively low-volume corridors. For example, Bogota's TransMilenio BRT system is acknowledged as one of the highest capacity systems, with a passenger demand of 1.98 million per day; while low capacity systems in Paris and Johannesburg move fewer than 70,000 passengers daily (Carrigan et al., 2013:25). In reality, the highest-volume systems are designed to optimize capacity, while the lower capacity systems are either tailored for needs of a lower-demand corridor, or performing below their carrying capacity. However, its short implementation time and cost-savings potential have promoted its use in highly congested, private car-oriented mega-cities of the developing countries like Jakarta, Sao Paolo, Delhi, Ahmedabad, Bogota, Curitiba, Quito and Lagos (Levinson et al., 2002:20; Kumar et al., 2012:5; Cervero, 2013:4; Rizvi & Sclar, 2014).

According to Wirasinghe et al (2013:5-15) a BRT system is defined by the factors in Table 3.3:

Table 3.3: Overview of defining factors of a BRT system

Elements that define a BRT system		**Factors that define BRT performance**	
Factor	Description	Factor	Description
Running ways/guide ways	Ranges from mixed-traffic operations to fully grade-separated busways. Advantages of mixed traffic operations are low costs, quick implementation and minimum construction efforts.	Speed	The operating speed and passengers travel time are largely impacted by the spacing of stops
Vehicles	The vehicle quality conveys system identity and image. The vehicle features essential for improving the BRT service quality are: vehicle size and body structure; doors; bus interior design; floor elevation; vehicle propulsion; vehicle form and aesthetics; Wi-fi	Capacity	Transit capacity is either capacity in passenger per hour per direction or capacity in vehicles per hour per direction
Stations	Stations serve as the links between the systems and their customers, and they are largely defined by location, spacing and design. The characteristics include length, platform height, fare collection practices and amenities provided for users.	Reliability	The three main aspects are running time reliability, station dwell time reliability and service reliability.
Operations and control systems	The control technologies are determined by the operating environment, physical constraints of the city, as well as budget limitations.	Accessibility and safety improvement	Accessibility is defined by seat layout, additional door channels and enhanced wheelchair securement. Safety is measured by accident rates and public perception of safety.
Fare collection systems	Methods include off-board, on-board, payment by cash, prepaid tickets, passes, magnetic strips or smart cards		
Passenger information system	It can take many forms, such as information before, during and at the termination of the trip.		

Source: Own construction (2018) adapted from Wirasinghe et al. (2013:5-15)

In terms of the interface of BRT with urban development, there have been various theoretical and empirical perspectives, but they all underscore the age old debate about the role of land use in reducing journey times. Carrigan et al. (2013:42) argues that as well as accommodating existing travel demand on a corridor, a BRT system may induce higher-density development around stations as a result of increased accessibility and higher pedestrian volumes. For example, the TransMilenio has effectively consolidated Bogota's existing high-density urban form (Gilbert, 2008:453).

Although empirical evidence from TransMilenio's terminal stations reveals a relative increase in new building activities, the same cannot be said for intermediate stations which experienced fewer densifications (residential and commercial) relative to areas outside 1000 meters proximity to the stations (Bocharejo et al., 2013; Cervero, 2014:184). Cervero (2014:185-186) argues that the mixed outcomes at the stations, as well as the non-pedestrian friendly nature of Bogota BRT's intermediate stations, underscore the significance of pro-active integration of land use and transportation at the planning phase.

The significance of proactive integration of transportation and land-use has been reinforced in cities such as Adelaide, Ottawa, Brisbane, Pittsburg and Curitiba, with benefits similar to those generated by rail transit (Levinson et al.,:10). In line with this argument Vessali (1996:99) maintains that the only substantial impact of transit on land use are those that have been planned, and such planning entails a significant investment of public sector resources and coordination. Incidentally, there are lessons from other developing countries like Singapore, to reinforce the assertion by Vessali (1996) and Cervero (2014). Singapore is recognized for integrating its mobility master plan to the main urban development projects in the city. Therefore, urban development in Singapore is premised on the city's mass transit system, which includes major bus lines (Di Pasquale et al., 2016:3292).

Overall, conventional wisdom has suggested that because urban bus systems do not include the same permanent infrastructure investments, nor improve accessibility to the same degree as a rail system, they would not influence urban growth to the same degree as rail systems (Carrigan et al., 2013:40). Consequently, it can be deduced that the complexities involved in the integration of land use and transportation (Handy, 2005) are reflected in the context of a BRT implementation. Therefore, it is essential to incorporate considerations for other modes into a BRT investment plan, underpinned by a pro-active integration with land use planning that is informed by a sound knowledge of the operating environment. This is because the process of influencing city shape in desirable ways through transport investments is more complex than it seems, and it requires appropriate planning, with provisions for the forces that shape cities (Berg et al., 2017:472).

Based on this deduction, it can be further argued that new residential and commercial building developments induced by a BRT system (like the case of the TransMilenio in Bogota) can increase local traffic congestion. However, a traffic impact study, consolidated into the existing land use-transport synergy, and promoted by all role players – the developer, city administration and traffic consultant – may facilitate the mitigation of likely congestions arising from transit-oriented developments associated with a BRT system. According to UN-ESCAP (1999:5), these mitigation strategies include (i) land use growth control – applied to regulate the types and densities of development; (ii) building regulations – used to control the intensity of development and adherence to building standards; (iii) impact fees;(iv) negotiated agreements and (v) impact exactions; which are all complementary funding sources for additional roadway facilities and other improvements needed to accommodate the traffic generated by new developments.

3.4.2. Non-motorized transport (NMT)

Non-motorized transport modes are considered the green modes of commuting because of their presumed ecological and sustainability advantages (Plaut, 2005:348). For example, local advantages of cycling include environmental sustainability – because there are no direct emissions of pollutants, CO2 or noise; cheap infrastructure requirements; and improvements in public health (Heinen, et al., 2010:59). According to Cervero (2014:178), walking and bicycling are the healthiest, least intrusive and most affordable forms of movement. Non-motorized transport modes do not merely serve as the main (sole) mode of transport; they are also used as links to transit modes like bus and train.

Although it appears that the reason for using NMT differs across countries or cities, some of the common factors that encourage it include city size, density, safety, social conventions, natural environment (landscape, weather conditions and climate), mixed land use, accessibility, street connectivity and existing infrastructure (Cervero, 1996; Pucher et al., 1999; Pucher & Dijkstra, 2000; Badland & Schofield, 2005:185). For example, high-density residential development can catalyze higher rates of commuting via walking, cycling or public transportation, as well as less dependence on private cars (Plaut, 2005:348). Likewise, specific urban design fundamentals – traffic calming, automobile restrictions and pedestrian and cycling sensitive designs – may encourage the use of non-motorized transport (Badland & Schofield, 2005:185).

Along with land use planning, improving the infrastructure and opportunities for non-motorized transport can help to: create cities that are conducive to walking and cycling; as well as reduce transport emissions through a decline in motorization (IEA/OECD, 2009:261). However, it is argued that there are other factors that can influence the decision to use NMTs. In this regard, Plaut (2005:349) maintains that cycling to work can be promoted through factors like employer support (providing showers and lockers) or employer travel plans, safety aspects, gender, infrastructure planning, and incentives like increasing costs of car use.

In contrast, Cervero and Duncan (2003:1483) assert that the influence of urban form on the choice of non-motorized mode is stronger at trip origins than destinations. In their research on the San Francisco Bay Area, the authors (Cervero and Duncan, 2003:1483) found that the built environment exerts bigger impacts on walking and bicycling in and around a person's residential neighborhood than destinations would do. On the other hand, Cervero et al (2009:223) in their research on Bogota, conclude that the configuration, density and connectivity of streets matter more than other built environment factors, such as urban densities, land use mix and destination accessibility.

However, studies have demonstrated the significance of trip length (distance) in the choice of non-motorized transport as a commuting mode (Cervero, 1996; Cervero & Duncan, 2003:1481; Dickinson et al., 2003; Timperio et al., 2006; Parkin et al., 2008; Badland & Schofield, 2005:186). In general, the modal share decreases with increasing distance between residential and work locations, because of the physical effort required (van Wee et al., 2006). Nevertheless it appears that the acceptable maximum travel distance is associated with individual capabilities and gender. A study by McDonald and Burns (2001) suggests that women will cycle for an average trip distance of 6.6 km, while men are willing to cycle for 11.6 km.

Generally, it can be concluded that in spite of the relationship between land use and the use of non-motorized transport modes, natural environment factors such as topography, darkness, extreme heat and rainfall have far stronger influence on modal choice. For example, in hot, humid mega-cities of Southeast Asia, residents might avoid walking and cycling, regardless of how pedestrian and bike friendly the cities might be.

3.5. Design standards

Based on the above views, it can be deduced that the success of a sustainable urban transportation is informed by the selection of optimal design and service aspects of a transit system, with provisions for customers and operators' needs. However, within each transit mode, there are variations in the design and service aspects, and these differences can influence outcomes for specific urban environments and service requirements (Wirasinghe et al 2013:1). Tables 3.4, 3.5, 3.6 and Figure 3.2 set out some of the key design standards associated with the transit systems:

Table 3.4: Key characteristics of mass rapid transit (MRT) systems

	Busway transit (BRT)	**LRT**	**Metro**
Right-of-way (ROW)	Vehicles can operate in all kinds of traffic, but the provision of lanes increases speed, reliability and identity	Physically segregated along much of route; some grade separated junctions.	Fully grade-separated
Stations	Easily recognizable design that differentiates them from regular bus stops		
Station spacing (m)	200-500	500-1000	800-1200
Average speed (Km/h)	20-25	20-30	30-40

Rolling stock	Vehicles are designed to improve comfort, speed and safety; with distinctive colours and graphics.		
Propulsion technology	Combustion or electricity	Electricity	Electricity
Signaling	Visual, with some signals	Visual plus signals	Automated
Platforms	Low level (but innovative high-level designs in Brazil).	Low and medium levels	High level
Minimum headways	10	60	90-120
Passengers/car	90	240	400
Cars/train	1	2/4	6/8
Train length (meters)	8-11	70-100 (three car)	100-140 (six car)
Ticketing	Off-board	Off-board	Off-board
ITS	Use of intelligent transport system improves comfort and speed, as well as safety for users and planners.		
Roadway configuration	A corridor may have multiple configurations over its length because it is informed by different local contexts.		

Source: Fouracre et al (2003:301)

Table 3.5: Lanes and vehicle design standards of BRT systems

Lanes		**Vehicle**			
Lane type	**Standard width (meters)**	**Vehicle type**	**Vehicle length (meters)**	**Capacity (passengers per vehicle)**	**Cities**
Footpath	3	Bi-articulated	24	240-270	Curitiba
Busway lane at thestation area	3	Articulated	18.5	120-170	Bogota
Busway lane along the corridor	3.5	Tandem	15	80-100	
Barrier/curb separator	0.5	Double-decker	12-15	80-130	Hong Kong, Dhaka
Mixed-traffic lane	3.0	Standard	12	60-80	Brisbane
Other lanes for mixed traffic	3	Midi-bus	6	25-35	
Station width	5	Mini-bus (vans)	3	10-16	

Source: BRT Planning Guide (2007:351, 408)

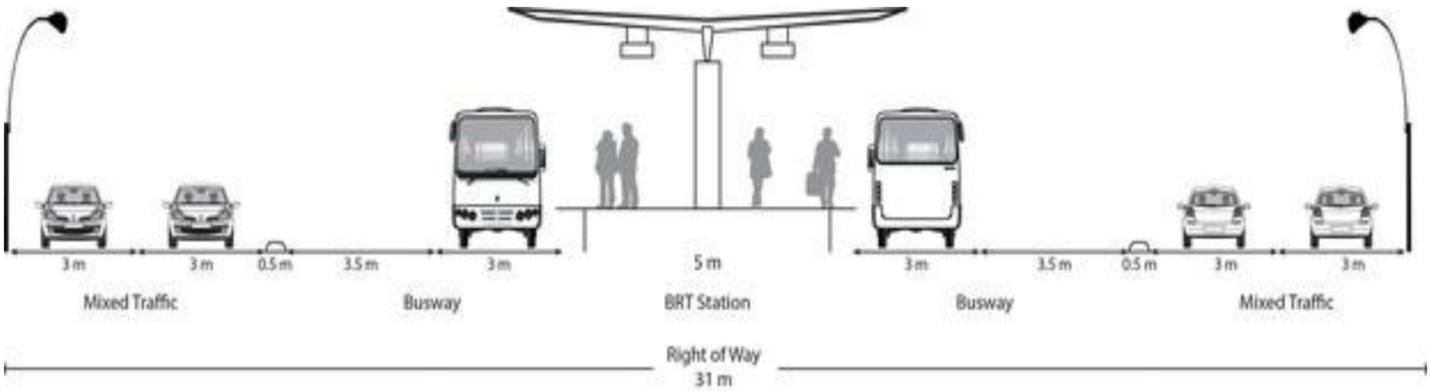


Figure 3.2: A conceptual design of a BRT corridor

Source: BRT Planning Guide (2017:695)

Table 3.6: Integrated spatial and transportation planning design standards of a BRT system

Elements of land use/transport integration		**Design Assumptions**	**TOD design standards**
Pedestrian and bicycle access enhancements	Provision of contiguous sidewalks and bicycle lanes on both sides, and removal of barriers to pedestrian and bicycle traffic at station areas.	(i). 2.0 meters for separate one-way bikeways, including space for buffer areas or separator. (ii). 3.0 meters for shared bikeways/sidewalks; (iii). 1.5 meters for marked, one-way bicycle lanes in the roadway, indicated using signage; (iv). 2.5 meters may be recommended if bike lanes will be used by non- motorized three-wheelers.	a). The speed at mixed traffic streets should be capped at 15km/hr. Safe all accessible crosswalks required at intersections with higher speed. Crosswalks required at 200 meters interval in dense street networks. (b). The speed at cycling oriented street segments should be capped at 30km/hr. Cycle parking facilities should be located clear of pedestrian or vehicle circulation paths, and within 100 meters of a transit station entrance. Secure cycle parking applies to buildings with a floor area larger than 500 square meters or 6 residential units.

Appropriately designed and sited parking facilities	Provision of appropriate parking spaces to meet demands. However, the parking spaces must not obstruct pedestrian and bicycle access to stations and adjoining destinations. In addition, the design and location of parking spaces must not disrupt transit operations.		
Creation of origin-destination pairs	Promotion of intense mixed-use development can create the origin-destination pair required for transit success.		
Walking distance to transit			a). Transit stations should be accessible to all by design, with a minimum 15-minute service frequency between 7am and 10pm. (b). Buildings within TOD must all be within a 1000-meter all accessible walking distance of a rapid transit station, or within a 500-meter of a qualified non-rapid direct service.
Complementary uses			a). Development is internally complementary if residential uses account for no less than 15% and no more than 85% of the total developed floor area. (b). A station catchment area is balanced when residential to non-residential uses ratio of floor area is between 50%/50% or 40%/60%

Access to local services			a). Fresh food sources could be outside the station catchment area but within 500-meter walking distance of all TOD buildings. (b). Primary schools and healthcare facilities should be within 1000-meters walking distance to the farthest building in the TOD, with school fees paid according to income level.
Access to parks and playgrounds			Park or playground should be 300 square meters in area and publicly accessible 15 hours or more per day. It could be outside of the station area but within 500 meters walking distance of the TOD.
Affordable housing			Affordable housing standards to align with the local context, or below 30% of the average income in the income category.
Housing and business/services preservation			Options should be provided for households and businesses whose building will be upgraded to acceptable TOD standards. In order to preserve community ties, they may be relocated to within 500 meters (households) and 500-1000 meters (businesses) of their old locations, with adequate provision for public transportation.

Density			Development could be at least 85% residential in a predominantly non-residential area or 85% non-residential in a predominantly residential area. Residential density (gross household or dwelling unit density) is derived by dividing the total number of dwelling units by the gross land area.
Transit options			These include regular transit lines, non-BRT and paratransit modes that operate from 7am to 10pm with a service frequency of 20 minutes or less. A dense public bicycle sharing system may equally serve as a transit option.

Source: VTA (2007:13); ITDP (2017:30-99)

3.6. Conclusion

The chapter contained reflections from a developing country perspective and it is focused on urbanization and the provision of public transportation. Outcomes from developing countries are largely informed by factors such as rapid motorization, inadequate funding and subsidy regimes, as well as a lack of public participation in decision-making processes. However, it was argued that sustainable urban public transportation that consists of modes such as mass transit and non-motorized transport, can limit outcomes which had been exacerbated by haphazard growth patterns and a weak link between the social, economic and environmental implications of the transportation sector.

CHAPTER 4: INTERNATIONAL CASE STUDIES

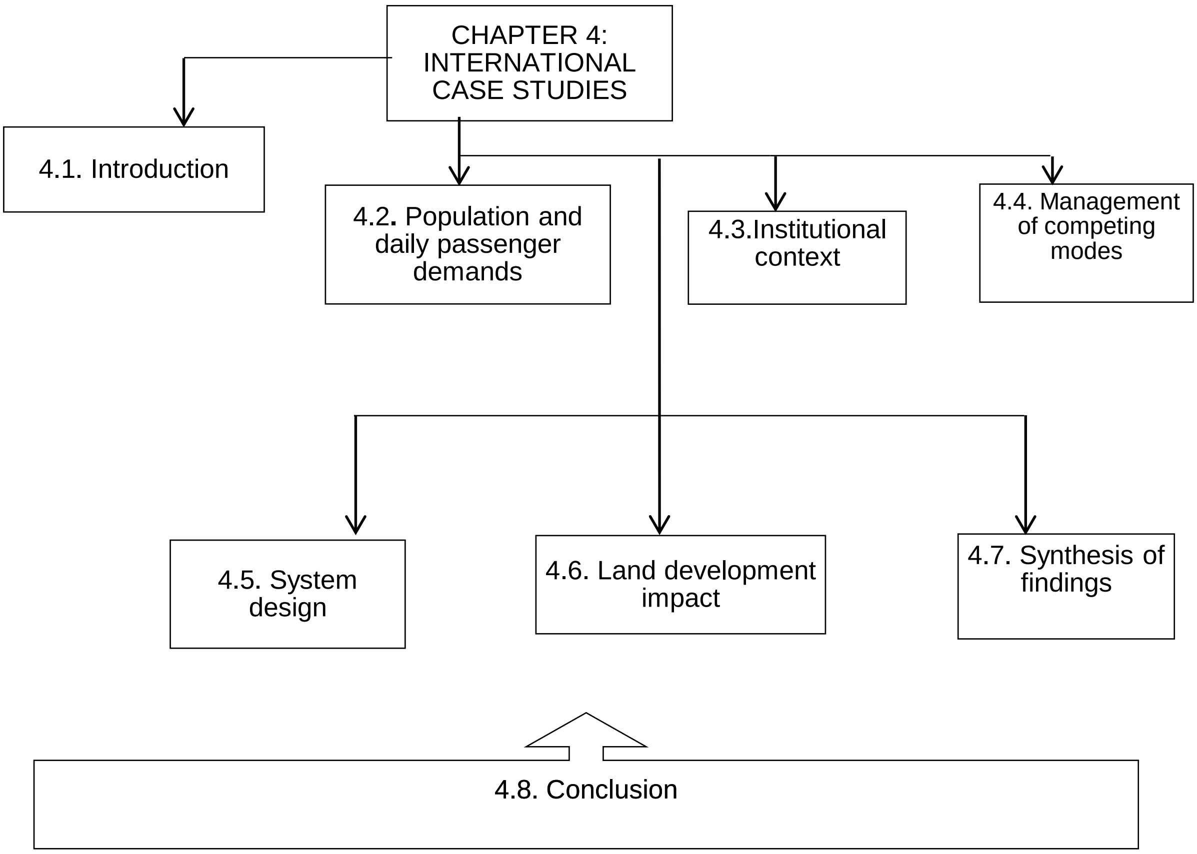


Figure 4.0: Layout and footprint of chapter 4

4.1. Introduction

The objective of this chapter is to provide insights on case studies of mass transit systems from an international perspective, with provisions for differences in context, level of development (developed and developing countries) and different sizes. The chapter compares three contrasting efforts to implement BRT in developing and developed country context. Brisbane is a typical developed city, sprawling and car oriented, in which middle and high-income groups continue to perpetuate the use of private cars (Mallqui & Pojani, 2017:256). On the other hand, Bangkok is an ideal developing city with a metropolitan population of 14 million, and a limited BRT system that is incomplete due to under-performance and differing ideologies associated with political turnovers (Wu and Pojani, 2016:45). Ahmedabad is a commerce and industry hub, and it accounts for 14% of total investments in all stock exchanges in India and 20% of the regional GDP (Kumar et al., 2012:53).

Based on the theoretical framework that outlines the key factors that lead to success or failure of BRT systems, as adapted from Lindau et al. (2014); Wu and Pojani (2016) and Mallqui and Pojani (2017); the case studies are presented along certain themes. The key factors, as articulated by these authors are highlighted in Figure 4.1:

Figure 4.1: Key factors for the success or failure of BRT systems

Source: Own construction (2018) adapted from Lindau et al. (2014); Wu and Pojani (2016) and Mallqui and Pojani (2017)

In a similar research on international experience in BRT implementation, Kumar et al (2012:9-22) concluded that the causal factors of the variance in degrees of success demonstrated by the systems in selected developing countries are: political leadership, planning and development; communications; service plans; operating arrangements; and implementation and operating finance. It can be deduced that the factors highlighted by Kumar et al. (2012) are embedded in the theoretical framework illustrated in Figure 4.2. It thus implies that in as much as the outcomes generated by a BRT system is largely informed by the local context, both developing and developed cities may be influenced by these themes.

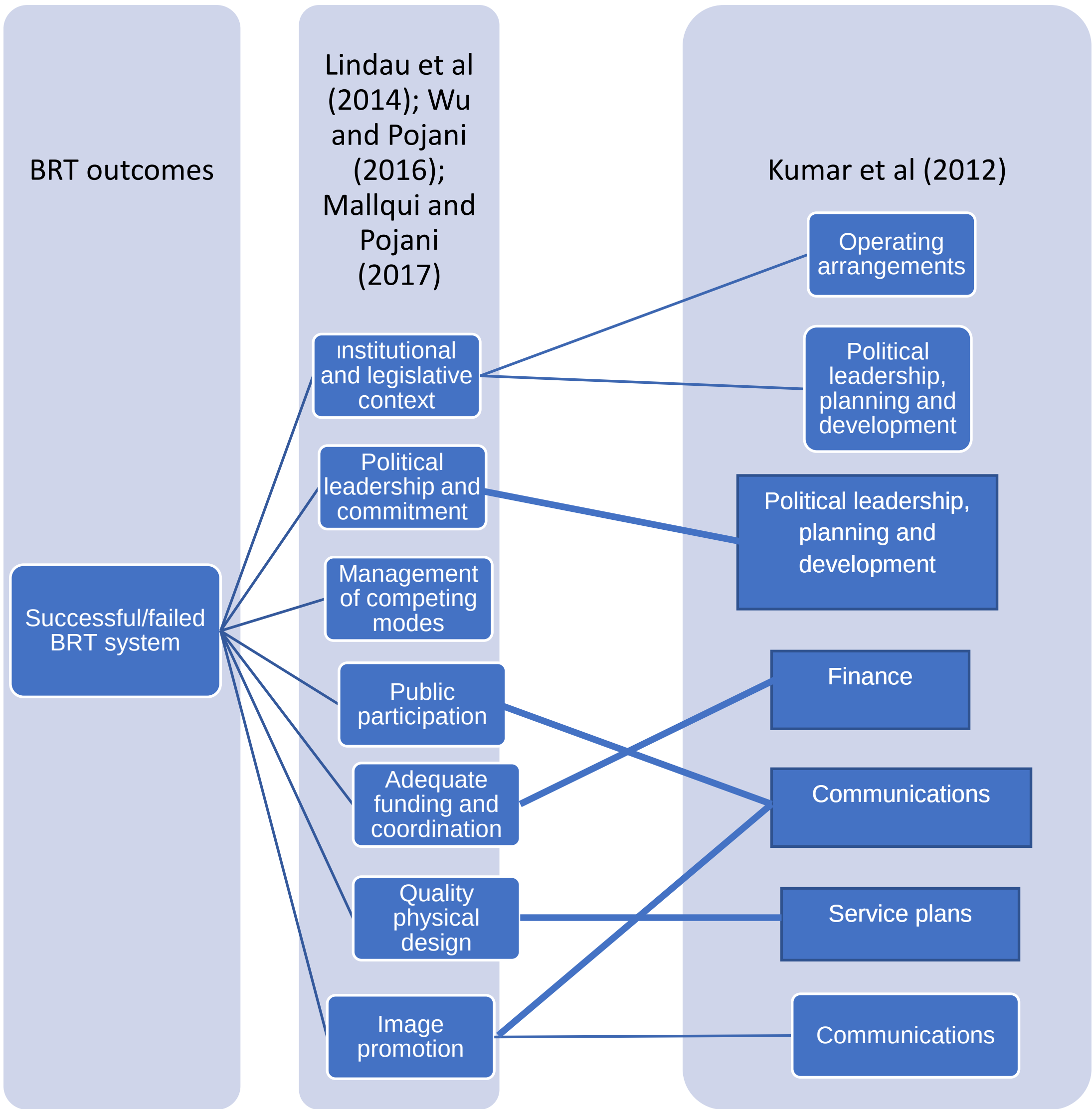


Figure 4.2: Overview of factors that determine a successful or failed BRT system

Source: Own construction (2018)

Based on this deduction, Brisbane and Bangkok BRT systems were selected because they share a similar characteristic with the Rea Vaya (Johannesburg) BRT: both have implemented limited BRT in the last decade (28km and 15km respectively) and they have potentials for future expansions. Ahmedabad was selected because India and South Africa appear to be in similar stages of economic development, a deduction reinforced by their joint membership of BRICS (Brazil, Russia, India, China and South Africa), an economic bloc of developing countries at similar stages of development.

In addition to demonstrating similar level of economic growth as the City of Johannesburg; Ahmedabad was selected because the BRT system is a representative of some milestones in the permanent evolution of BRT in a developing country context, informed by bottom-up planning and implementation approach, and underpinned by strong political will across three tiers of government, and a relatively short implementation time – within single term of political office (Rizvi & Sclar, 2014:202). For example, the Ahmedabad Janmarg Limited, a special purpose vehicle (SPV) created by the municipality to oversee the BRT system has won many national and international awards for implementing the BRT system (Kathuria et al., 2016:18).

In line with the above arguments, lessons learnt from similar studies are presented in Table 4.1. While Kumar et al. (2012) presented a research on BRT systems in developing countries (Africa and Asia), Levinson et al. (2002) articulated the lessons based on systems primarily from developed countries (North America and Europe).

Table 4.1: Highlights of lessons from past research on the synthesis of case studies

Key lessons learned	
Kumar et al., 2012	**Levinson et al., 2002**
Political will underpinned by strong and resourceful institutions	Alignment of stakeholder interests through an open planning and project development process that objectively considers BRT relative to alternatives.
Communication channels that incorporate all stakeholders	Integration of key system elements, such as physical design and system image can enhance outcomes.
Promote flexibility in operations and implementation	An ideal system with exclusive right-of-way and proximity to key transit markets enhances speed, reliability and safety.
Tailor system planning, design and implementation to align with the operating environment. There is no single BRT system prescription.	Context sensitive station design that promotes safe NMT and auto access is critical to achieving ridership objectives.
Focus on level of service (LOS), infrastructure, intermodal integration and system identity	Focus on quality vehicles that provide for customer comfort and cleaner air and noise emissions.
The system can be self sufficient	Strong system image and identity.
	A comprehensive service plan that incorporates possible passenger transfers, as well as peak and off-peak demands.
	The use of intelligent transportation system (ITS) as part of an integrated regional transportation system.
	Off-board fare collection is most desirable because: it permits multiple door boarding; can reduce station dwell times, passenger travel times and bus operating costs.
	In city contexts where there are barriers to implementation of a fully integrated BRT system, selective incorporation of the different components can be adopted by existing bus systems to enhance their overall attractiveness and cost effectiveness.

Source: Own construction, 2018 adapted from Levinson et al (2002) and Kumar et al (2012)

From the foregoing, the motivation is to identify the significant lessons from the selected BRT systems, by highlighting the pitfalls and barriers, along with the positive outcomes. It can be argued that there is as much to learn from failure as from success. Implicitly, these perspectives can provide useful lessons on the promotion of better outcomes from the point of view of the study area.

Consequently, the international case studies are presented based on data from the global BRT ;database, as well as reflections from empirical evidence by Satiennam et al (2006); Kumar et al (2012); Cervero (2013); Currie and Delbosc (2014).; Rizvi & Sclar (2014); Swamy (2014); ITDP (2016); Kathuria et al (2016); Wu and Pojani (2016); and Mallqui and Pojani (2017).

4.2. Population and daily passenger demands

From Table 4.2, it can be concluded that Bangkok has the highest metropolitan population but the least daily demand. It is argued that this outcome may be informed by its dispersed urban form, which reflects in its low population density. This argument is reinforced by the views of Satiennam et al. (2006) and Wu and Pojani. (2016). According to Satiennam et al. (2006:62) and Wu and Pojani (2016:45) most Asian cities were developed under city plans premised on land transport development and weak land use control, a practice that has increasingly caused sprawling and severe traffic congestion. For example, in Bangkok, the corridor with supporting population density for BRT development was difficult to identify because of low population densities informed by rapid sprawling.

Table 4.2: Population, population densities and passenger volumes

	Population (City)	**Population (Metro)**	**Population density (metro) (Persons/km^2)**	**Passengers per day**	**Peak (persons/hour/ day)**
Brisbane	1,970,000	2,065,996	347	356,800	19,900
Bangkok	8,305,218	14,565,547	1,876	15,000	1,200
Ahmedabad	5,726,000	6,240,201	4,060	130,000	1,780

Source: Own construction (2019) using data from http://www.brtdata.org

By drawing a comparison with the passenger demand of the Brisbane BRT, one can deduce that in spite of its lower population density (which implies an equally sprawled nature), the very strong private car orientation (from Figure 4.3); the BRT attracts more daily passengers than Ahmedabad and Bangkok BRT. In Brisbane, housing is predominantly single family, while the CBD is clustered with jobs and office buildings (Mallqui & Pojani, 2017:256). However, it appears that other factors may inform such outcomes, for example, the development level of the economy in Brisbane is very high, with a gross domestic product (GDP) per capital of close to USD50,000 (as illustrated in Figure 4.4). The GDP is the country's gross domestic product divided by the population, measured in US dollars. The Brisbane BRT is one of the busiest in the world (Currie

& Delbosc, 2014:145, 149; Kathuria et al., 2016:6), with an increasing use of public transport for daily commutes catalyzed by infrastructure and service improvements, ticketing integration (shown in Table 4.3) and higher parking costs in the CBD (Mallqui & Pojani, 2017:257).

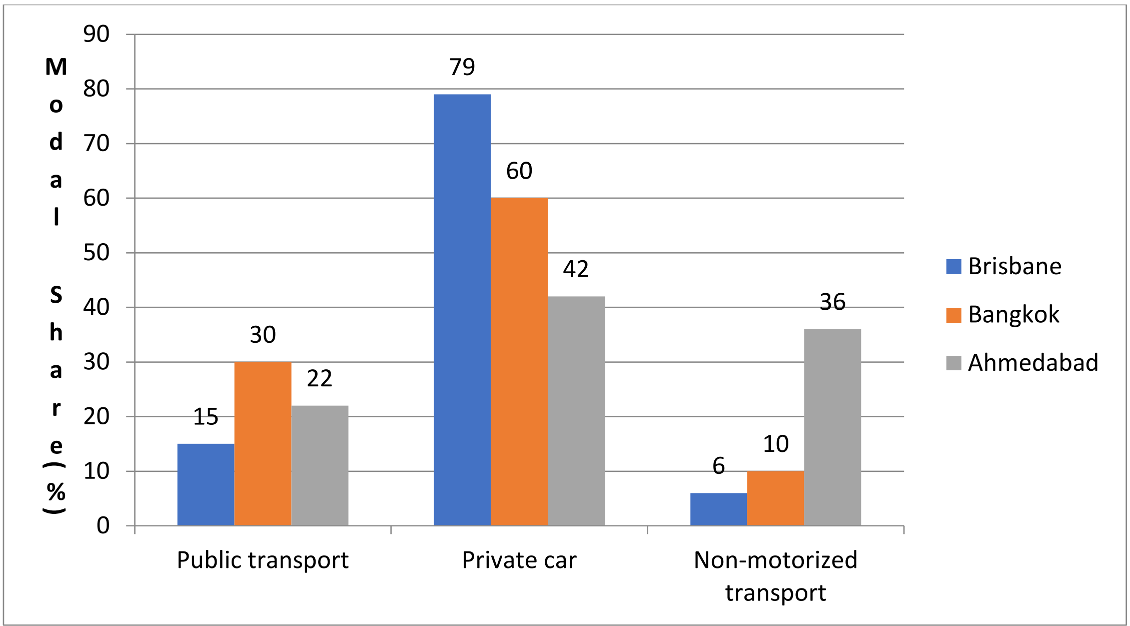


Figure 4.3: Modal share across the three international case studies

Source: Own construction (2019) using data from http://www.brtdata.org

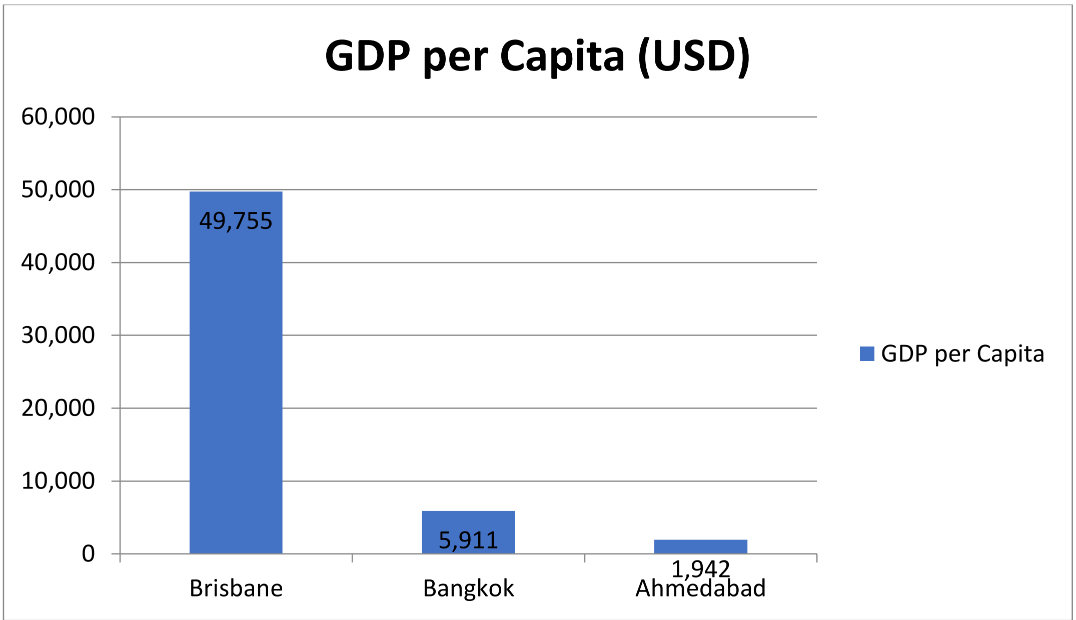


Figure 4.4: GDP per capital as an implication of economic status

Source: Own construction (2019) using data from from http://www.brtdata.org

Table 4.3: BRT system integration and fare collection structure

	Fare integration within system	Intermodal fare integration	Transfer Stations	Integration terminal	Pre-board fare collection
Brisbane	Yes	Yes			None
Bangkok			0	2	
Ahmedabad	Yes	No		2	None

Source: Own construction (2019) using data from http://www.brtdata.org

With regards to development level of the economy, Ahmedabad appears to be the least developed, with a GDP per capita of USD1, 942, a factor that is however not reflected in its daily passenger volume. This may be facilitated by the city's compact nature (reflected in its high population density), fare integration within system, physical integration with other modes at the 2 terminals, short average trip lengths (less than 5km) (Kumar et al., 2012:53; Rizvi & Sclar, 2014:196), and a fairly even mix of all different land uses between the core and the periphery (Kumar et al., 2012:53).

4.3. Institutional context

Bangkok BRT has highly fragmented transport planning agencies, with no single agency to oversee the hierarchical line of authority. There is significant function overlaps exacerbated by lack of integrated decision making process. In addition, selective knowledge transfer from the west, as well as a strong political influence by private car oriented elites have militated against a change of emphasis to public transport.

In Brisbane, the BRT is publicly operated, unlike other BRT systems in Australian major cities (Sydney, Melbourne and Adelaide) (Currie & Delbosc, 2014:146, 149). Earlier fragmentations of functions and activities between the two spheres of government responsible for the provision of public transportation was overcome by the introduction of an umbrella agency (Table 4.4) that drives integration of ticketing and fares for all public transport modes. In contrast, land use development is highly fractured, however, while the conflicts have not impacted on the BRT, they create an environment of distrust or avoidance between the two spheres of government.

From inception, institutional responsibilities for the Ahmedabad BRT were clearly integrated, with an agency created by the municipal government serving as the chief executing authority of the system. The private sector, local scholars (from the University) and foreign institutions like the ITDP were involved in planning and design, to maximize expertise and efficiencies.

Table 4.4: Institutional integration

	Transit Agency
Brisbane	Translink
Bangkok	
Ahmedabad	Ahmedabad Janmarg Ltd

Source: Own construction (2019) using data from http://www.brtdata.org

4.4. Management of competing modes

There is intense competition from the private car and other mass transit modes in Bangkok. This deduction is illustrated in Figure 4.5, with the private car responsible for 60% of the city's daily travel modes. Compared with other case studies, the private car is more dominant in Brisbane, at 79% (Figure 4.6), which implies that almost 8 out of every 10 daily individual trips are done with the private car. It can be argued that the city's high GDP implies a high level of affordability for private cars. Although it appears that residents are not averse to using public transport, they are only attracted to a mode that is extremely convenient in terms of stop locations, faster and more cost-effective than the private car. Then factors within the local context, such as cheap fuel prices and private car oriented policies have reinforced the dominance of cars. It can be deduced from Figure 4.7 that non-motorized transport mode (36%), which is largely two-wheelers, is the preferred means of travel after the private car (42%).

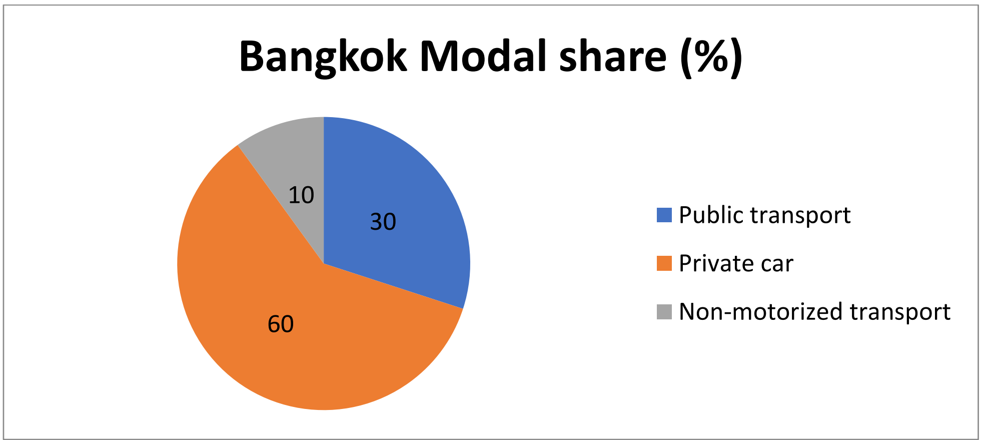


Figure 4.5: Modal distribution in Bangkok

Source: Own construction (2019) using data from http://www.brtdata.org

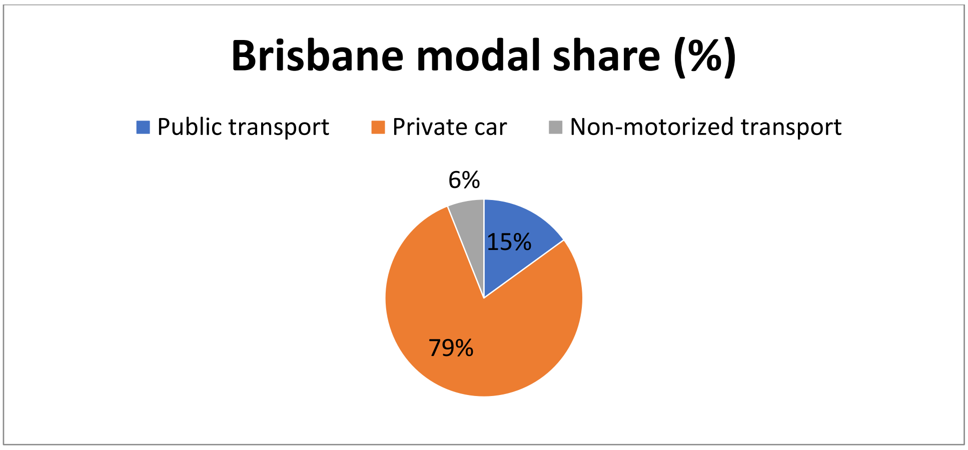


Figure 4.6: Modal distribution in Brisbane

Source: Own construction (2019) using data from http://www.brtdata.org

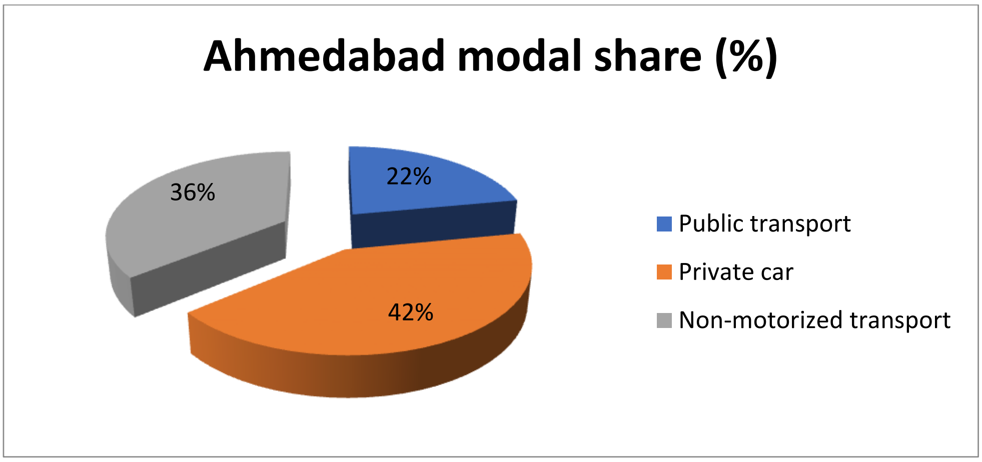


Figure 4.7: Modal distribution in Ahmedabad

Source: Own construction (2019) using data from http://www.brtdata.org

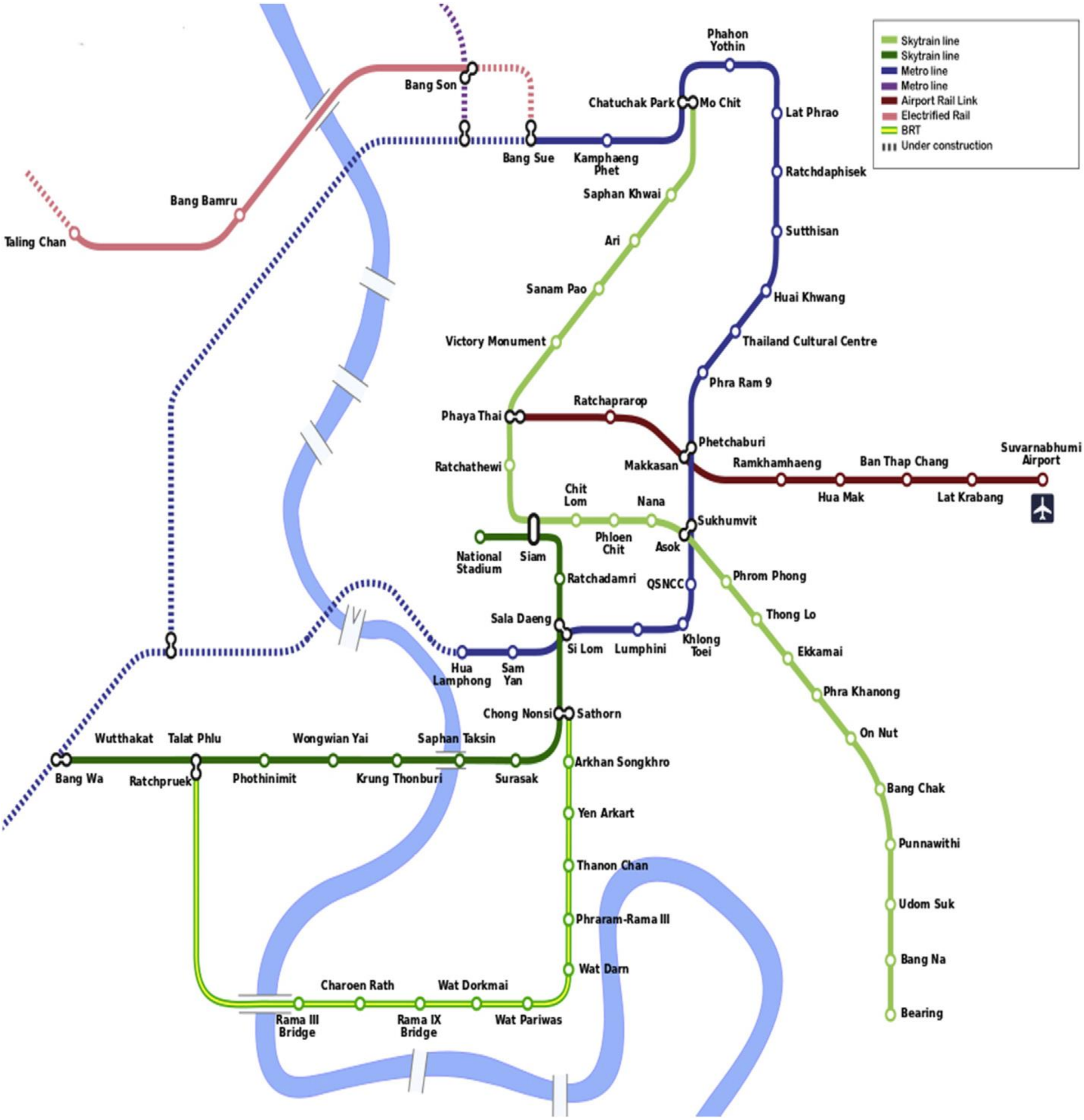
With regards to the integration or competition from other modes, there are three other mass transits in Bangkok, although they all have limited reach. However, Bangkok rail transit has a wider network, with a route length of almost 80 kilometres, and an ambitious long-term plan to expand it beyond 290 kilometres (as illustrated in Map 4.1). In this regard, one can deduce that the BRT systems in Brisbane and Ahmedabad have greater potential for higher passenger volumes, because they are physically integrated with the rail systems. Brisbane's BRT physically overlaps with the city's rail network (see Map 4.2), but it appears that the creation of the single transit agency has reduced the possible limitations. In Ahmedabad, the BRT system is integrated with the city's railway, as illustrated by the inter-modal station integration in Map 4.3. In practice, it is argued that integration through physical transfer points and fare integration with other modes can enhance outputs. Physical transfer points reduce walking between modes and reduce travel time by limiting complete exit when changing modes (ITDP, 2016:60). However, only the

Brisbane system has intermodal fare integration (Table 4.5), while fares are only integrated within the Ahmedabad system. But the three systems lack the pre-board fare collection system which is one of the most significant factors that reduce travel time and increase user experience (ITDP, 2016:33).

Table 4.5: Fare and modal integration

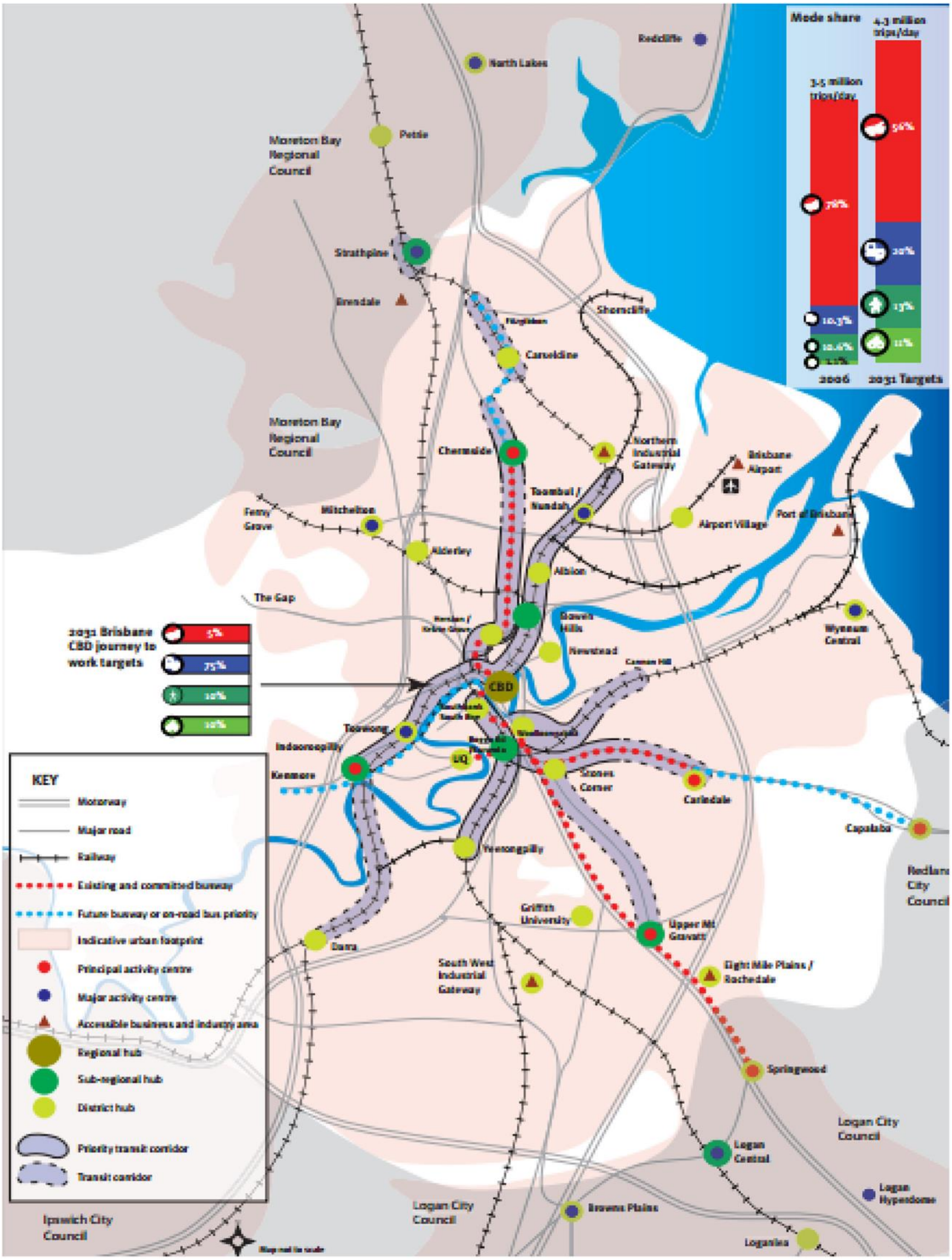
	Fare integration within the system	Intermodal fare integration	Transfer Stations	Integration terminal	Pre-board fare collection
Brisbane	Yes	Yes			None
Bangkok			0	2	
Ahmedabad	Yes	No		2	None

Source: Own construction (2019) using data from http://www.brtdata.org



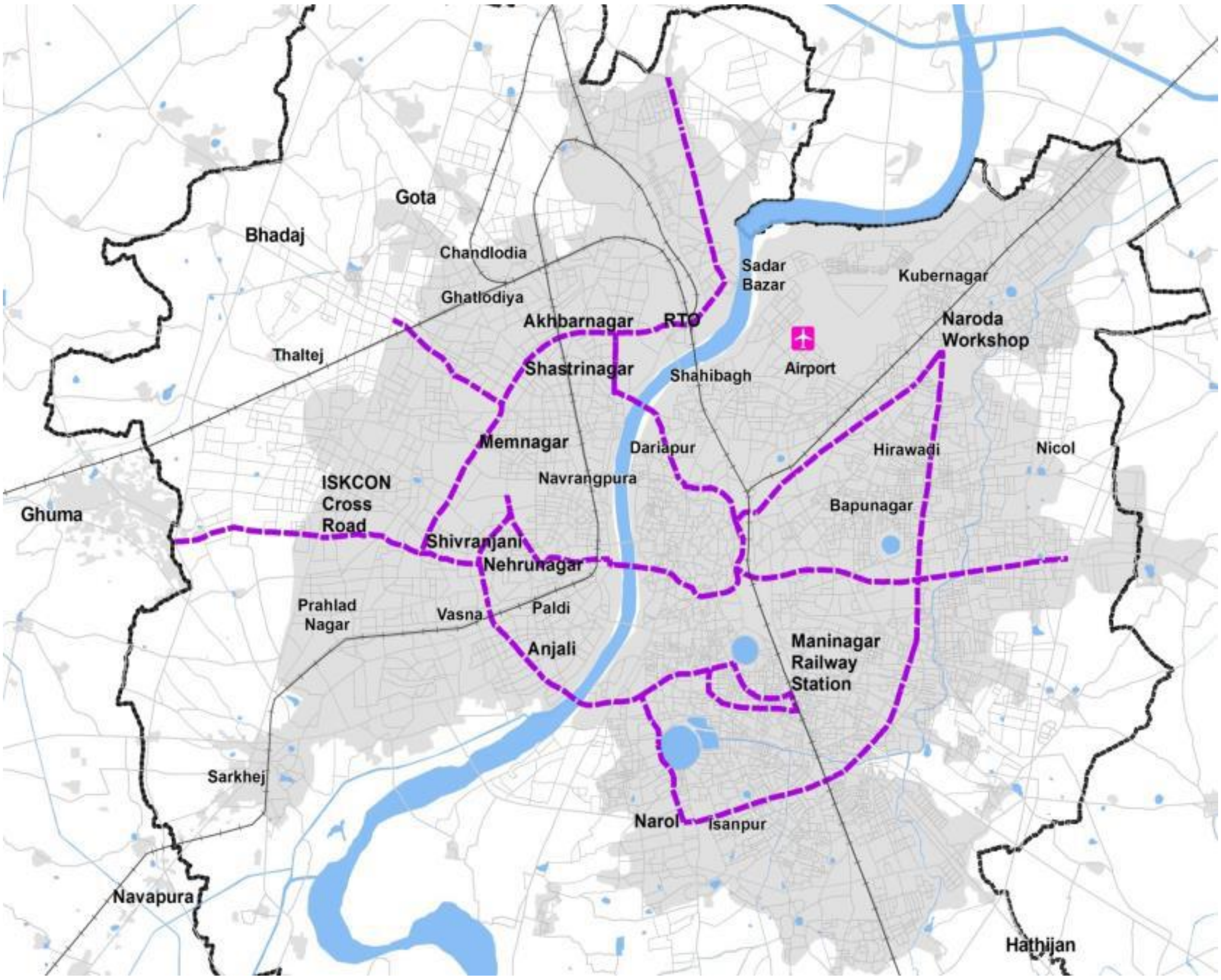
Map 4.1: Public transit map of Bangkok showing its poor integration with the rail transit

Source: Wu and Pojani. (2016:46)



Map 4.2: BRT and rail in Brisbane (2031)

Source: Mallqui and Pojani (2017:262)



Map 4.3: Ahmedabad (Janmarg) BRT network

Source: Swamy (2014:4)

4.5. System design

Ahmedabad BRT system is the longest but it has the least average operating speed (Table 4.6). The deduction from this is that travel time may be longer in the city, when compared to the other case studies, although their different local contexts may largely influence the average speed. It is argued that the system has a poor NMT orientation because provisions are only made based on an allowance by the right of way (ROW) (Rizvi, 2014:70). However, the design process was iterative, drawing heavily from local (Delhi and Pune) and international BRT experiences. The strategic use of incremental construction reinforces the iterative design process and demonstrates the flexibility of the design team to feedback and adaptation. For example, design for phase 2 incorporated the lessons learnt from phase 1.

Table 4.6: BRT system design for the international case studies

	System length (km)	Corridors	Stations	Station spacing (Meters)	Real time information	Operating speed (km/h)	Total fleet
Brisbane	28.4	3	25	1,153	All	37.5	475
Bangkok	15	1	10	1,530.00		26	20
Ahmedabad	82	1	167	645.7	All	24	136

Source: Own construction (2019) using data from http://www.brtdata.org

Although the Bangkok BRT is limited, it is of high quality, with design characteristics such as buses running on natural gas, air-conditioned terminal stations, and use of escalators, electronic displays and smart cards. The major design limitations include: operating in mixed traffic in crowded portions of the center; running through a low-demand area because securing the right-of-way (ROW) was less controversial; and poor physical integration with other modes.

In terms of station spacing, it appears that only the Ahmedabad system meets the BRT standard of the average distances between stations. Optimal spacing between stations should be between 300-800 meters (ITDP, 2016:53). Any distance above the 800 meters standard as observed in Brisbane and Bangkok may imply that more time will be imposed on users walking to stations than would be saved by higher bus speeds. It implies that the long station spacing between the Bangkok BRT stations could contribute to its low ridership figures, because it may be unattractive to users of other modes. In another context, the multi-corridor nature of the Brisbane BRT may induce demand, because multiple corridor BRT systems form a network that expands travel options for users and enhance the level of service (ITDP, 2016:44).

For station boarding, Ahmedabad system (Table 4.7) facilitates time saving because platform level systems reduce boarding and alighting times per passenger. This is because they reduce the vertical gap between the bus floors and station platforms. The on-street boarding of the Brisbane system may increase travel time and reduce user safety and comfort (ITDP, 2016:36). However, it can be deduced that the overtaking lanes present at Brisbane stations may be the catalyst to the system's high bus frequencies. This is because they reduce congestion by enabling stations to accommodate a high volume of buses.

Table 4.7: Additional design standards of BRT systems

	Position of with-flow lanes	Position of bus doors	Lane material on running ways	Lane material at bus stops	Overtaking lanes	Station boarding level	Peak frequency	Fuel type
Brisbane	Separated ROW	Left	Asphalt	Concrete	All	On street, no level boarding	295	CNG and Diesel
Bangkok	Median	left & right					15	
Ahmedabad	Median	left & right				High-level boarding	20	Diesel

Source: Own construction (2019) using data from http://www.brtdata.org

4.6. Land development impacts of the BRT systems

There appears to be limited research based empirical evidence on the spatial impacts of these systems, however two separate empirical findings on Ahmedabad BRT produced different perspectives. Cervero (2013:16) argues that because the BRT was designed as mobility investment, and not for city-shaping, land development changes at station areas were few. According to Cervero (2013:16), where they have occurred, they have been solely driven by private sector forces. But in a different view, Swamy (2014:14-36) concluded that the BRT has spurred an increase in all land uses on the Shivranjani BRT station area except for open space and utility. To ascertain the BRT impacts, the study compares land use changes at the BRT station area with a regular transit station area between 2006 and 2014. However, the results reflect changes at both areas, but it can be deduced that the BRT station area attracted more commercial land use. For example, there was an increase of 292.3% in commercial land use compared to 123.4% increase at the regular transit station area.

In contrast, mixed land uses became more dominant at the regular transit station area (91.9%) compared to a 46.3% growth at the BRT station area. Similarly, residential land uses increased more (16.0%) at the regular transit area compared to the BRT station area (9.0%). In addition to this, the two areas had an increase in multi-story buildings, with those more than 4 floors largely dominant at the 2 study areas. However, in spite of the higher proximity of the regular transit station compared to the BRT station (Figures 4.8 and 4.9), the BRT generate more daily trips (1,100) than the regular transit (636). Commuters come from as far as 1.2km to 1.5km to board a bus at the BRT station. This could be as a result of a package of factors such as travel time, affordability, safety and integration within the system. But the spatial implication of this is that the BRT station is not easily accessible and transit induced growth (TOD) may require density oriented policies and public sector interventions to stimulate private sector developments.

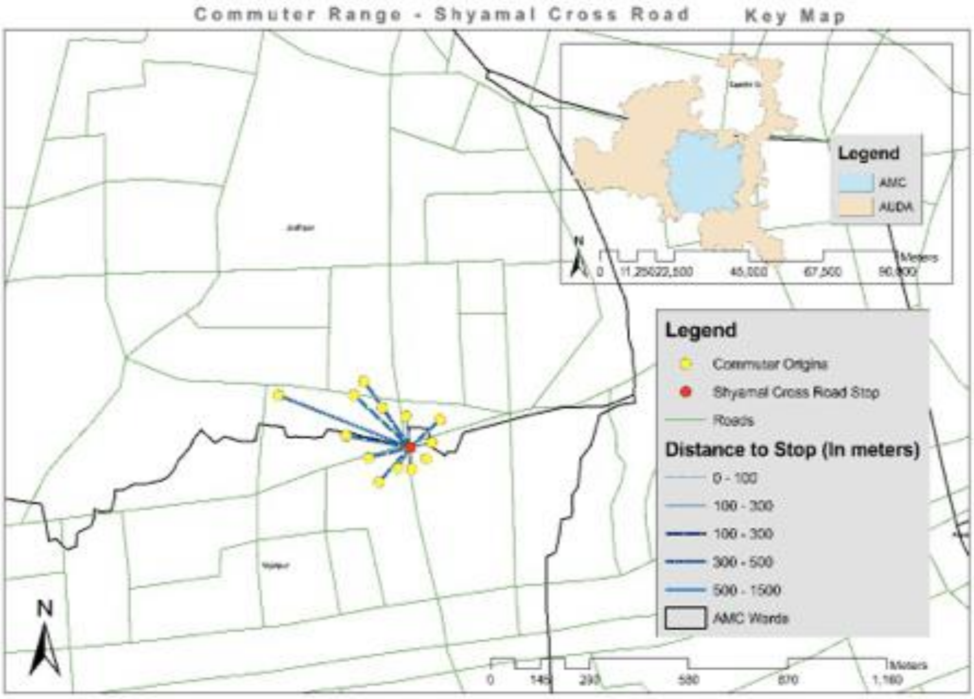


Figure 4.8: Commuters distance to Shyamal Cross Road regular transit station in Ahmedabad

Source: Swamy (2014:18)

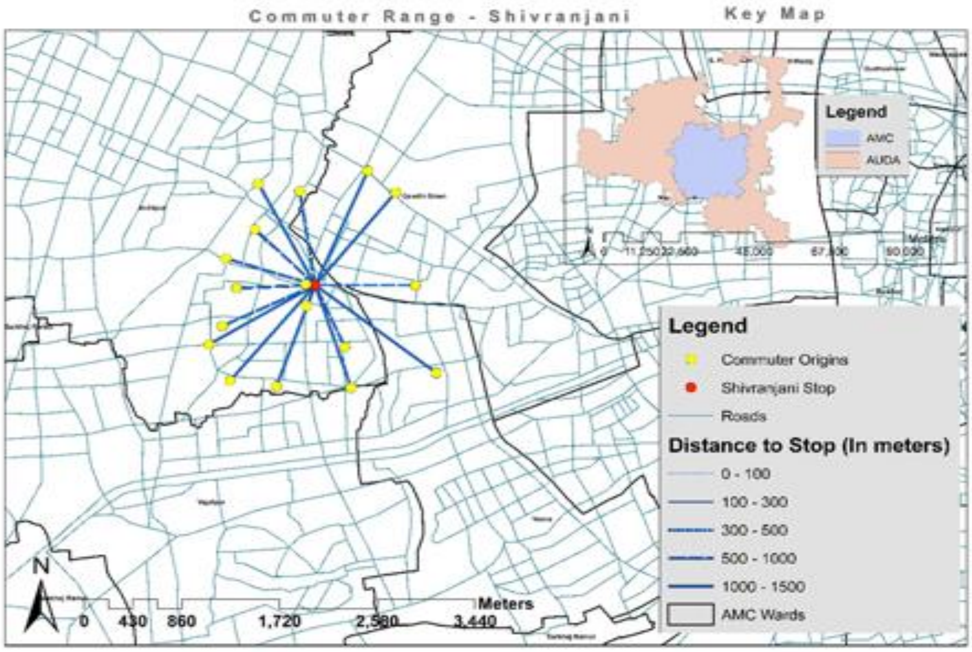


Figure 4.9: Commuters distance to Shivranjani BRT station in Ahmedabad

Source: Swamy (2014:18)

In the case of Brisbane, Yen (2014) concluded that the BRT stimulated an increase in land values because of its wide network coverage and a relative lack of rail based competition. In addition, the research, which studied the spatial distribution of land value increases, found that it is spatially distributed over the BRT network. Therefore, Yen (2014:2) deduced that: housing prices benefit from proximity to a BRT through the addition of a premium; these premiums vary over space and the research underlined the significance of a high frequency feeder bus network by implying that it catalyzes the capitalization effects on adjoining land values. The conclusion from Brisbane is similar to the outcomes in Ahmedabad, if taken in the context of the increase in land values on the BRT corridors. In this regard, Swamy (2014:21) established through empirical research that residential land prices grew between 50-105% while commercial land prices escalated between 60-185% on 6 BRT corridors.

4.7. Synthesis of findings: key lessons learned

Table 4.8 summarizes and compares the case studies based on the 6 themes developed from a desktop review of international case studies. Comparison of the 3 case studies demonstrate a number of similar attributes, such as high quality, strong competition from dominant modes and potential for expansion. For example, Bangkok BRT is of high quality, in spite of its limited coverage and low ridership. Although Ahmedabad BRT has been argued to be relatively successful, especially when compared to the system in Delhi, the more affordable two-wheelers remain the dominant mode. However, public transport users still rely on alternatives such as the unsafe and sub-standard buses operated by the municipality. In Brisbane, close to 80% of trips are private car oriented, and driving remains the preferred travel mode.

Table 4.8: Summary of empirical findings on international case studies

	Bangkok	**Brisbane**	**Ahmedabad**
Institutional and legislative context	Fragmented and private car oriented leadership	Umbrella agency and fractured land use development process	Institutional integration underpinned by private and scholar inputs
Political leadership and commitment	Unstable political landscape	Political turnover after implementation has hampered expansion	Strong political leadership
Management of competing modes	Competition is intense	High private car use, but the system is integrated with rail transit	Provision was made for competing modes during planning and design
Public participation	A top-down approach that excludes operators of competing modes	Extensive public engagement during the planning process	The system is supported because the idea was locally driven

Adequate funding and coordination	Funding is limited because proponent belonged to different ideology and political party	Deliberate funding shortages because there was change of leadership, and the new leaders are private car-oriented	Funding was provided internally through the JnNURM
Quality physical design	High quality system, but poorly integrated with other modes	Very high quality system, integrated with the rail transit	Branded buses and ITS equipped stations
Image promotion	The image was poorly managed from inception	Well accepted by residents, and the busiest system in Australia	The bottom-up approach facilitates participatory planning and enhances system image
Length (Km)	15	28	82
Speed at peak period (km/hr)	26	80	24
Daily ridership	15,000	200,000	130,000
Public transport modes	Airport elevated rail link, BRT, skytrain, conventional buses, conventional trains, paratransit, boats/ferries	Regional rail transit, BRT, conventional buses, river ferries and bike sharing	Two wheelers, sub-standard conventional buses, rail transit

Source: Own construction, 2018 adapted from Satiennam et al. (2006); Kumar et al. (2012); Currie and Delbosc (2014); Rizvi & Sclar (2014); Swamy (2014); Kathuria et al. (2016); Wu and Pojani (2016); and Mallqui and Pojani (2017).

However, the contrast of outcomes was subject to the contextual differences of the three cities, as reflected in responses to the themes highlighted in the theoretical frameworks. Based on this, the major lessons learned are organized into the following categories:

- Funding – funding for the development of Bangkok's BRT was primarily sourced from the national government, and this contributed to the long implementation period of the project, because of differences in political affiliations and ideologies between the city leadership and the national stakeholders. The BRT was the idea of the then city governor, but the time spent on aligning differing political interests contributed to the damage on the appeal and image of the BRT system, before implementation. It appears that the creation of an independent institution responsible for providing funds for such projects, such as the JnNURM in India can serve as a panacea to the funding limitations demonstrated in Bangkok. On the other hand, Brisbane demonstrated that, in spite of a different tier of government having responsibilities for such municipal projects, funding barriers can be overcome if ideologies are aligned from inception.

  In addition, funding can also be obtained from international financial institutions with mandates for supporting sustainable public transport initiatives. It appears that projects funded by such institutions are usually subjected to objective planning and unbiased consideration for alternatives.

- Design – best outcomes are achieved when the design is adapted to local conditions and constraints. This provision can be incorporated during consultations and engagements at the planning stage, with the direct involvement of role players with a good understanding of the local operating environment. For example, in addition to the Ahmedabad BRT being a local initiative, inputs were consolidated from scholars in the local University, industry professionals and the public through outreaches and workshops; to facilitate a design process that reflects and synergizes the feedbacks, and adapts to the evolving local conditions. The use of incremental construction contributed to a system design that is flexible and responsive to changing contexts.

- Private sector involvement – although the three case studies are publicly operated, it appears that privatization can foster competition and facilitate the reduction of subsidies. It enhances government savings and promotes fair distribution of capital for re-investment or in other sectors. This approach has been implemented in other Australian BRT systems, and considerable savings were identified.

- Integration – integration (physical and operations) of the BRT with a system network that incorporates competing modes and provides for NMT proximity and access to stations is essential for optimizing the potential benefits. Since residents will only be willing to use new alternatives that are extremely convenient, faster and cheaper; the network integration should reflect a mode that provides comfort and appeal through system identity, quality physical designs – such as clean vehicles, distinct stations and short distance between stops – and a level of service that generates pleasant travel experience and reduce travel time. Policies that limit the dominance of competing modes, such as congestion and parking pricing, e-tolling and fuel tax can enhance the integration of the system network with competing modes.

  In addition, the integration of institutions under an umbrella agency can have profound impacts on the final outcomes. For example, the creation of a single agency to operate the BRT and competing public transport modes in Brisbane has increasingly eliminated their overlapping nature, and facilitated the provision of funding to the system that benefits the people. However, capacity building across institutions and private consultancies, reinforced by provisions for frequent knowledge sharing can increase their preparation to face the complexities of high performance transit systems.

- No universal approach – solutions are provided based on unique conditions, and it is essential for planners and other professionals to be flexible and result oriented. For example, it was argued that the development of Bangkok's BRT system's first corridor in a low-density part of the city contributed to its failure to meet projections, because a transit system is driven by high demands. The government attempted to reduce cost by avoiding the complexities such as not-in-my-backyard (NIMBY) associated with high density areas. In contrast, the incremental construction approach implemented in Ahmedabad ensures that construction and operations started from the less problematic areas to the more complex areas. This provided rooms for improvements on failures and successes identified, as well as enhancing the image and acceptability of the system.

- Density drives demand – it can be concluded that the high population density of Ahmedabad is one of the drivers of the daily demand for the BRT service. In spite of the city's level of economic development, which is the least of the three case studies, its passenger volume is largely incomparable with the Bangkok system. It is therefore argued that BRT passenger output is largely informed by population densities at the corridors, and building the infrastructure in the highest demand segment of the roads ensures that customers benefit significantly from improvements.

4.8. Conclusion

The outcomes of a BRT investment are contingent on key factors that impact on all phases of its implementation. While all the factors have significant impact, it appears that they are all driven by a political leadership underpinned by a common orientation and unbiased interests concerning the cost and benefit implications of the development. This conclusion is reinforced by the outcomes from the three case studies. The landmarks achieved by Ahmedabad BRT are catalyzed by the alignment of agendas between the spheres of government, as well as adequate communication through public participation at the design, implementation and expansion stage. Public participation was facilitated by initiatives driven by political and institutional role players, and such initiatives include outreaches and frequent users survey.

In the same vein, the chapter revealed that political transition in Brisbane has hampered the expansion of the BRT because the new leadership had a different ideology that promotes the provision of rail transit. Meanwhile, Bangkok's BRT has not been expanded beyond the initial 15 kilometers because implementation transcends two political dispensations, and it was regarded as a pet project of the city governor who was unable to complete the project before leaving office.

The lessons learnt from the case studies were informed by the theoretical frameworks that influence success or failure of the BRT system, irrespective of the city context. The lessons learnt are categorized under the following themes:

- ✓ Funding
- ✓ Design
- ✓ Private sector involvement
- ✓ Integration
- ✓ No universal approach
- ✓ Density

Generally, it can be concluded that desired outcomes may be promoted in the study area by incorporating lessons learnt from own success and failures (as in the case of Ahmedabad), as well as inspirations from international experiences; because it eliminates the practice of wrongfully importing transportation planning approaches directly from the developed countries to the developing countries.

However, it is argued that the decision-making process is profoundly influenced by the existing legislative and policy framework in the study area. In practice, it appears that the land use-transport synergy is largely driven by institutional and legislative context, which, in line with the conclusion from this chapter, is public sector orientated. This argument aligns with the assertion by Goldman and Gorham (2006:2), on the significance of policy guidance in addressing sustainability issues.

Based on this conclusion, the next chapter will provide an analysis of the legislative context in the study area, as well as the key urban transformation instruments and their influence on the research theme.

CHAPTER 5: POLICY AND LEGISLATIVE FRAMEWORK IN THE STUDY AREA

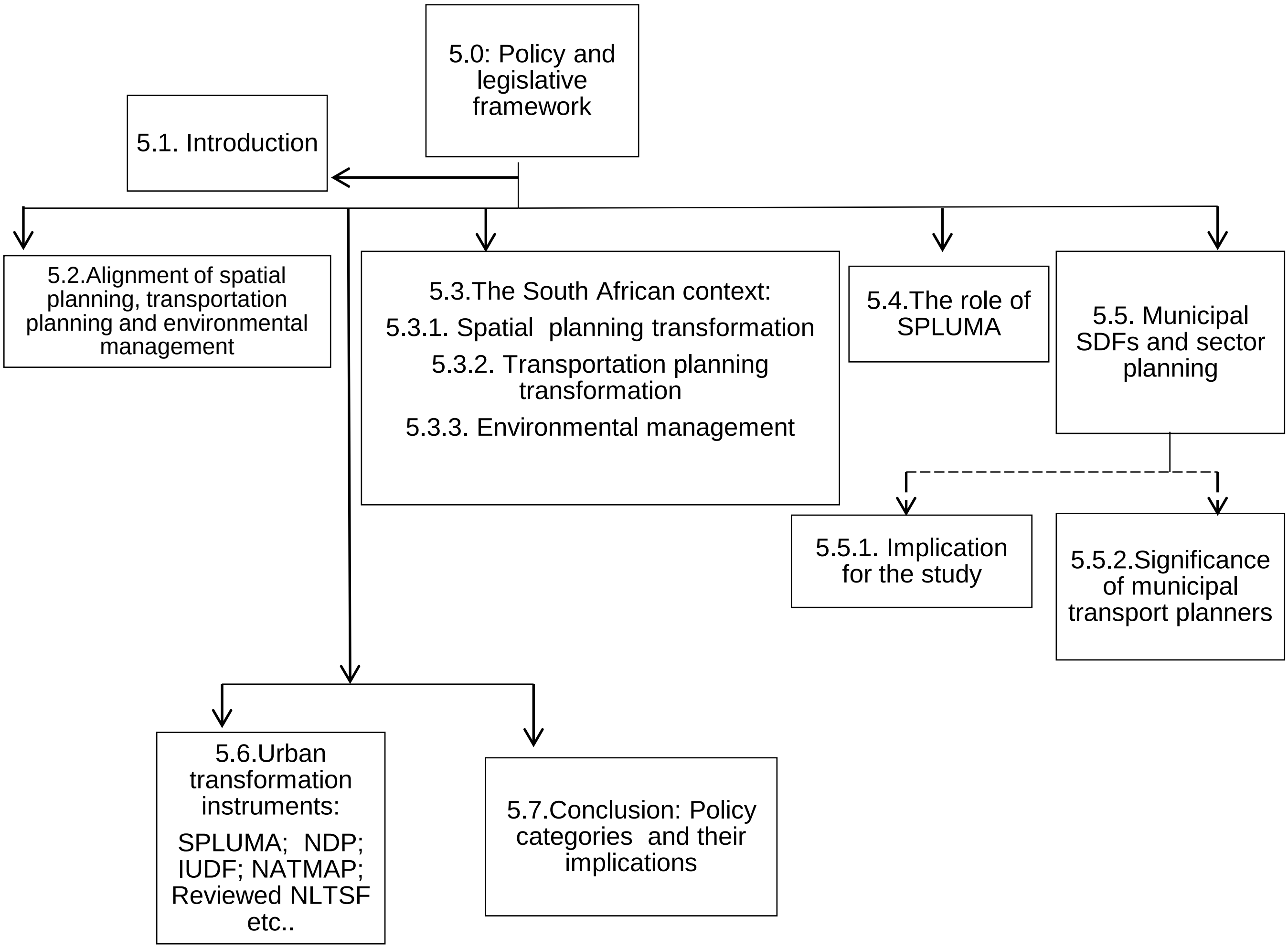


Figure 5.0: Layout and footprint of chapter 5

5.1. Introduction

The last chapter contained the lessons learned from BRT implementation in a developed and developing country context. In addition, the significance of the legislative context in the operating environment was highlighted. It is essential to explore the relevant policy and legislative framework (South African context) that influence the research topic. In this regard, the complexities in the alignment of spatial planning, transportation planning and environmental management, three overlapping fields with direct bearing on this study will be discussed. This is simultaneously done with the role of SPLUMA in the alignment of these processes and its place in giving power to the local government. A brief case is also made on the need for municipal transport planners, followed by the relevant urban transformation instruments and their implications for the research. The roadmap below is a graphical overview of the chapter.

5.2. Alignment of spatial planning, transportation planning and environmental management

Public transport has always been on the front burner of South Africa's historical development phases. People were artificially located long distances away from economic opportunities, shops and public services. The government is faced with reversing the travel patterns that have been associated with this historical spatial, transport and environmental imbalances. However, policy implementations that will dictate the extent of this change have been inconsistent across the modes of transport. Walters (2013:34) concludes that while progress has been made with the introduction of modes like the BRT and Gautrain, the commuter bus mode has been less progressive. Bickford (2013:17) suggests that process issues and foundational institutional challenges must be addressed to promote public transport and mobility in cities. Transport land-use integration is also essential for the delivery of more sustainable and equitable transport practices. Consequently, there is a profound need to align transport planning processes with spatial planning (urban panning) processes. Environmental management is another discipline that feeds into the process and there is a concern about how these complex relationships have combined to shape South Africa's transport imperatives.

The interface and alignment between spatial planning, transportation planning and environmental management is essential for the promotion of sustainable planning and development. Though it is such a delicate balance, a lack of it results in ecological degradation, increased (development) inequality, segregation and compartmentalization of planning and non-delivery. This alignment entails the articulation of the policy instruments used by professionals in these fields and a manner of coordination that enhances integrated outcomes (Schoeman, 2015:42). However, such functional and operational fragmentations have been non-existent in South Africa since the apartheid days, and it even became more prominent after democratization in 1994 (Schoeman, 2015:42). In addition, when taken separately, the three fields have fractured legal and institutional arrangements that make the achievement of set outcomes (sustainable development) more problematic.

For instance, spatial planning and land use management in Gauteng Province have a plethora of applicable laws and fragmented institutional responsibilities that lead to inefficiencies (Baylis, 2011:6). However, the introduction of the Spatial Planning and Land Use Management Act (SPLUMA) (Act 16 of 2013) and the SPLUMA Regulations (March 23, 2015) has stimulated a transformation in spatial and statutory planning legislation within municipalities. Although the country is not alone in the struggle for harmonizing policies across the three functional fields as Geerlings & Stead (2003) articulate the need for a synergy in transport, land-use planning and environmental policy in the European context.

Sectoral policies were autonomously developed in the absence of institutional structures to harmonize deliveries and outcomes. There was a need to integrate (rather than merely co-ordinate) policy development and delivery across the three disciplines (Geerlings & Stead, 2003:193-195). In the South African context, authors like Sowman & Brown (2006:695-712); Todes et al. (2009:411-431); Berrisford (2011:259); Kihato (2013); Du Plessis (2014:80-81), Ruwanza and Shackleton (2016:28-30, 36); and Snyman (2017) reinforced the need for stronger integration between planning (Integrated Development Planning) and environmental management at the municipal level.

Their views were premised on the need to promote sustainability through a better handshake between spatial planning and environmental management. While Todes et al. (2009:425) argue that the environmental dimensions of strategic plans have been poorly developed (with few exceptions), and sustainability poorly represented; Retief (2007:83) concludes that the Strategic Environmental Assessment (SEA), the tool used to improve the sustainability aspect of spatial planning had failed to inform or influence decision making. Nevertheless, Schoeman's (2015:43) contribution to the debate was for the inclusion of transport planning in integration and alignment considerations. According to Schoeman and Schoeman (2017:121), the sectoral compartmentalization challenge can be partially addressed by assessing South Africa's existing policy and legislative framework, and more specifically, the opportunities created by SPLUMA (2013) and SPLUMA Regulations (2015).

South Africa has a pre-democratic legacy of separate urban areas for different racial groups, an apartheid ideology that resulted in many spatial planning, cultural and social problems. One of these problems is the motor car and transportation in general. The private car was highly promoted by the apartheid legacies and public transport was only provided to move workers from townships to places of employment. Post-democratic legacies have been doing much to re-orientate public institutions to prioritize public transport. An efficient public transport is critical for integrating the different urban areas and overcoming the fragmented urban fabric. Besides, to achieve an integrated land use, transportation and environmental management strategy, the several processes and actions needed to realize the substantial policies must be synergized.

Several policy documents such as the National Transport Master Plan (NATMAP), the National Infrastructure Development Plan (NIDP), the Draft Integrated Urban Development Framework (DIUDF), and the National Land Transport Strategic Framework (NLTSF) promote alignment and strategic integration between their different policy focuses, as being promoted by this research. In this regard, the Intergovernmental Relations Framework Act (IGRFA) (Act 13 of 2005) provides a platform for coherence and consistency in visions and processes (GSDF 2030:7-8). However, in practice, there is always the "challenge of maintaining the global coherence of the policy cycle over an extended time period, including the different decision makers at neighborhood, city, regional and national level, as well as ensuring the participation of relevant stakeholders and the civil society in the various steps of the process" (TRAANSPLUS Consortium, 2003:16).

5.3. The South African context

An analysis of the country's existing policy and legislative framework shows the complexities in alignment between spheres of government, stakeholders and professions. Such complexities promote misalignment, disintegration, subjective application of planning tools and principles and non-delivery in terms of roles and functions. This condition was informed by transformations which have occurred in transportation planning, spatial planning and environmental management.

5.3.1. Transformation in spatial planning

It appears that the country's new democratic government inaugurated in 1994 inherited a fractured spatial system informed by an evenly ineffective policy and legislative framework (Schoeman, 2010:2). For example, the scope of planning during the apartheid era was fairly narrow, and it was exacerbated by a neglect of environmental issues (Joscelyne, 2015:51). The transformation of this dysfunctional framework began with the Draft Green Paper on Development and Planning, developed by the National Development and Planning Commission in 1999. This was followed by the White Paper on Planning and Land Use Management. Schoeman (2010:3) describes South Africa's spatial planning and institutional context before 1994 with the following periods which are mainly politically influenced:

- 1910 to 1930, the spread of the British planning influence;
- The 1930s, Second World War and the post-war reconstruction efforts;
- The post-1948 era and grand apartheid;
- The period following the Soweto uprising in 1976;
- Post-1985 late apartheid reforms.

Spatial development has evolved in South Africa and the most recent phases – the post-1994 urban re-integration and rural development phase and the spatial system development, reconstruction, integration and consolidation phase (Schoeman, 2015:44) – which have been informed by the Reconstruction and Development Programme (RDP) and some set of new democratic laws like the Development Facilitation Act (67 of 1995) and the Constitution of South Africa (1996). However, it is argued that the RDP is fundamental to post-1994 South Africa, as according to the National Planning Commission (NPC) (2011:34), it provides a base for the country's political, economic and social transformation, by promoting inclusive growth and addressing service and infrastructure backlog. In spite of the inroads achieved since the introduction of the RDP, opponents have highlighted limitations such as poor housing quality (Moolla, 2011:89) and violent conflicts generated by housing delivery in some communities (Kotze & Molle, 2011:143). Nevertheless, it can be argued that the RDP is not completely a failed policy because it is open-ended, and it is under implementation after 25 years of its creation.

By reflecting on the policy and legislative contexts after the creation of the RDP, one can deduce that the spatial transformation process was largely facilitated by the Development Facilitation Act, the Integrated Development Plan and SPLUMA. In underscoring the significance of the Development Facilitation Act (DFA), Nel (2016:257) argues that other legislations enacted by post-apartheid democracy prior to 2013 had relatively little impact. However, according to Nel (2016:257), although the DFA generated innovations such as development principles and strategic municipal planning in the form of land development objectives; it failed to change the overall planning landscape.

Conversely, the spatial planning landscape was eventually changed with the promulgation of the Municipal Structures Act (117 of 1998) and the Municipal Systems Act (32 0f 2000). This culminated in the formulation of the Integrated Development Plan (IDP) for all institutional entities within the municipal sphere of government, which is used by municipalities to manage the use of scarce resources. The IDP was inspired by events like the Rio Earth Summit (1992) of Sustainable Development. The Rio Summit generated a strong basis for promoting more sustainable and compact cities. It emphasizes on land use and transportation planning and the need for local governments to incorporate citizen participation in municipal planning.

The transformation process climaxed with the creation of the National Planning Commission (NPC) in 2011, the National Development Plan (NDP) in 2012 and the approval of SPLUMA (2013) and SPLUMA Regulations (2015). Sadly, these processes resulted in a fragmented land-use decision-making because the division of functions and powers was inappropriately addressed by the policy and legislative framework (Schoeman & Schoeman, 2017:147). They were also unable to "resolve the need to transform the legislative reality guiding spatial planning and development as regards new democratic needs and expectations" (Schoeman, 2015:44); but SPLUMA (13 of 2013) and its Regulations (2015) have significantly impacted on outcomes.

SPLUMA (2013) and its Regulations (2015) guides municipal planning by formalizing the role of Spatial Development Frameworks (SDFs) within all spheres of government (SPLUMA Sections

12-21), and they emphasize the significance of municipalities among the spheres of government (SPLUMA Section 22), because a municipality is closest to the people and communities. SPLUMA (2013) became the interface that promotes alignment and integration within the existing policy and legislative framework guiding planning and development (Njenga et al., 2014:624; Joscelyne, 2015:52). Likewise, SPLUMA contains normative principles that guide spatial plans and applications intended for addressing the inequalities inherited from apartheid (Nel, 2016: 257; Snyman, 2017:20). For example, on a provincial scale, the SDF attempts to reverse historical inequalities through strategic interventions such as public transport oriented nodal growth, reinforcement of municipal urban growth boundaries to limit sprawling, coordinated interventions and upgrades of historical dormitories, and the use of land banking to promote spatial transformation and township regeneration (Figure 5.1) (GSDF 2030:121-125).

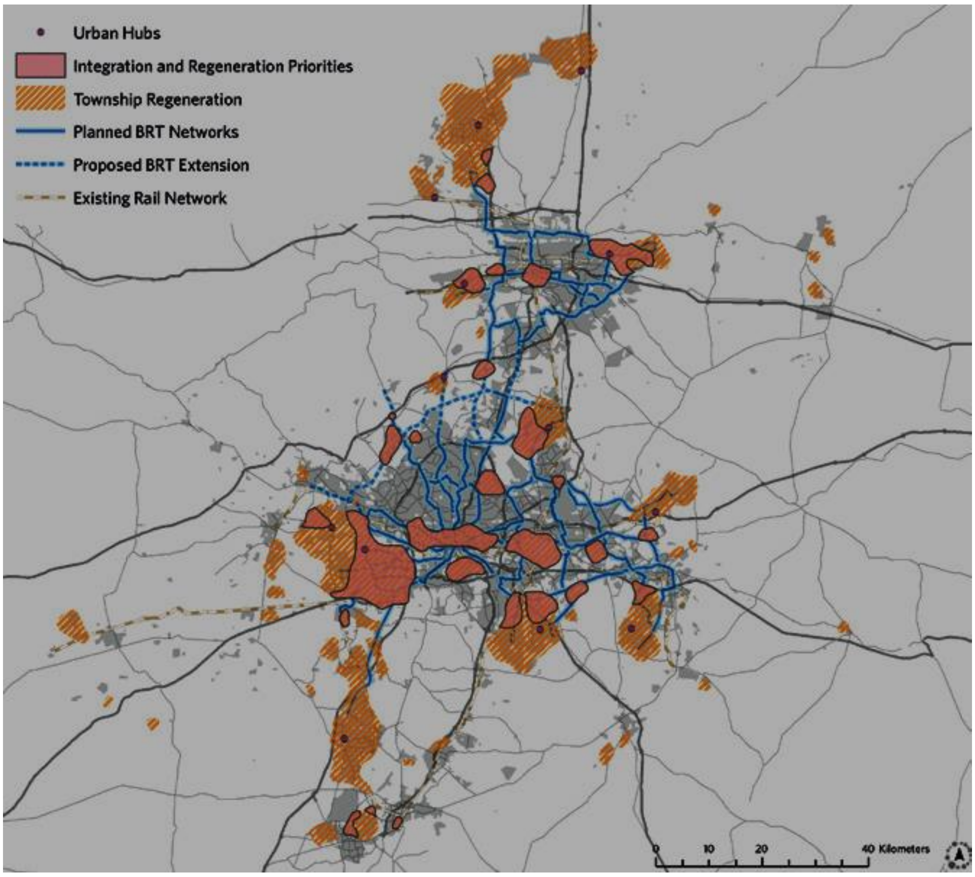


Figure 5.1: Spatial integration and township regeneration in Gauteng

Source: GSDF (2030:122)

Most recently the Department of Planning, Monitoring and Evaluation (DPME) was established in 2014 (to replace the Department of Performance, Monitoring and Evaluation) with the mandate of monitoring implementation of the NDP and its five year plan, the Medium Term Strategic Framework (MTSF). Guided by the NDP, the DPME is introducing the Draft Integrated Planning

Framework Bill 2018 to direct coordinated planning among the different spheres of government, State Owned Enterprises (SOEs) and public entities in government (South Africa 2018:6-7).

5.3.2. Transformation of transportation planning

Statutorily, transportation planning gained impetus in South Africa with the creation of the Urban Transportation Act 78 of 1977. Post-apartheid, the National Land Transport Transition Act (NLTTA) 22 of 2000 was used until the promulgation of the National Land Transport Act and its Regulations in 2009. However, this transformation was informed by policy documents such as the White Paper on National Transport Policy (1996), Moving South Africa (Vision 2020) (1999), Rural Transport Strategy for South Africa (2003), and the National Transport Master Plan 2050 (NATMAP 2050) (Schoeman, 2011:4). NATMAP 2050 was adopted by the National Department of Transport (NDoT) in 2014/2015, leading to the creation of a Synopsis Report to address specific components relating to alignment, integration and transportation-related system and network issues and components (Schoeman, 2015:45).

Based on this reflection, it can be deduced that transportation planning in South Africa has been largely influenced by post-apartheid legislations. In the context of the study area, Table 5.1 gives an overview of some of the public transport capital investments for 2 financial years 2013/2014 and 2014/2015. It can be concluded that the municipality's capital investments in public transportation were significantly informed by improvements to the Rea Vaya BRT, with 98% of medium-term capital budget for the financial period dedicated to the BRT.

Table 5.1: CoJ capital investments in Rea Vaya BRT and other public transport modes (2013-2015)

Investment (2013-2015)	Project	Benefit
R2 million	Dedicated public transport lanes in Soweto	Reduction in travel time
R2 million	Extension of dedicated public transport lanes in the Johannesburg CBD	May reduce congestion in the CBD because it would lead to higher frequencies and increased capacity for public transport modes
R10 million	Upgrading of Kazeme public transport facility	It enhances perception
R2 million	New Midrand taxi holding area	It could facilitate future modal integration
R4 million	Design and construction of new taxi rank at Slovvoville	It enhances mobility

R2.16 billion	Bus Rapid Transit (BRT) System: roads and ancillary works, depots, termini, land, Intelligent Transport System (Automatic Public Transport Management System & Automated Fare Collection System)	It may lead to a reduction in travel time and increase in passenger figures
Total: 2.2 billion		

Source: Own construction adapted from CoJ Draft Medium-Term Capital Budget (2013-2015)

5.3.3. Environmental management

Environmental assessment only became active in South Africa with the promulgation of the Environment Conservation Act 73 of 1989, which made provisions for the formulation of environmental policy to guide decision-making and preparation of environmental impact reports (Schoeman, 2015:45). Environmental management concept was introduced in South Africa by the publication of the Integrated Environmental Management document in 1989. From 1994, the concept existed parallel to the Land Use Management (LUM) system, with the development of innovative environmental planning and assessment tools like the Environmental Management Frameworks (EMFs), Strategic Environmental Assessment (SEA) and Conservation Planning (C-Planning). There have also been project level environmental management tools like Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), and Heritage Impact Assessment (HIA).

However, the introduction of the National Environmental Management Act (NEMA) 107 of 1998 changed the approach and role of environmental considerations in development (RSA, 1998). It provides the framework for cooperative environmental governance in South Africa and promotes the application of environmental assessment and management tools to ensure integrated management of activities (DEAT, 2004). An EIA Regulations which was first published in 2006 to formalize the intention of NEMA was revised in 2010 to reflect changes to the activities with impact on the land use, as would be provided for in SPLUMA (2013).

Tables 5.2 provides an overview of the interface between focuses and instruments as provided for in spatial planning, transportation planning and environmental management in the study area. The tables give a reflection of a strategic alignment that fails to address operational and functional perspectives.

Table 5.2: Interface between focuses and instruments as provided for in spatial planning, transportation planning and environmental management from the study area perspective

SPLUMA (2013)	NLTTA (2000)/NTA (2009)	NEMA (1998)
Development principles and norms and standards Intergovernmental support/Cooperative governance Spatial Development Frameworks (SDFs) National Spatial Development Framework (NSDF) Provincial Spatial Development Framework (PSDF) Regional Development Framework (RSDF) Municipal Development Framework (MSDF) Precinct Plans Land Use Management (LUM) Land Development Management (LDM) Municipal Land Use Plans (MLUP) Statutory Planning (SP)	General principles for transportation planning Types of transportation plans Provisions on transportation Planning Private sector integration Rail based modal integration National Land Transport Strategic Framework (NLTSF) Provincial Land Transport Frameworks (PLTF) Integrated Transport Plans (ITPs) Freight Transport Plans (FTP) Transportation plans and changes in land use and public transport infrastructure and services Rationalization of public transport services Public Transport Plans (PTPs) Commuter rail plans (CRP) Transport Impact Studies (TISs) Traffic Impact Assessments (TIAs)	General objectives Environmental Implementation Plans (EIPs) Environmental Management Plans (EMPs) Integrated Environmental Management (IEM) Environmental Impact Assessments (EIAs) Environmental Authorizations (EAs) Strategic Environmental Assessments (SEAs) Environmental Management Programme (EMPs) Monitoring and Performance Assessment (M&PAs) Mine Closure Plans (MCPs)

Source: Own construction (2019) adapted from Schoeman (2017:185)

5.4. Role of SPLUMA

The inference made from the table is that of a planning and development landscape that neither aligns nor integrates the processes that underlie the current policies. The complexities are obvious and there is a need for a form of comprehensive and overarching guideline document that promotes alignment and integration. However, the introduction of SPLUMA (2013) and its Regulations appear to have facilitated the needed alignment of spatial planning, land use management and other kinds of planning – such as transport and environmental planning [Sections 3; 12(3)-(5); 24(2)(b)]. SPLUMA promotes inclusive developmental, equitable and efficient spatial planning at the different spheres of government, with provisions for more consistency and consistency in the application procedures and decision-making by role players in land use decisions and development applications (South Africa, 2013:10).

For example, the recent debate on greening the infrastructure sectors in municipalities is reinforced by the guiding principles of SPLUMA – spatial justice, spatial sustainability, efficiency, spatial resilience and good administration (Schoeman & Swart, 2018:8). In addition, because it is impossible to consider land use planning in isolation from other sectors, such as transport, housing and environmental sectors; there is an increasing effort to align SPLUMA with the National Environmental Management Act (NEMA), through Sections 19(g), 24(2) (b), and 42(2). For example, Section 19(g) demands for a compliance of SDFs with environmental legislation, which is defined in Section 1 as NEMA and any other legislation that regulates a specific aspect of the environment.

Based on the foregoing, the question is if the complexities are increasingly eliminated with the implementation of SPLUMA. It can be concluded that in spite of the mixed-outcomes, implementation is a process that will involve lessons from successes and failures. For example, as part of the process of implementing SPLUMA (2013), the Department of Rural Development and Land Reform (DRDLR) has since 2013, embarked on a process that will catalyze the development of a standardized land use classification system and symbology sets across all levels of government (Njenga et al., 2014:625). The objective is to create a national system (nomenclature) for defining groups of land use and land cover features. At the provincial level, sector plans such as the Land and Transport Framework and the Infrastructure Framework reinforce the alignment of the Growth and Development Strategy (GDS) with the NDP, as well as facilitate an effective allocation of public transport and human settlement grants (DRDLR 2014:9).

In contrast, outcomes from the process of aligning municipal by-laws to provincial legislation are not uniform. The municipal planning by-laws contain provisions that give effect to SPLUMA, by operating subject to provincial legislation. Although Sections 12-22 of SPLUMA provide essential guidelines for municipal by-law drafting; it can be deduced that there are contrasting outcomes. This is informed by the differing contexts of the municipalities, as provided for in Section 11 (1) of SPLUMA. As an example, it is important to ensure that the by-law and land use scheme fully align with the SDF; and where there are exceptions, considerations must be given for delineation in the by-law. It thus implies that the municipalities with such provisions recognize the key role provincial legislation plays in further regulating municipal planning. For example, Section 10 of the City of Johannesburg's planning by-law acknowledges provincial legislation. In contrast, the by-law of Sol Plaatjie municipality in the Northern Cape made no provision for its alignment with provincial law (Poswa, 2017:29).

Imperatively, achieving this alignment and integration depends on co-operative governance in both process and management practices across the three spheres of government. Berrisford (2011: 256) stresses the "low-intensity friction' that has existed between the national and provincial governments, on the obligation of driving planning law reform, since democratization in 1994. In providing likely solutions to the overlapping nature of the division of state functions between more than one sphere of government, Steytler and Fessha (2005:338) maintain that greater role clarification must be promoted by the executive and legislative levels of government.

In the same vein, Van Wyk (2012:312) emphasizes on the constitutional mandates of the three spheres of government in ensuring adherence to the principles of co-operative governance. For example, SPLUMA reinforces the provisions of the Municipal Systems Act (MSA) that mandate municipalities to align with and complement the development objectives of other affected municipalities and organs of government. In essence, the municipal SDFs should align their objectives with the provincial SDF, while the province aligns its objectives with those of the National Spatial Development Framework (NSDF), as informed by the National Development Plan (NDP) 2030 (as illustrated in Figure 5.2). However, every SDF is substantially themed on bio-physical, socio-economic and built environment factors. But in practice, it can be deduced that the content of these themes is contingent on the scale of spatial plan and the context of the area.

With regards to the integration of SDFs between spheres of government, the NSDF Draft 2018 promotes the involvement of sector departments and provinces in municipal spatial development planning. It is argued that this will lead to outcomes such as: the preparation and use of progressive, quality municipal SDFs; and the enforcement of land use policies and rules generated by such municipal SDFs in municipal land-use management systems (LUMS), as provided for in SPLUMA (NSDF Draft 2018:87).

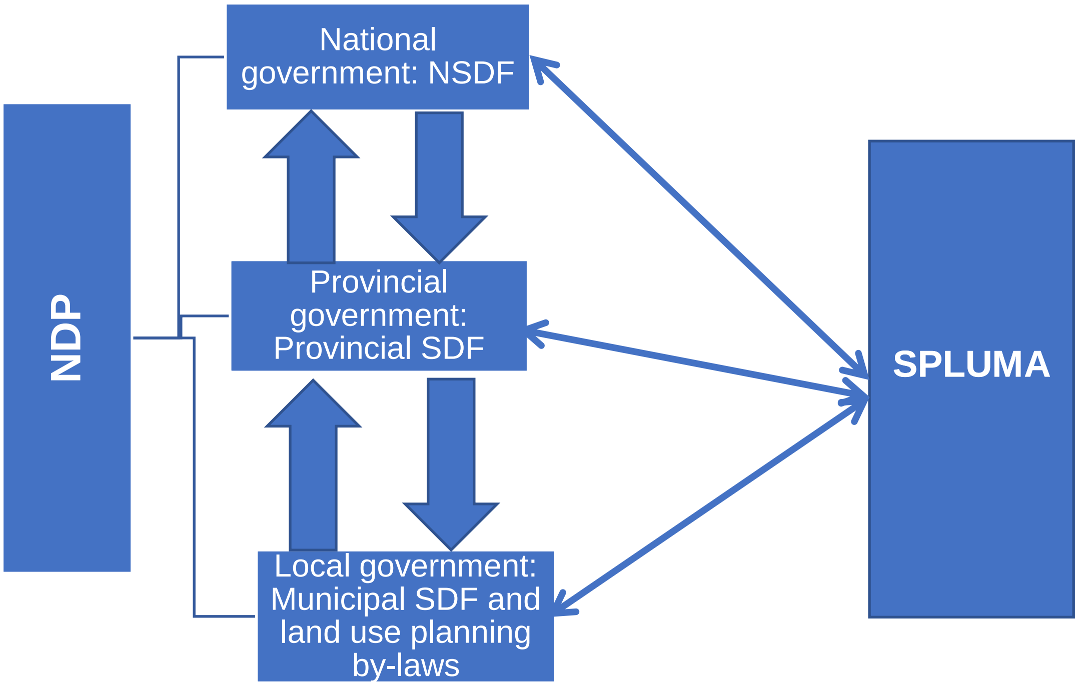


Figure 5.2: Alignment of SDFs between the spheres of government

Source: Own construction (2018)

According to Van Wyk (2012:312), these constitutional principles of cooperative governance are underpinned by the need to avoid conflicts in cases of overlaps in the discharge of functions or state power. He concluded that finding a balance of these planning complexities remains an ongoing debate (Van Wyk, 2012:314/638). Consequently, Schoeman (2015:49) provides further insight on the core functions and activities of spheres of government as it relates to spatial planning, transportation planning and environmental management, by drawing from the provisions of the 1996 Constitution and the Municipal Structures Act (1998). In the same vein, the functions of each sphere of government, concerning policy creation, regulation and implementation across different sectors, are highlighted in Table 5.3.

Table 5.3: Constitutional assignment of government functions in South Africa

	National	Provincial	Local government	
Spatial planning	Regulation	Regulation, planning and development	Regional planning	Local planning and development control
Economic development	Macroeconomic policy	Industrial policy and promotion, regional economic planning	District tourism: promote economic development of community	Local tourism: promote economic development of community
Environment	Regulation	Planning and regulation	Environmental enforcement	
Transport	National roads, rail, major ports	Provincial roads and traffic, public transport	District roads, municipal public transport	Local roads, municipal public transport
Water	Bulk/dams			Bulk and reticulation, limited to potable water supply systems
Waste management	Regulation			Sanitation, limited to domestic wastewater and sewage disposal systems, stormwater, refuse and solid waste disposal, cleansing.
Public safety	Policing	Policing oversight and traffic management		Metro policing, traffic management
Housing	Regulation	Implementation and policy		Implementation
Education	Tertiary	Primary and secondary		Early childhood development
Health	Regulation	Tertiary, secondary and primary	Municipal health	Municipal health

Source: OECD (2011)

In this regard, the national treasury has developed the Cities Support Programme (CSP) 2012 to provide an integrated package of assistance to cities to sustainably strengthen their capacity to provide basic services within integrated human settlements. Although it is informed by the need to constructively enhance municipal performance, albeit its premise on human settlements, public transport and climate resilience and sustainability on a city/municipal scale; the CSP underlines the significance of integrating the three spheres of government by highlighting their respective functions. For example, while the municipality will be responsible for managing programme implementation at the local level, the provincial government will play the monitoring role, and the national treasury oversees the implementation through collaborations with national departments such as human settlements, transport, energy, water and environmental affairs (CSP, 2012:33-34).

Past uncertainties in this regard are also been addressed by SPLUMA (2013). Therefore, to further expand on the role SPLUMA plays in the interface of the three disciplines, Table 5.4 gives an overview of the interface between the focal points and instruments as provided for in the policy framework highlighted in Table 5.2.

Table 5.4: Interface in focus and instruments as provided for in core spatial planning, transportation planning and environmental management legislation

SPLUMA (2013)	**NLTTA (2000)/NTA (2009)**	**NEMA (1998)**
Development principles, norms and standards Intergovernmental support Spatial Development Frameworks (SDFs) National Spatial Development Framework (NSDF) Provincial Spatial Development Framework (PSDF) Regional Spatial Development Framework (RSDF) Municipal Spatial Development Framework (MSDF) Land-Use Management (LUM) Land-Development Management (LDM) Municipal Land-Use Plans (MLUP) Statutory Planning (SP)	General principles for transportation planning Types of transportation plans Provisions on transportation planning National Land Transport Strategic Framework (NLTSF) Provincial Land Transport Frameworks (PLTF) Integrated Transport Plans (ITPs) Freight Transport Plans (FTP) Transportation plans and changes in land use and public transport infrastructure and services Rationalization of public transport services (RATPLANS) Public Transport Plans (PTPs) Commuter rail plans (CRPs) Transport Impact Studies (TISs) Traffic Impact Assessments (TIAs)	General objectives Environmental Implementation Plans (EIPs) Environmental Management Plans (EMPs) Integrated Environmental Management (IEM) Environmental Impact Assessments (EIAs) Environmental Authorizations (EAs) Strategic Environmental Assessments (SEAs) Environmental Management Programmes (EMPs) Monitoring and Performance Assessments (M&PAs) Mine Closure Plans (MCPs)

Source: Schoeman (2015:48)

Against this background, emphasis is placed on the role of municipalities in the achievement of the objectives. This also has a direct bearing on the research scope, which focuses on the implications for two formal public transport systems in the City of Johannesburg Metropolitan Municipality.

5.5. Municipal SDF and sector planning

The Municipal SDF plays a pivotal role in promoting sector alignment, as confirmed in section 21 of SPLUMA. According to SPLUMA, a municipal SDF assists in integrating, coordinating, aligning and expressing development policies and plans emanating from the various sectors of the spheres of government as they apply within the municipal area (SPLUMA 4a[12:2b]). A municipal SDF does not confer or remove land use rights; rather it guides and informs decisions to be made by a municipality regarding land development (van Wyk, 2014:7). The SDF is a part of the statutorily mandated municipal Integrated Development Plan (IDP), a tool that consolidates all strategic plans in decision making from all angles of development to mobilize progress (Maphunye & Mafunisa, 2008:461).

The IDP indicates priorities and development directions of the municipality, guiding sector plans, budgets and the main programmes and capital projects over the next five years (Todes, 2012:162), correlating with political terms of office in local governments. It is reviewed annually and revised every five years. To eliminate the ambiguities generated on the respective roles and contents of IDPs and SDFs, it can be deduced that the SDF has a longer time horizon than the IDP, and it provides the long-term spatial context for the IDP. Therefore, it implies that the municipal short term (5 years) spatial priorities are incorporated in the IDP as the SDF sector plan.

However, outcomes are largely contingent on provisions for public participation, which include significant role players such as developers and/or owners as well as neighbours and third parties (van Wyk, 2014:2). According to van Wyk (2014:6), such public participation must incorporate informal communication between parties at the beginning of a process, because it prevents conflicts, delays and financial expense in the longer term. In addition to this, the role of the municipal SDF as an essential component of the IDP that guides municipal planning and implementation is further strengthened by the definition of the IDP's role in the Municipal Systems Act (2000) and its Regulations (2001) (SACN, 2015:44).

Both transportation planning and environmental management have linkages to the Metropolitan Spatial Development Framework (MSDF) as guided by SPLUMA. The SDF and land use management system take guidance and input from the environmental sector planning and instruments. A municipal SDF must include a strategic assessment of the environmental pressures and opportunities within the municipal area, including the spatial location of environmental sensitivities, high potential agricultural and coastal access strips (SACN, 2015:46). It can be argued that municipalities can enhance sustainability by integrating the environment in spatial planning. According to Cilliers and Cilliers (2016:39), spatial planning has evolved to the promotion of green infrastructure in municipal budgeting and planning, with every stage of planning providing avenues to anticipate the scale (household, neighborhood, regional, national) of impact of the green spaces and ecosystem services.

The complex and multi-dimensional infrastructure and transport sector aligns with the SDF through transport planning, strategic infrastructure projects and infrastructure grants and the related Built Environment Performance Plans (BEPP). It thus implies that the municipal SDF feeds into other sectoral plans of a municipality such as environmental, transportation and housing plans. To reinforce the significance of a municipal SDF in this regard, SA (2011:7) defines it as a core component of a municipality's economic, sectoral, spatial, social, institutional and environmental vision. However, the research scope is limited to its interaction with transportation planning. The National Land Transport Act (2009), the legislation that regulates transport planning mandated the preparation of an Integrated Transport Plan (ITP) by planning authorities at the local government level. The ITP must be directly aligned with the IDP, and indirectly with the SDF. The ITP and SDF share a two-way relationship, with the ITP playing the role of a guide by giving input into the SDF, while the SDF simultaneously provides guidance to the ITP. The SDF must also seek to limit car dependence by indicating municipal land use strategies that will be used to discourage urban sprawl and the dispersal of activities.

Figure 5.3 shows a process relationship that explains the complexities in the interface between the three disciplines from the IDP, ITP and IEM perspective within the municipal sphere of government. It demonstrates the vertical and horizontal alignment within a municipality and with adjacent municipalities; such as provided for in SPLUMA, 2013.

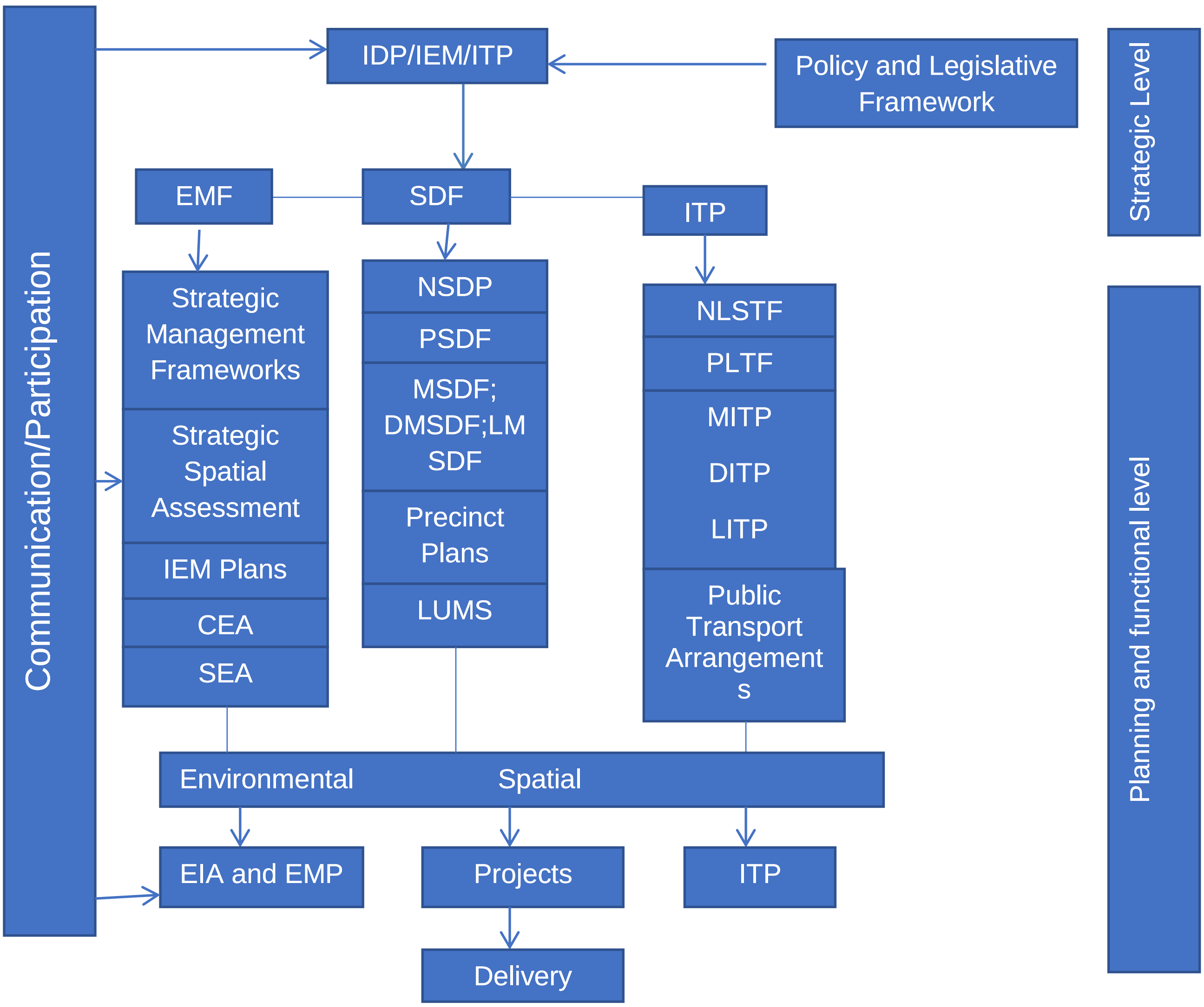


Figure 5.3: Process relationships between spatial planning, environmental management and transportation planning within municipalities

Source: Schoeman (2015:52)

Based on the foregoing, it can be deduced that the process of formulating a municipal SDF should incorporate concerns from all public and institutional role players and align inputs from other sectors. According to DRDLR (2014:72), the process comprises of 5 phases which are designed to flow from one to the next, culminating in its incorporation in the IDP after council approval of the final MSDF. Figure 5.4 is an illustration of the phases in the process of completing a municipal SDF.

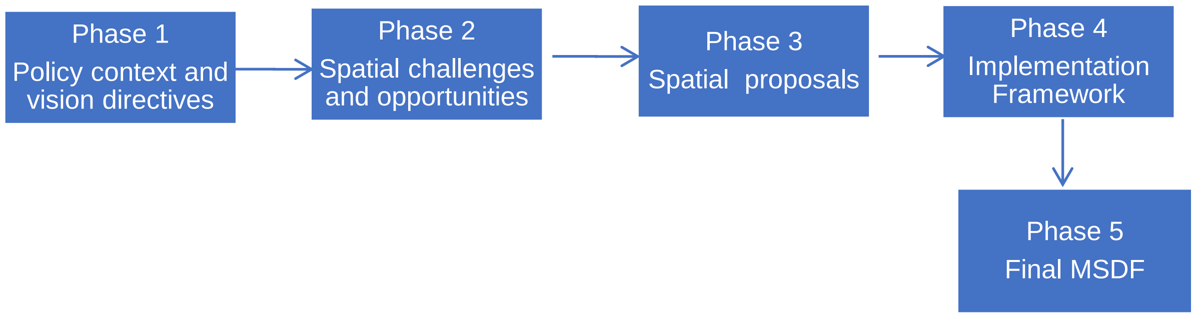


Figure 5.4: Phases in the process of completing municipal SDF

Source: Own construction (2019) adapted from DRDLR (2014:72)

5.5.1. Implications for this study

In the case of the City of Johannesburg, its SDF is oriented towards an urban management approach with the view to maximizing development in strategic areas within the city. It uses the urban development growth boundary as a tool to limit expansion beyond the urban edge. Public Transport Management Areas (PTMAs) have also been identified, and the city is actively trying to 'densify' these corridors with mixed-use developments. The city's policy is geared towards multimodal transportation and land-use patterns that support public transport and non-motorized transport (pedestrian movement), and increased densification of strategic locations with coordinated investment in infrastructure to support such densification initiatives. The city is also promoting corridor development to unlock under-utilized economic and social development potential.

The Rea Vaya (Phase1) corridors have been selected as the defining development corridors and nodes for the city's growth plan. Key economic centers will also be strengthened to ensure balance and distribution of growth within the city and with neighboring municipalities. In addition, there is an emphasis on the need to cluster various activities at accessible nodal locations. This will strengthen the functioning of the nodes with regard to public and private sector investments and facilitate economic growth and development (CoJ, 2011). Johannesburg's SDF is supported by its Growth Management Strategy and the Capital Investment Framework.

The SDF is further cascaded into Regional Spatial Development Frameworks (RSDFs) to provide more detailed planning guidance. More specific Precinct Plans and Urban Development Frameworks are also developed in local areas requiring attention (CoJ, 2016:30), such as the Sandton CBD, the Gautrain, Rea Vaya and Metrorail precincts; as well as the marginalized areas of the city, namely Alexandra, Orange Farm, Soweto, Diepsloot and Ivory Park. These plans are used to assess individual applications for development, and to guide capital investment (Todes, 2012:162).

Figure 5.5 represents the city's spatial framework which promotes (CoJ 2016:23-27):

- An integrated natural environment that provides the basis for future planning, development and land use decisions. Protecting this natural environment will enhance sustainability and reinforce a liveable and valuable built environment.
- The transformation zone, which includes the metropolitan core, the Corridors of Freedom, Soweto, Randburg-OR Tambo corridor and the mining belt will serve as investment priority areas. This is because of their capacity to induce growth on a metropolitan scale. For example, compact precincts of inclusive residential densification structured around public transit and economic activities would be created at the metropolitan core. In addition nodal growth through transit oriented developments (TOD) would be facilitated around Rea Vaya, Gautrain and PRASA stations, sprawling would be reduced by strategically driving growth between Johannesburg north (Randburg, Sandton, Alexandra) and the aerotropolis around the OR Tambo International Airport (Ekurhuleni), while diversification and intensification would be promoted at Soweto to enhance self-sufficiency and reverse its largely residential nature.
- Infrastructure upgrades at the consolidation zone, which includes historically deprived and marginalized areas, to stimulate new developments and economic growth.
- Compact growth and preservation of the natural environment by limiting development beyond the urban development boundary (UDB).

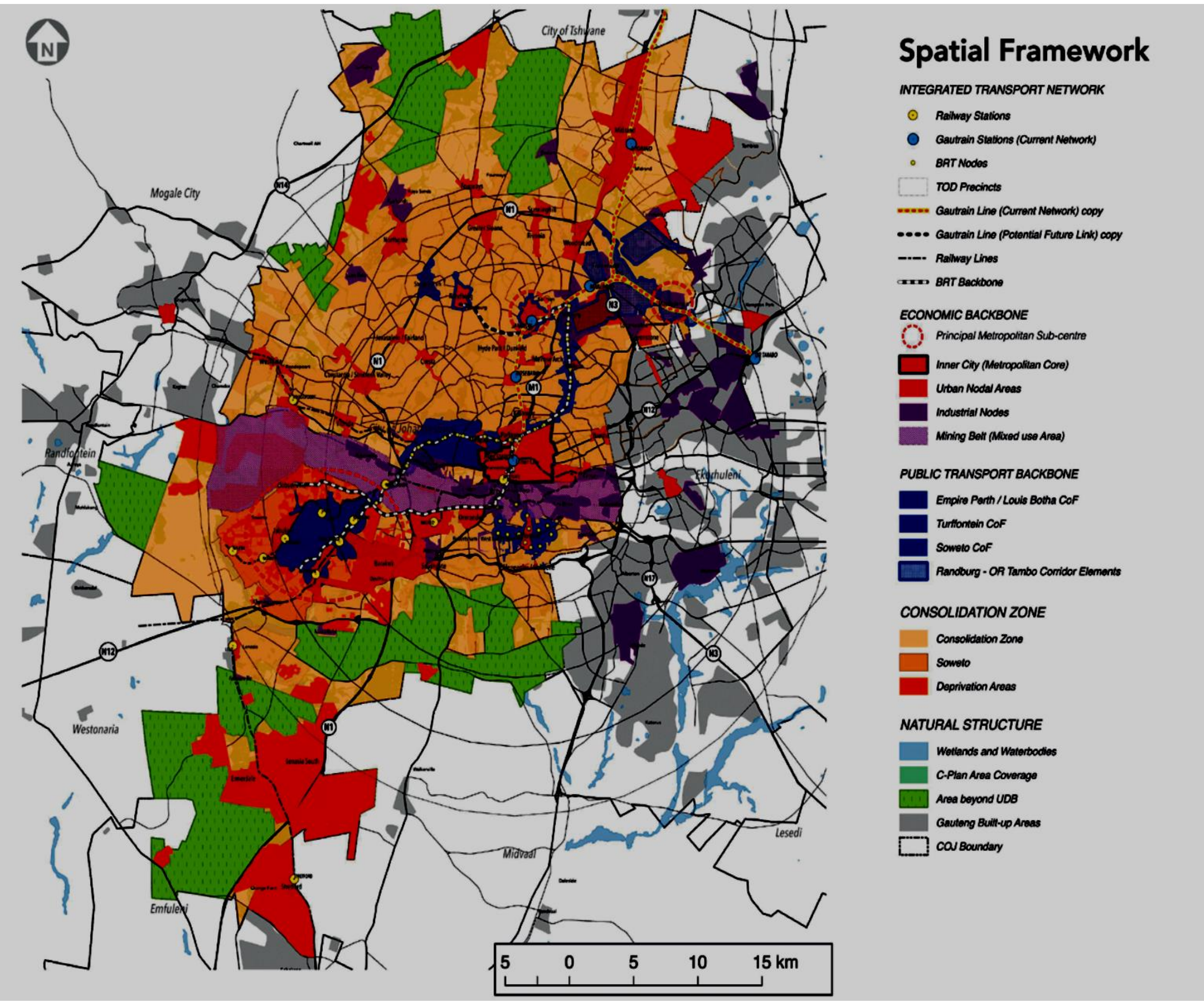


Figure 5.5: City of Johannesburg Spatial Development Framework (SDF)

Source: CoJ (2016:22)

Furthermore, in line with the principles of cooperative government, the location of Johannesburg within the Gauteng City-Region demands a consolidation of institutional and legislative contexts among the municipalities. According to the Gauteng Planning and Development Bill (2011), while the province will continue to play a key role in the land use planning of Gauteng, the majority of land use planning and management matters will be undertaken at the municipal level (SACN, 2015:25). This only underpins SPLUMA's devolution of power to the municipalities, and calls for consolidation of spatial, transportation and environmental management legislations across the three metropolitan, two district and five local municipalities in Gauteng province.

The identification of transit-oriented development as a growth strategy in the City of Johannesburg necessitates the need to prioritize institutions and professionals responsible for the provision of public transport. Due to the fragmented institutional and funding nature of public transport in South Africa, the decision to devolve its planning and provision to local government has been questioned by authors like Bickford (2013:6); Walters (2014:4); Thomas (2016: 356, 362); and Pillay et al. (2017:40-42). In addition, the national government's focus on the provision of public transport and non-motorized transport has been undermined by practices that reinforce the apartheid planning era (Bickford, 2013:7). It is essential to understand users' needs and provide for them in a sustainable and equitable manner. Bickford (2013:8) further argues that legislative requirements like the Traffic Impact Assessment (TIA) exacerbates the problem by constraining the framing and measuring process used in decision making.

In a report prepared by Pillay et al (2017) for the Local Government Sector Education and Training Authority (LGSETA), they identified the multi-disciplinary nature of the transport planning profession and the absence of an accredited professional body to regulate it. There is a growing shortage of transport planners in the South African public sector, especially within municipalities. Though a number of Universities in the country offer transport planning courses; only postgraduate holders are professionally recognized as transport planners. And the fact that less than five universities offer the course at postgraduate level has also contributed to this shortage. Other limitations identified from the report include lack of demand for transport planners in the private sector which discourages Universities from offering degrees; lack of incentives in the public sector to attract and retain transport planners; ignorance of senior role players in the public sector on the ability of transport planning to stimulate economic growth; and the absence of mentorship opportunities in public institutions (Pillay et al., 2017:57-58).

However, the NLTA (2009) makes provision for municipalities to engage with other spheres of government for its transport planning needs. Consequently, the government initiated various interventions to improve the capacity of municipalities:

- The Public Transport Network Grant is provided for 8 metropolitan municipalities and 5 secondary cities to improve their public transport systems and develop integrated public transport network infrastructure that incorporates BRT, conventional bus services and non-motorized transport;
- The infrastructure Skills development Grant is provided for certain municipalities to develop capacity by creating a sustainable pool of young professionals with technical competencies related to municipal services like water, electricity and town planning.

But it appears that these measures have not done enough to eliminate the fundamental challenges of a fragmented institutional and funding landscape. This is in addition to the non-alignment of transport planning with spatial planning and environmental management from the policy and legislative framework perspective. For example, Walters (2014:7) highlights at least five institutions responsible for management or planning of public transport in Gauteng. This is aside from the stand-alone taxi industry that does its own planning through route associations and operators.

Funding is also highly fragmented, a situation that complicates integrated transport planning, because each funding stream has its own set of funding requirements and criteria (Walters, 2014:7). Although the NLTA (2009) was clear on the role of each sphere of government in public transport planning, and it even calls for the establishment of intermodal planning committees in areas with commuter rail; it is evident that all role players must do more to increase the capacity for successful policy implementation. A strategic transportation planning is an essential element of a spatially transformed urban form that departs from segregations seen in South Africa's historical spatial realities. The instruments informing this transformation will be discussed in the next section.

5.6. Urban transformation instruments

In relation to the discussion above, the instruments used to drive sustainable integrated development through the transformation of spatial planning and development will be discussed in this section (Table 5.5; 5.6 and Figure 5.7). These are the Spatial Planning and Land Use Management Act (SPLUMA) (2013) and its Regulations (2015), the National Development Plan (2012) and the Integrated Urban Development Framework (IUDF) Implementation Plan (2016). The contributions of National Transport Master Plan (NATMAP) (2011), its Synopsis Update (2015) and the National Land Transport Strategic Framework (NLTSF) (2014) will also be highlighted. In addition to the national instruments, reflections on provincial and municipal instruments are provided to demonstrate their implications on the study area.

Table 5.5: National urban transformation instruments

	Description
SPLUMA	It incorporates environmental concerns into spatial and transportation planning. SPLUMA strongly emphasizes on the coordination role of the provincial SDF in terms of spheres, sectors and municipalities. The act promotes sustainability (as shown in Figure 5.6, and all municipalities are obligated to adopt it in order to achieve urban integration. It thus implies that the adoption of SPLUMA by the COJ metropolitan municipality should facilitate sectoral integration between spatial, transportation and environmental outcomes.

NDP	It promotes modal integration and prioritizes modal shift to public transport. The non-integration of public transport in the city of Johannesburg may hamper its growth as alternatives to the private car. The NDP highlighted the need for institutional integration across spheres of government, in order to eliminate duplication of functions. Through the creation of regional transit authority, the CoJ municipality can induce outcomes that align with the objectives of the NDP. In line with this research theme, the NDP advocates for transit-led growths, underpinned by plans for the urban form. However, it is imperative for considerations for TOD and urban form planning to be incorporated at the planning and design stage.
IUDF Implementation Plan 2016	The strategy advocated by the IUDF Implementation Plan 2016 is to spatially transform all urban contexts. It thus implies that implementation of the framework in the city region will consolidate inputs of the three metropolitan municipalities and the adjoining medium-sized and smaller urban areas. It promotes incremental planning that incorporates successes and failures from outcomes into future inputs. Its objective of promoting collective interests over sectoral goals will facilitate institutional integration in the study area. Overall, the framework underscores the significance of public participation and private sector driven development. Implicitly, the City of Johannesburg may promote private sector involvement and public participation in planning and design for integrated land-use transport outcomes.
NATMAP 2050 Synopsis Update	The NATMAP 2050 Synopsis update recognizes the significance of tailoring land-use transport solutions that align with the operating environment. It implies that the urban context must inform the inputs from role players. In the CoJ, the essence is to gain an understanding of the population distribution and economic growth engines; as well as the promotion of modal integration premised on corridor development.
Revised NLTSF 2017-2022	The framework provides strategies that reinforce the integration of land transport with airports and harbours. With concerns for environmental preservation, the NLTSF highlights the integration of land use and transportation planning, and the creation of sustainable transport systems that meet the needs of all residents. From the point of view of the study area, integration of the Gautrain with the OR Tambo International Airport can provide a basis for the synergy of land transport with airport. It is argued that implementation of the provisions of the NLTSF may necessitate strong institutional collaborations of the three metropolitan municipalities in the GCR. In addition, another implication for the city region is the creation of terminals and transfer points informed by data availability and consolidation of interests.

Source: Own construction (2018)

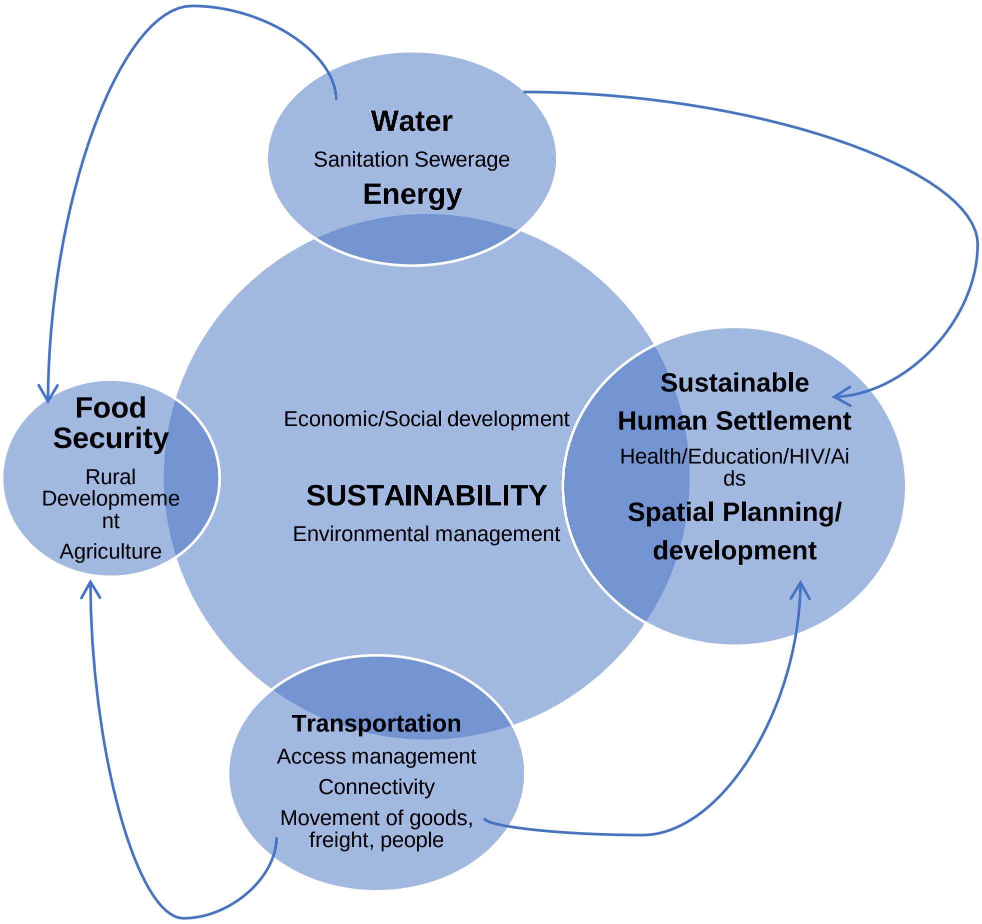


Figure 5.6: Promotion of sustainability by SPLUMA (2013)

Source: Schoeman (2015:53)

Gauteng SDF

- The objective of the Gauteng SDF is to limit urban sprawling through infrastructure investment premised on promotion of public transport.
- The Gautrain and Rea Vaya BRT will provide foundation for regional urban form informed by mass transit, and reinforced by urban structuring elements such as consolidation zones, urban corridors, and urban activity nodes.

Gauteng ITMP25

- With GIS and ITS serving as the bedrock of an integrated land use-transportation plan that is premised on rail transport; the Gauteng ITMP25 provides solutions to the anticipated short term and long term transportation challenges of the province.
- In addition to promoting residential densification and mixed-use development, the plan prioritizes public transport, traffic demand management (TDM), and the enhancement of NMT.
- In the context of the study area, the metro rail and Gautrain can provide the foundation for the rail based urban transformation, while the e-tolling system is an example of the TDM promoted by the Gauteng ITMP.

Figure 5.7: Provincial urban transformation instruments

Source: Own construction (2019)

Table 5.6: Municipal urban transformation instruments

	Description	Implication	Implication for adjacent municipalities
CoJ Strategic Integrated Transport Plan Framework (SITPF)	The plan recognizes the use of transit oriented developments (TOD) inspired by investments in public transport systems that incorporate the best mode for route. In addition, the SITPF promotes the integration of non-motorized transport with other modes at the planning and design stage. The Johannesburg Roads Agency (JRA) is obligated to facilitate the initiative through the complete streets programme.	Future expansions to the Rea Vaya and Gautrain may make provisions for the best mode for route approach, to avoid overlapping with existing modes. In line with the research hypothesis, the SITPF emphasizes the need to incorporate the needs of all users at the planning stage. This implies that integration should not be reactive.	
CoJ SDF 2040	The objective of the SDF 2040 is to limit existing sprawls, job-housing mismatch and inefficient land use and residential density through nodal developments that promote a compact polycentric urban form (as in Figure 5.8). However, the goal of the SDF may be limited by the unavailability of land - especially at the core (highly urbanized areas), and increased sprawling. For example, if high density residential development takes place in the outer nodes (such as Cosmo City) without equal	This implies that the trips between jobs and housing may become shorter, with significant provision for public transport system to connect activities. With a focus on developing the aerotropolis corridor, the integration of Johannesburg with Ekurhuleni metropolitan municipality may be facilitated. This is because activities in the corridor will be intensified, and outcomes may be enhanced through policy and institutional integration.	The integration with Ekurhuleni is reinforced by the provision for re-urbanization, which is a central theme for the Ekurhuleni metropolitan SDF. Through this strategy, the SDF promotes regional integration by redeveloping the aerotropolis, as well as facilitating a regional network system of air, rail and road transportation.

	growth in job and economic activities; it compounds the current inverted polycentric pattern.		
CoJ Nodal Review 2018	The nodal review promotes the use of a transect approach that attempts to limit peripheral growth and enhance redevelopment in core areas through the provision of land.	The implication of the transect approach on the City of Johannesburg may be higher land prices at the core and increased public spending on the provision of infrastructure.	

Source: Own construction (2018)

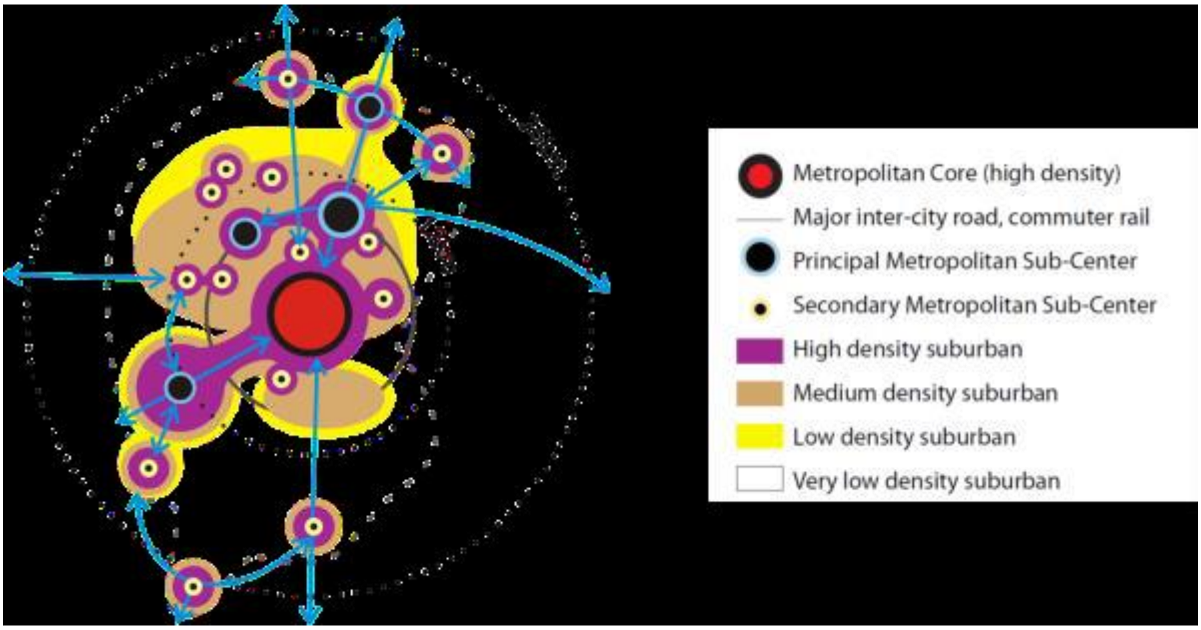


Figure 5.8: Johannesburg future compact polycentric urban form

Source: CoJ Draft Nodal Review (2018:11)

Against a background of the complexities and clarities before and after the promulgation of SPLUMA (2013) respectively, South Africa’s space, sector and institutional landscapes are informed by a framework illustrated with Figure 5.9 below:

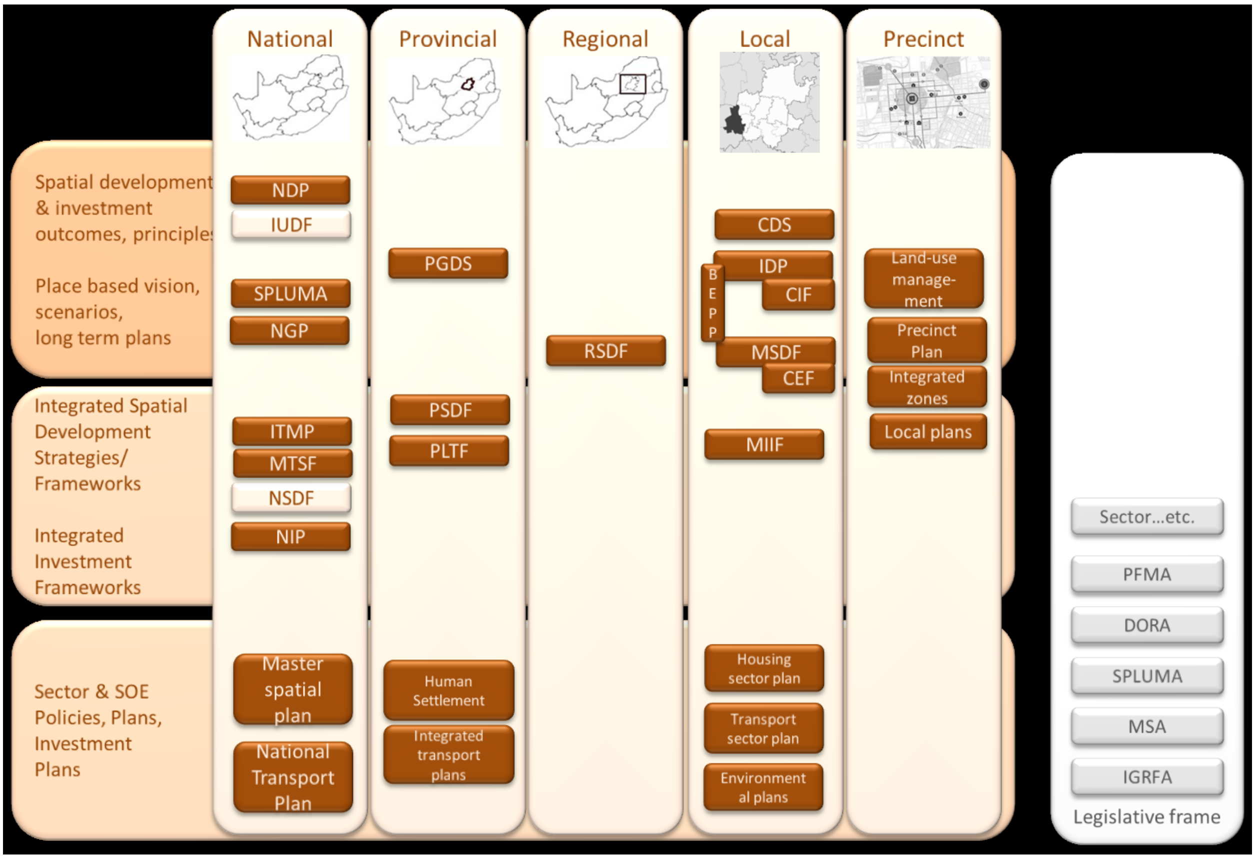


Figure 5.9: Key policies impacting on space in South Africa

Source: SACN (2015:9)

However, except the IUDF, these policies are drawn from SPLUMA and they form the backbone of spatial planning in South Africa.

5.7. Conclusion

Table 5.7: Summary of policy implications by categories

Policy category	**Implication for the study**
Transport planning policies	- Land transport planning must be integrated with land use planning and development processes - Establishment of an intermodal planning committee to coordinate modal interactions - Public transport service must be regulated with the use of an operating license or permit - Promote densification and corridor development through progressive development strategies - Increase access and mobility for all public transport users

	- Promote greater efficiency and effectiveness by fostering healthy competition with the provision of an enabling environment for all players - Establish dynamic and sustainable public transport systems that are demand responsive and cost effective - Develop a central land use/transportation data bank (GIS) that is real-time and universally accessible - Promote the introduction of Bus Rapid Transit Systems (BRTS) - Enhance fare and physical integration between modes to achieve an improved modal share of public transport - Upgrade infrastructure to make public transport more attractive and acceptable - Provide a safe and thriving environment for walking and non-motorized transport (NMTs) - Limit the environmental impacts of transportation by significantly reducing greenhouse gas (GHG) emissions - Intensive application of transport-oriented information technology - Stabilize and improve existing rail facilities to a desired integration with road-based services - Institutional reforms of public transport providers to reduce existing complexities - Focus on transit led growth (e.g. Corridors of Freedom) to increase urban densification - Provide environmentally and economically sustainable freight and passenger transport - Overcome apartheid spatial planning by integrating transport into spatial planning of human settlements - Optimize rail transport by restricting long distance freight to rail and promoting a modal shift in passenger transport - Bridge the policy gap between spheres of government and align goals to achieve a common result - Integrate land use and public transport planning by promoting residential densification and mixed-use development within the existing urban fabric

	- Expand rail transport as the core of an integrated public transport system - Enhance mobility and public transport accessibility across the province to stimulate a significant shift from private cars - Transform and commercialize the minibus-taxi industry - Mainstream NMTs by introducing cycle ways, pedestrianized roads and creating a functionally integrated natural open space - Harmonize green transport and spatial planning - Implement people-oriented measures to achieve the required culture, behaviour and mindset change needed for the desired modal shifts - Manage and reduce congestion through Traffic Demand Management measures to make Johannesburg more liveable - Provide the required resource and finance for Johannesburg's transport plan - Foster resilience and sustainability by providing urban infrastructure supportive of a low carbon economy - Promote a safe, smart and liveable city-region with an active citizenry and responsive metropolitan governments - Channel development opportunities into activity corridors and nodes linking or adjacent to the main growth nodes - Increase accessibility to key economic areas to expand economic opportunities to all residents - Promote consistency among institutional decision makers responsible for land use and development application
Spatial planning policies	- Provide a guide for the various levels of government on spatial planning and land use/development decision - Promote spatial transformation through integration of transport, social and economic areas; and collaboration across spheres of government, private sector and citizens - Improve the quality of life by increasing proximity to

	open spaces and socio-cultural facilities - Promote spatial balance by strengthening the relationship between public transport routes and urban intensification - De-emphasize investment in road infrastructure and shift to the expansion of mass transit systems - Promote the economic, social and spatial transformation of Gauteng using the Transformation, Modernization and Reindustrialization strategy of the provincial government to engender a functioning city-region - Establish a polycentric spatial network in Gauteng, with strong and resilient nodes enabling mutually beneficial exchanges of goods and services, and movement of people - Promote environmental and natural resource sustainability by guiding land use and development in Gauteng province - Foster integration between the north and industrial south of Johannesburg by consolidating the CBD using the public space and street networks - Promote a public transport based growth by linking key nodes in the city with strong integrated public transport - Improve service provision and stronger linkages in densely populated areas to enhance self-sustainability - Develop a nodal strategy to facilitate the growth of key identified nodes - Stimulate economic development in Ekurhuleni by encouraging the growth of Ekurhuleni Core Development triangle (CDT)

Source: Own construction (2018)

The non-alignment of the policy and legislative framework guiding spatial planning, transportation planning and environmental management lingered until the promulgation of SPLUMA (2013) and its Regulations (2015). There has been increasing transformation of the landscape, but it is still early days to expect the type of result that will change entrenched imbalances. However, the implications listed above are a reflection of what to expect in a national, provincial and local context if the three disciplines are aligned.

The next chapter contains an overview of the study area (City of Johannesburg), as it relates to its demographics, transport system and influence in the Gauteng City-Region.

CHAPTER 6: JOHANNESBURG AND ITS SPATIAL AND TRANSPORTATION LANDSCAPE

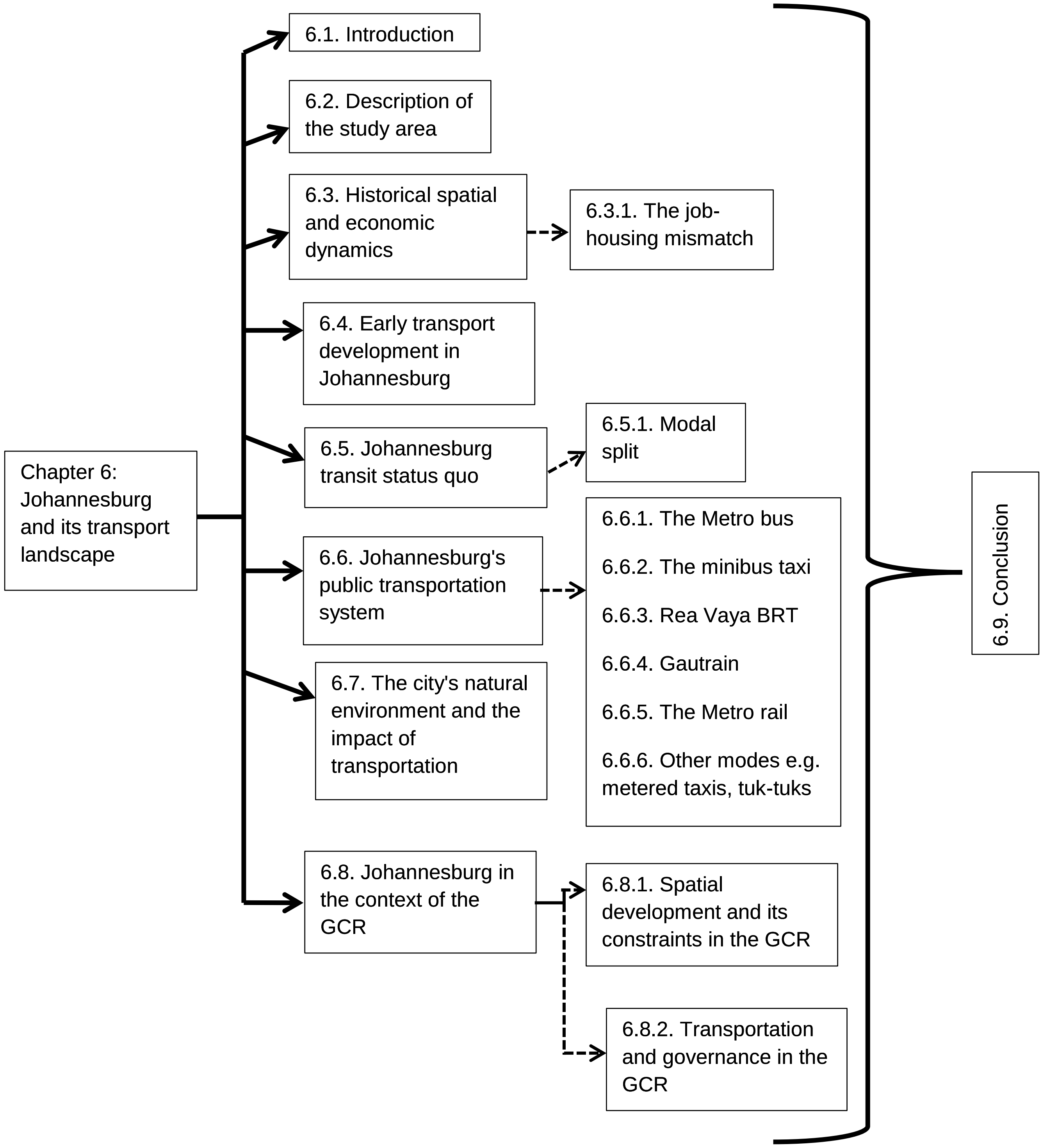


Figure 6.0: Layout and footprint of chapter 6

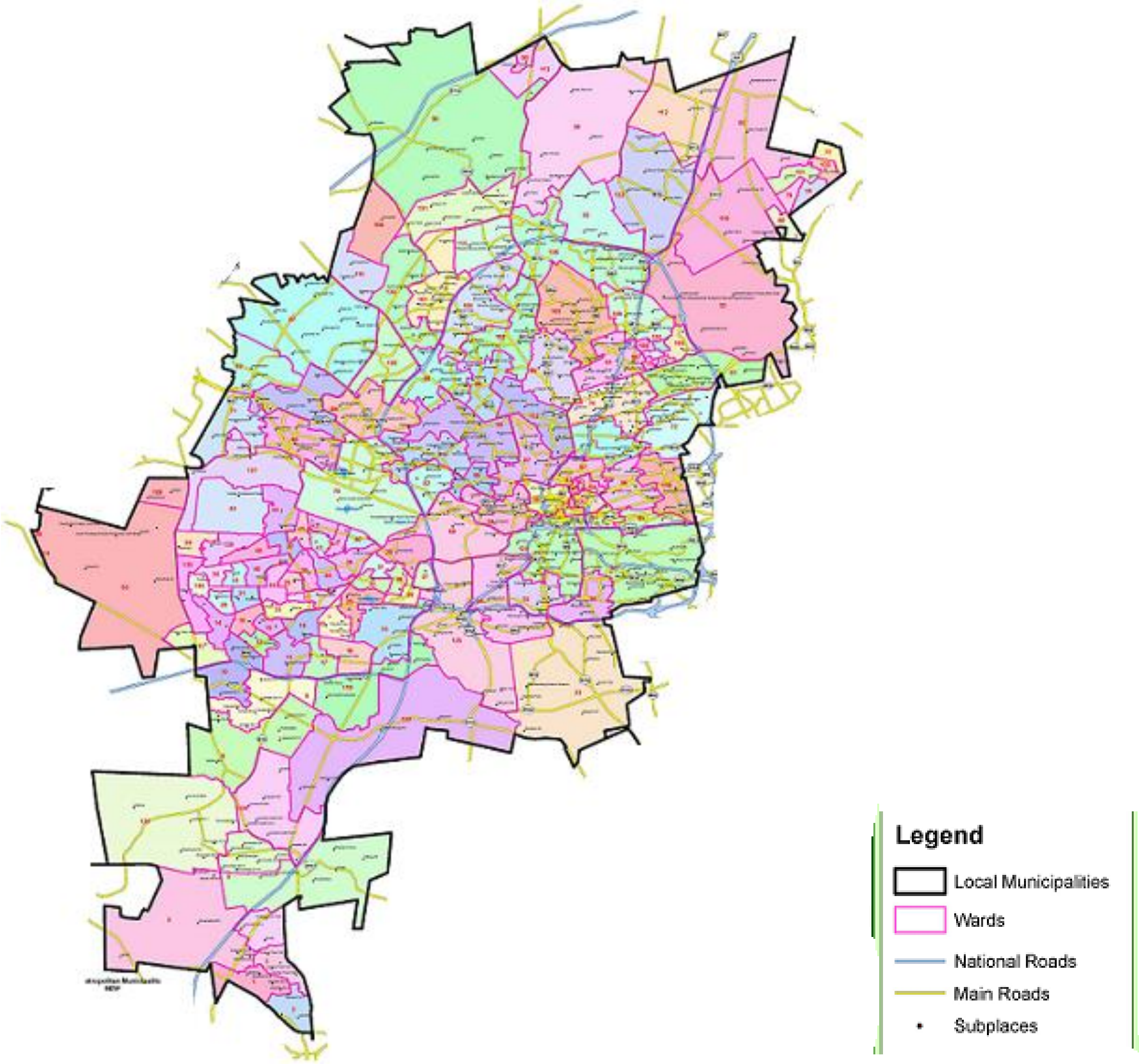
6.1 Introduction

After presenting the institutional and legislative context of the study area in chapter 5, this chapter will provide an overview of the City of Johannesburg, its importance in the context of the Gauteng City- Region (GCR), its existing public transport modes, the mode distribution and the evolution of the Rea Vaya BRT and Gautrain.

6.2 Description of the study area

The City of Johannesburg is the capital of Gauteng Province of South Africa, and it has 135 wards (illustrated in Map 6.1). Gauteng is currently home to 22.4% of the country's population and it is the province with the highest contribution to the nation's GDP (Johannesburg 2040 Growth and Development Strategy). Johannesburg has grown from its early beginnings as a mining camp to become a truly global and cosmopolitan city. The city falls within the Gauteng City-Region (GCR), a cluster of cities, towns and urban nodes that together make up the economic heartland of South Africa. Johannesburg has an area of 1,645km^2, with a population of 4.4 million people according to the 2011 census, comprising a total of 1.4 million households and an average of 2.8 persons per household (StatsSA, 2011).

The city has witnessed significant population growth and urbanization in the last two decades due to in-migration from neighboring areas like Potchefstroom, Sasolburg and Witbank/Middleburg/Secunda and other places in Africa (CoJ, 2011:39).



Map 6.1: City of Johannesburg locality

Source: http://www.demarcation.org.za/site/city-of-johannesburg/

With a population density of 2,696 persons/km^2 and a projected growth rate of 2% for the period 2015 to 2020 (CoJ, 2016:45, 54), it is still grappling with rapid urbanization. As a result, the population is projected to increase to 5.43 million in mid-2021, while the number of households may increase from 1.8 million in 2016 to about 2.16 million in 2021(CoJ 2016:1-2).

Its spatial composition is defined by years of segregation synonymous with the apartheid years that sees the dominant black population locate at sprawls and peripheral dormitory townships distant from jobs and opportunities. Post-apartheid governments have tried to correct this spatial anomaly and notable results have been achieved, but there is still more to be done. The existing spatial structure of the city is summarized with the following dominant elements (CoJ, 2016: 48):

- An established CBD that functions as a significant economic focus of the city. It is also reinforced by the two dominant development corridors that cross the city-region.
- An east-west urban corridor system that has developed around the key rail, road, and industrial areas that aided the mining industry which provided a foundation for the city's historic growth.
- A south-western part that is spatially and economically marginalized centered on the Soweto area and home to approximately 40% of the city's population. It is characterized by low to medium residential density sprawling settlement, relatively low levels of economic activities, and a generally poor connectivity to the activity oriented northern areas.
- An economically strong northern corridor reinforced by a major mobility spine supporting accessibility routes, further entrenched by a regional rail-based mass transit system (Gautrain).
- The concentration of medium- to upper-income people around the Inner City, with low-income earners south of the Inner City area and a series of marginalized, predominantly low-income residents characterized by low levels of economic activity, jobs and land use diversity.
- Marginalized and environmentally sensitive areas to the south.

In addition, residential development is currently the dominant land use with 30% of the total built environment while commercial land use accounts for only 10% (as shown in Figure 6.1).

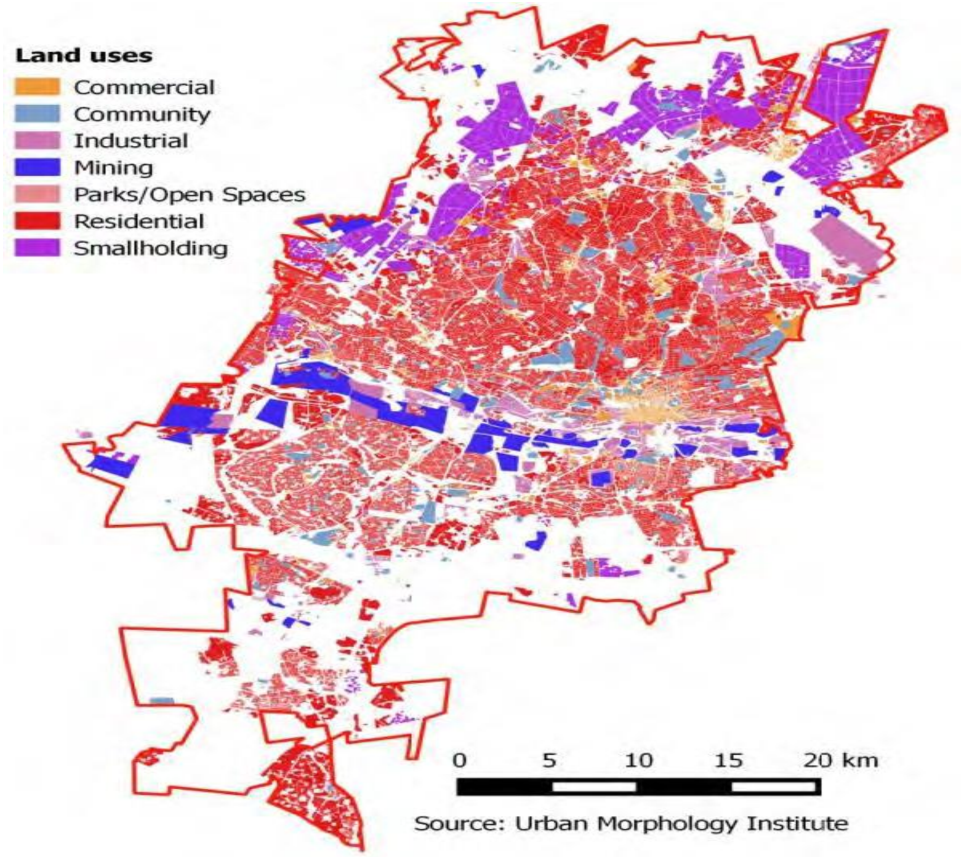


Figure 6.1: Land use pattern in Johannesburg

Source: CoJ (2016:60)

Economically, Johannesburg contributes 17% of national output and is host to two-thirds of all South Africa's corporate headquarters. Over the past 18 years, the city's economy has grown at a faster rate than that of the entire country (CoJ, 2016: 40). Johannesburg's economy is largely orientated by the tertiary sector, with trade, transport, finance and community services making up 76% of its economic output. However, the spatial inequality caused by the long years of apartheid has gravely impacted on the city's wealth distribution. Its economy is centered on two regions of intense economic activities, namely Sandton (Region E) and the Inner City (Region F) nodes (illustrated in Figure 6.2). Although the two regions constitute 50% of the city's 2013 economic output (CoJ, 2016: 57), only 23% of the city's population are housed there.

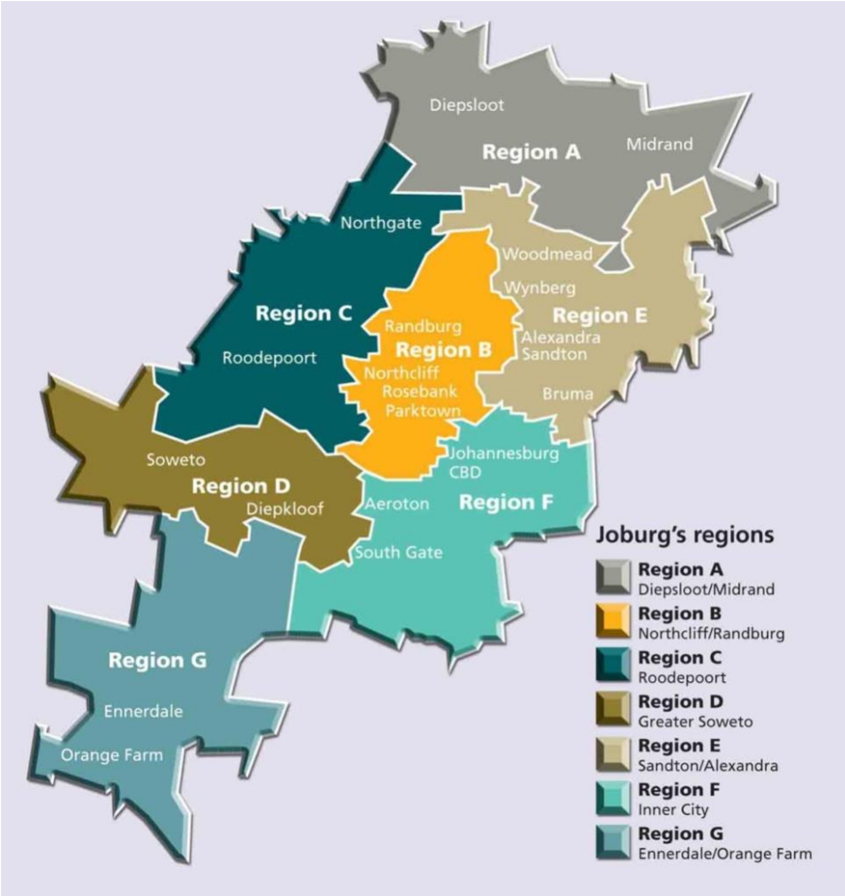


Figure 6.2: The administrative regions of Johannesburg

Source: CoJ (2016: 54)

As shown in Figure 6.3., the densely populated (contains 41% of the population) south-western regions (stretching from Soweto to Orange Farm) only contribute 13% of the city's economy. In addition, the figure reflects an agglomeration and linking of economic centers in the city-region, illustrated by the orientation of the Johannesburg's economy to Tshwane (Pretoria) to the north and Ekurhuleni to the east (CoJ, 2016: 47-48).

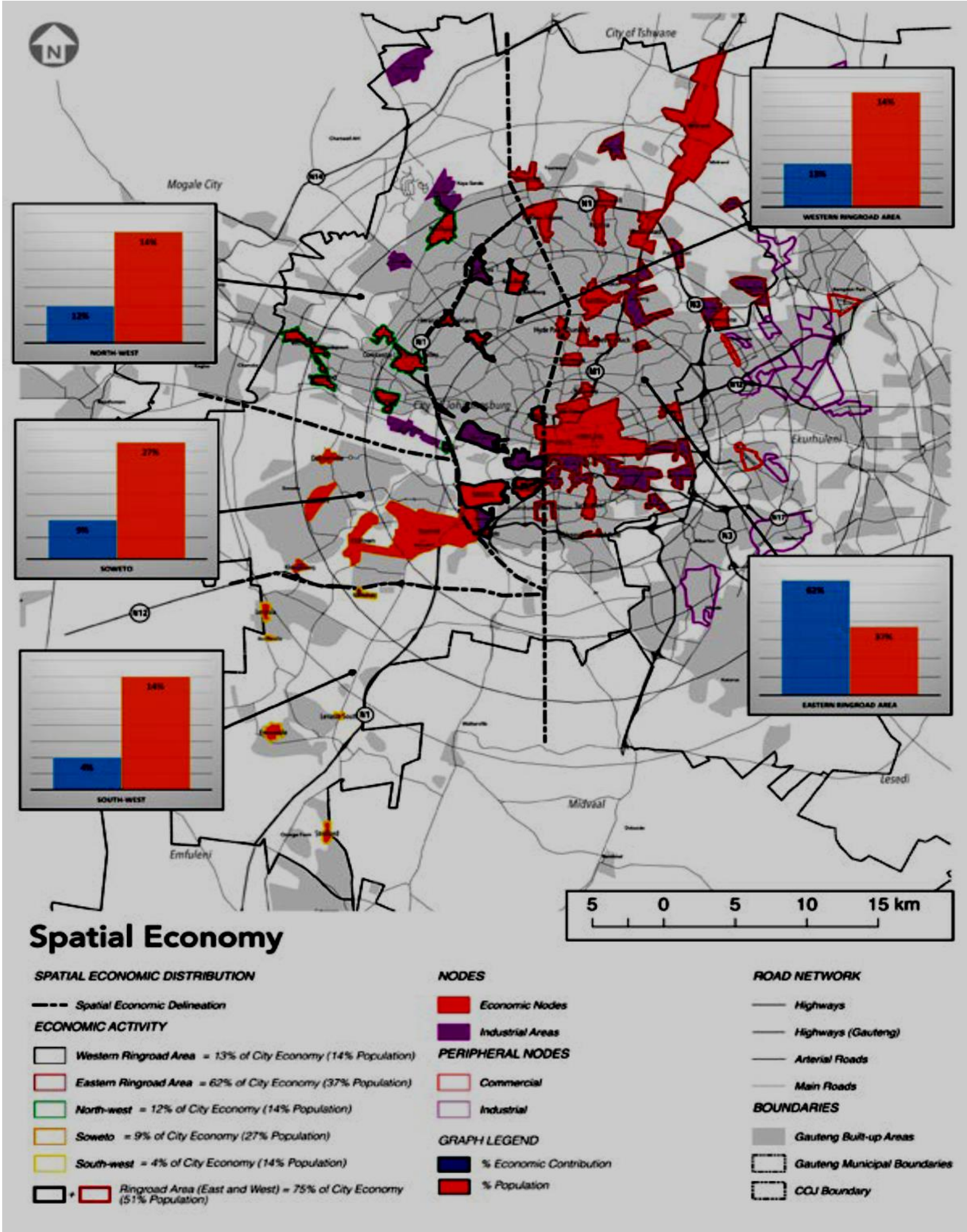


Figure 6.3: Spatial Economic Distribution of City of Johannesburg (blue: economic contribution; orange: population)

Source: CoJ (2016: 49)

6.3 Historical spatial and economic dynamics of Johannesburg

In its early days, Johannesburg's economy was mining based, because it was the mainstay of the original settlers of the city. Between 1931 and 1970, this had dwindled from 31% of its total labour force to only 8%. However, a decline in mining activities resulted in a shift to a metropolitan economic region that is tertiary sector oriented (Beavon, 2001:10). By 1970, the tertiary sector had become the dominant sector with 54% of its gross earnings and accounting for 37% of its entire labour force. The sector has grown increasingly, for example, it accounted for three times that seen in the manufacturing sector in 2004 (Kracker-Selzer & Heller, 2010:176). Mining accounted for just 1% of the city's economic output in 2013, though manufacturing still made up 16%, declining from 20% in 1996 (CoJ, 2016: 42).

Despite the adoption of export-led growth strategies to stimulate the expansion of the primary and secondary sectors, they have declined significantly over the last 40 years. Conversely, the tertiary sector has grown in leaps and bounds, producing the majority of the employment opportunities. It can be concluded that Johannesburg's economy is currently tertiary sector oriented, with trade, transport, finance and community services making up 76% of its economic output (CoJ, 2016: 42). It appears that the growth in the tertiary sector has been facilitated by complementary services from low income jobs (Kracker-Selzer & Heller, 2010:176).

Furthermore, with the development of Sandton, Illovo and Rosebank in the north, the region experienced a massive boom beginning from 1970. The private car became the dominant transport mode, and it induced sprawling and growth decline in the CBD. This rapid growth in the north was catalyzed by private sector investments. According to Goga (2003), it was stimulated by an over-accumulation of capital relative to investment opportunities within the city. For example, imposition of sanctions on the apartheid government by the international community resulted in limited investment opportunities in Johannesburg. Besides, in order to secure their investments, the private sector investors poached tenants from the CBD (Goga, 2003). However, the northern suburbs were primarily occupied by white residents, while the south was occupied by non-white residents and workers, leading to racial and class divisions within the metropolitan region. As a result, employment opportunities continued to move further away as northward development increased (Beall et al., 2002:54).

The non-white residents were driven further south, as a response to the demand for land within Johannesburg. This informed the creation of Soweto, Eldorado Park and Lenasia (Tomlinson et al., 2003:6). It also led to the provision of road and rail infrastructure, to facilitate mobility across the two divides, and the supply of cheap labour force to the manufacturing industry. Non-white townships in the west and south were connected to economic opportunities in the north by the expansions of these rail and road infrastructure.

However, it is argued that the political transformation to democratic government in 1994 stimulated changes such as the integration of middle-income non-white households into previously designated white areas. As a result, the CBD was decentralized, with expansion of businesses in numerous locations around the Johannesburg metropolitan region (Tomlinson, 1996). By 2004, the CBD was responsible for only 36% of the city's total output, while emerging economic nodes accounted for 52% of the output (Prim, 2016:45). This period also witnessed an influx of poorer migrants into areas of the CBD such as Hillbrow.

Recently, there has been pressure for significant new mixed use development south of Midrand on the Farm Waterval, adjacent to Lanseria Airport; the Farm Modderfontein and farm Frankenwald located east and north of Alexandra respectively. Places like Soweto, Orange Farm, Diepsloot and Ivory Park have also seen the emergence of mixed-use nodes in the last decade (CoJ, 2014: 6). However, this expansion of economic nodes requires on-going city intervention, if balance must be attained between population and job distribution in these townships.

The city has also experienced some industrial growth, especially in the last two decades, due to its mining history. However, between 2001 and 2010, industrial and commercial growth was experienced in the north-western part of the city, although it has a relatively small industrial sector when compared to Ekurhuleni. The greatest concentration of industrial activity is located in the old mining belt of the City in a west to east industrial corridor south of the CBD.

Currently, Johannesburg has a polycentric form, with economic opportunities found in the north and west, while the south has lesser concentrations of growth. This was primarily due to the proximity of the north and west to Pretoria and the CBD, in what may be viewed as a broader Gauteng City-Region. Morphologically, the city's polycentric nature is inverted, characterized by peripheral or satellite nodes that are disproportionately large compared to, and disconnected from the Inner City (CBD). It is also characterized by an illogical density gradient, where core economic areas are surrounded by low to medium density residential areas. In contrast, the high density residential areas are located on the fringes, far from job and economic opportunities (as shown in Figure 6.4).

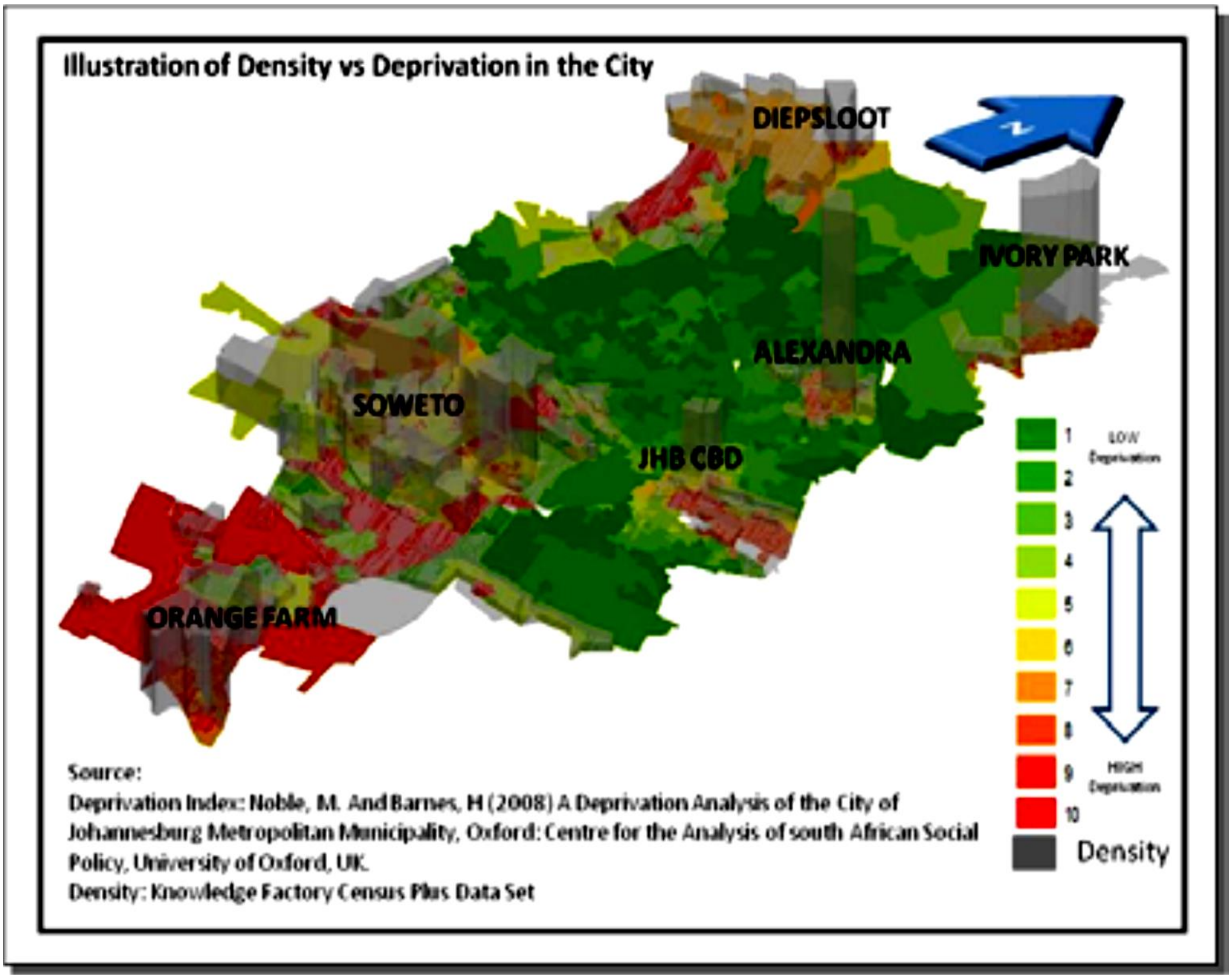


Figure 6.4: Illustration of population/housing density versus deprivation in the City of Johannesburg

Source: CoJ (2014: 8)

The highest concentration of jobs are located in regions B, E and F (Figure 6.5), while the highest population densities are found far off in Soweto, Ivory Park, Diepsloot and Orange Farm. This spatial contradiction translates into a job-housing mismatch, impacting significantly on: economic productivity by jeopardizing agglomeration economies, as well as energy and carbon intensity due to higher travel times and distances from jobs to housing.

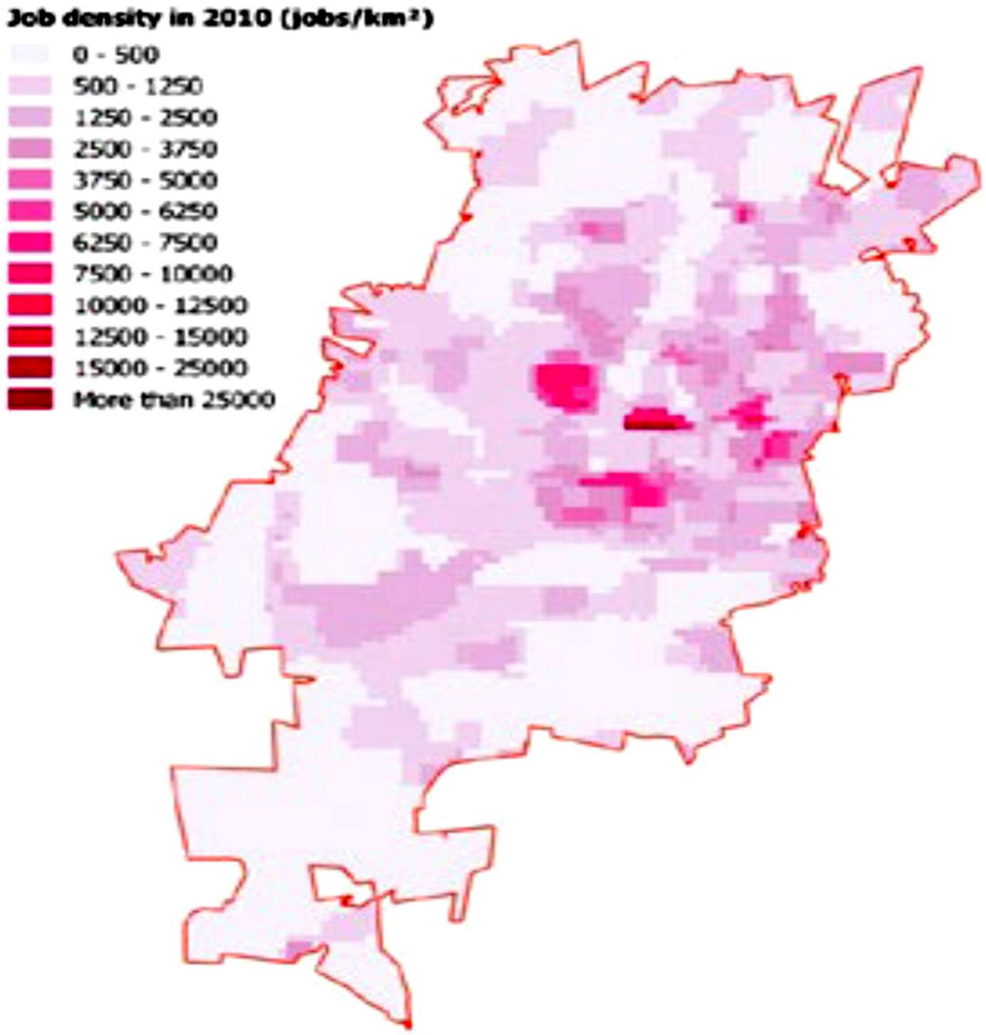
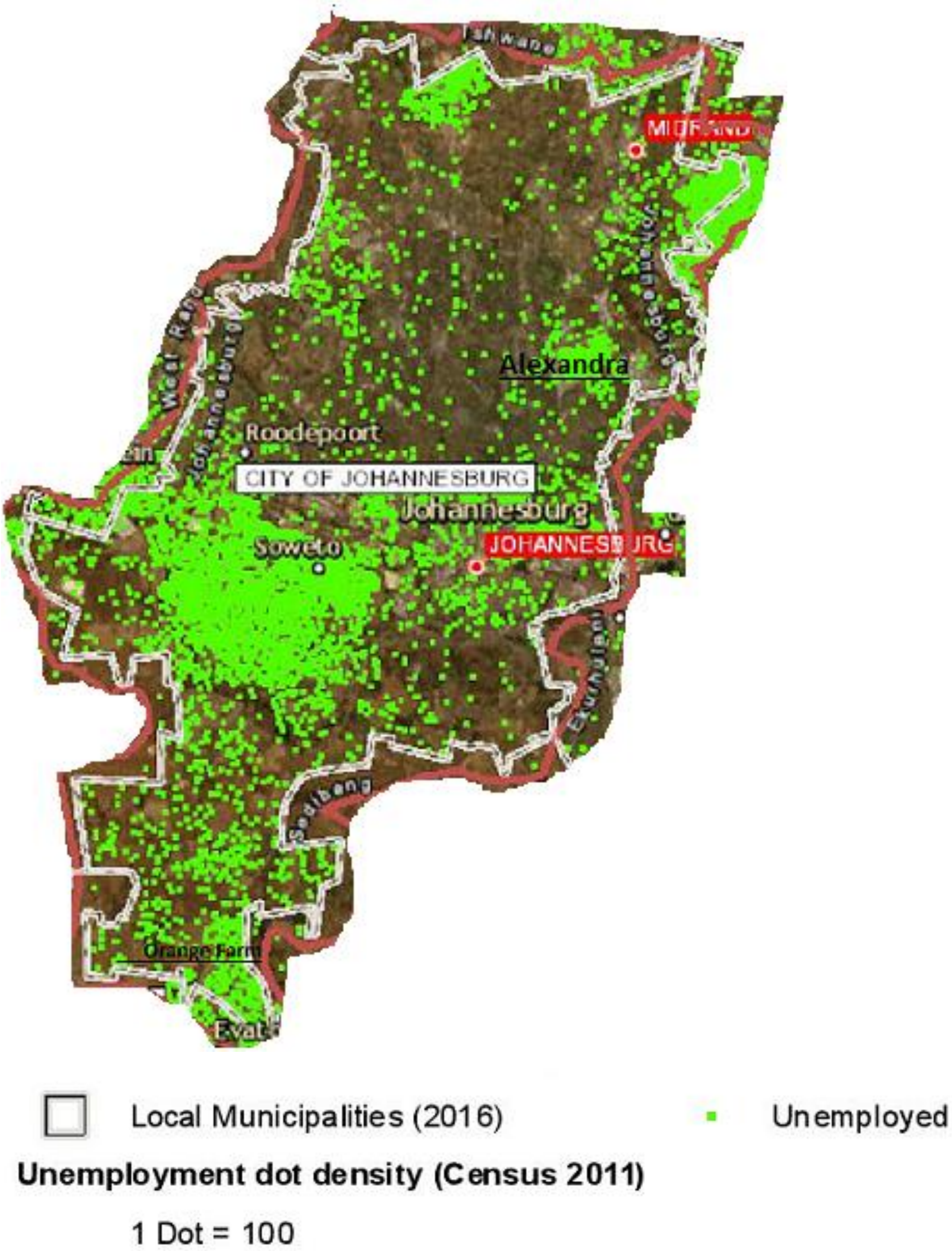


Figure 6.5: Formal job density in Johannesburg
Source: CoJ (2016: 56)

It can be concluded that the spatial inconsistencies discussed above have been the bane of both pre- and post-apartheid Johannesburg, leading to high levels of inequality. In the same vein, unemployment and poverty have not abated, especially in marginalized areas in the south, east and west. As a result, large clusters of unemployment are present in townships such as Soweto, Orange Farm and Alexandra (illustrated in Map 6.2). This has been exacerbated by the unavailability of effective public transport modes and the ignorant promotion of sprawl through the state's Reconstruction and Development Programme (RDP), a post-apartheid housing policy that provides low-cost mass housing projects at the fringes (GSDF 2030:68).



Map 6.2: Clustering of unemployment in the City of Johannesburg
Source: GCRO GIS viewer (2018)

6.3.1 The job-housing mismatch in the study area

The entrenched spatial inequality in the City of Johannesburg remains a social problem that successive post-apartheid administrations have not been able to solve. Post-apartheid planning has aggravated rather than alleviate the problem (CoJ, 2016:17), because the government has continued to establish locations, while informal settlements are increasingly developed on the peripheries, even more distant from the core, and still outside the transport corridors (Mubiwa & Annegarn, 2013:13). For example, in a comparison of jobs and housing density, the Johannesburg SDF 2040 reveals that only 3% of the metropolitan area host one-third of jobs, while 5% hosts one-third of residents. The spatial concentration of formal jobs in the city is much higher than the spatial concentration of housing.

In the Quality of Life (QoL) survey conducted by the Gauteng City Region Observatory (GCRO) in 2011, it was revealed that people travel from all corners of the metropolitan region to look for jobs. Johannesburg Inner City plays a central transportation role in this complex regional travel pattern, while movements to the north (Tshwane) and east of the city (Ekurhuleni) is a clear indicator of where the major economic activity of the region is located.

Interestingly, the SDF suggests that the economic growth potentials of the job concentration are yet to be optimized due to lack of an efficient transportation network (short term) and location of housing in close proximity (long term) (CoJ, 2016:56).

6.4 Early transport development in Johannesburg

After the discovery of gold at the Witwatersrand (the ridge of white waters) in 1886, the city witnessed rapid growth and was connected to towns and cities to the east and west of the Southern Transvaal, as it was previously known (Mubiwa & Annegarn, 2013:7). This led to the inauguration of the railway in 1890, with its catchment area extending to Boksburg (present-day Ekurhuleni) in the east and Krugersdorp in the west. The railway development stimulated economic growth in the Johannesburg CBD, influencing the pattern of shopping and facilitating the movement of people and mined goods from all over the Southern Transvaal (Beavon, 2001:4).

This was followed by the establishment of other public transport systems, such as the horse-drawn tram system and later the electric tram system, which was the most significant of all public transport developments in Johannesburg prior to the advent of the private car. The electric tram system also made peripheral areas more accessible and paved the way for urban and residential developments away from the CBD (Beavon, 2001:7). Furthermore, the tram system facilitated the development of residential land use around the stations because of the ease of mobility and improved mobility provided to residents. This led to the first transit-oriented development (TOD) model used in Johannesburg, and is seen as a significant morphological shifts in the city’s history (Chapman, 2015:80).

However, the creation of black settlements such as Soweto (1949/50) catalyzed the creation of new roads or the relocation of existing main ones (Mubiwa & Annegarn, 2013:14). An example is the old Potchefstroom road which passed through Soweto. This was followed by heavy investments in roads at the expense of rail infrastructure, because the rail was deemed too expensive at the time. These dense road networks covered the old Pretoria-Witwatersrand-Vereeninging (PWV), with Johannesburg serving as the central destination (Figure 6.6a). As a result, the PWV region became increasingly sprawled (see Figure 6.6b) due to the creation of a dense network of roads (Mubiwa & Annegarn, 2013:14). Although Map 6.3 revealed that there has been intensive suburban growth in the PWV, especially since the late apartheid period, it can be deduced that the sprawled landscape was exacerbated with the creation of more highways and development of informal settlements at townships such as Mabopane, Soweto, Thokoza and Daveyton. This further underlines the current complexities of the spatial and transportation outcomes in the study area.

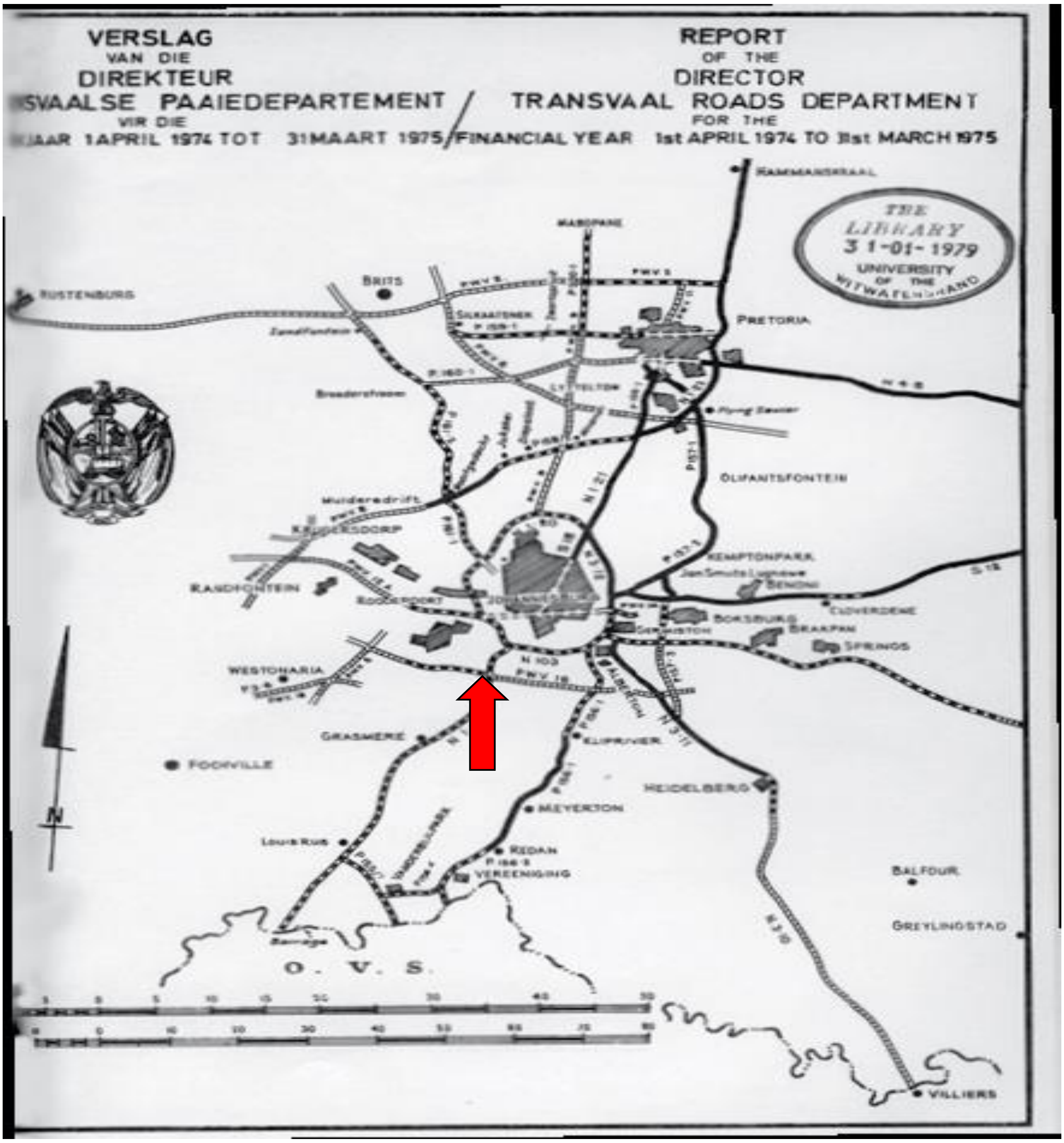


Figure 6.6a: The Pretoria-Witwatersrand-Vereeniging (PWV) as a network of freeways 1970s

Source: Mabin (2013:28)

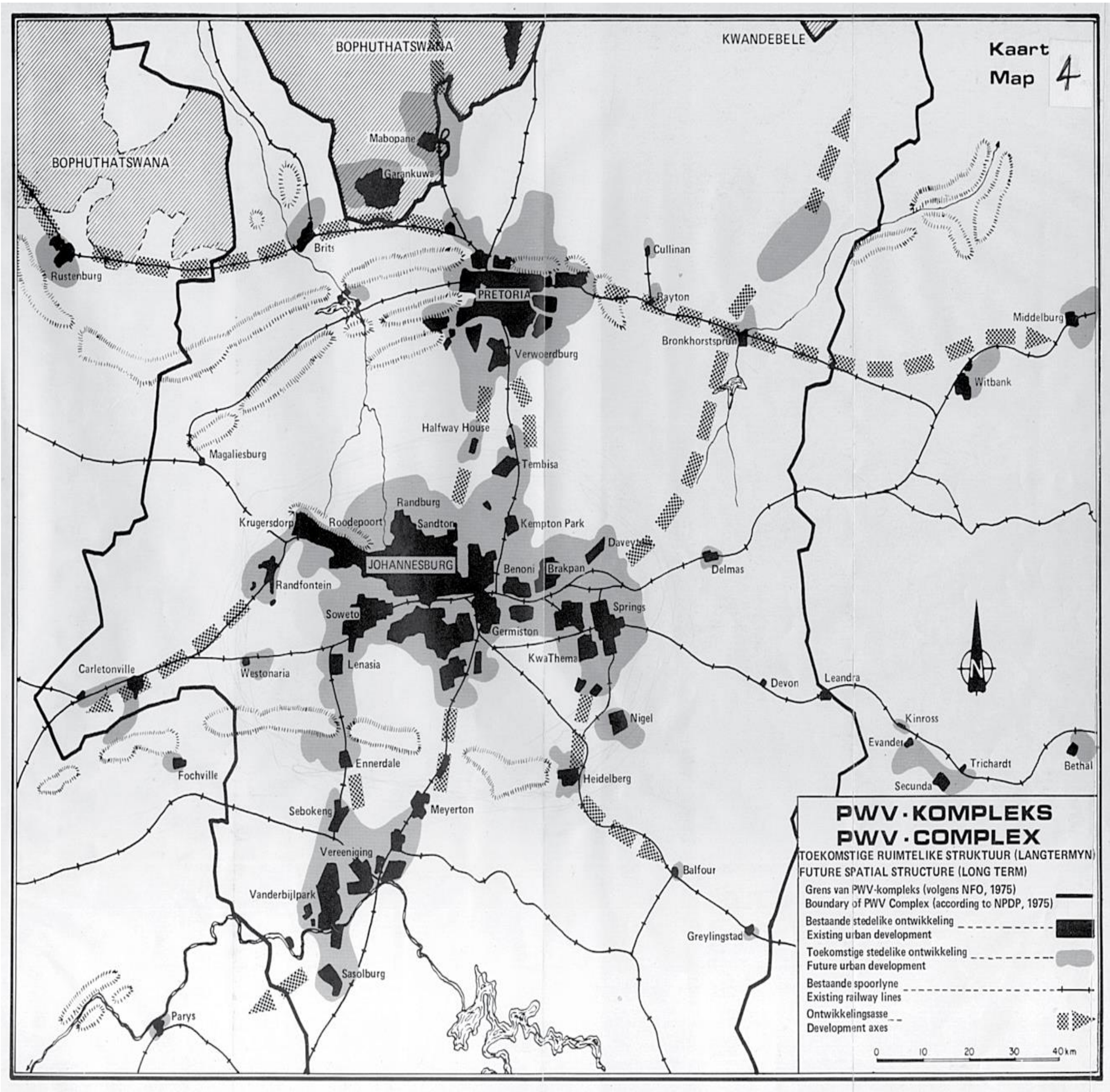
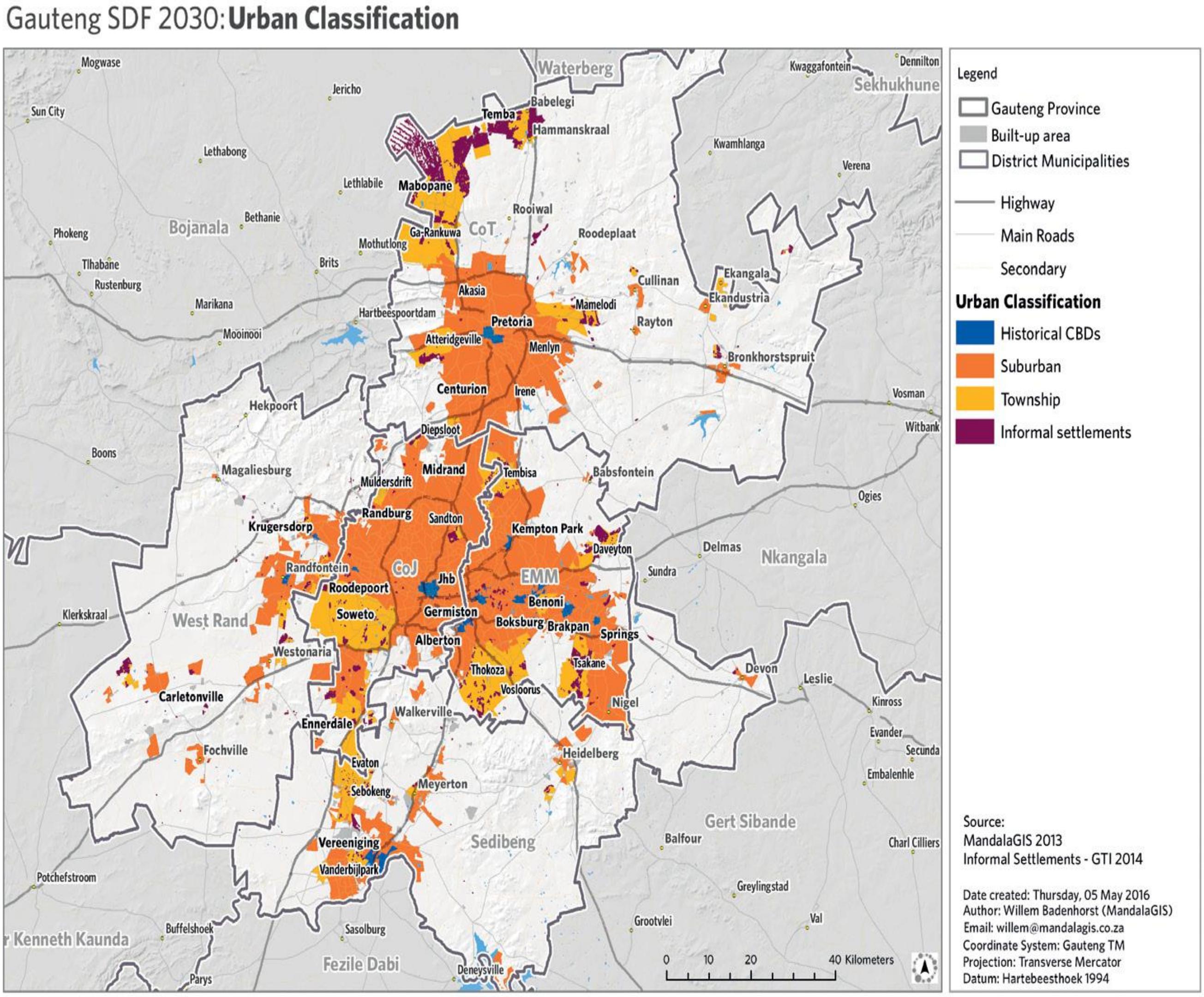


Figure 6.6b: A late apartheid view of the Pretoria-Witwatersrand-Vereeniging (PWV)

Source: Mabin (2013:34)



Map 6.3: Current urban classification in Gauteng

Source: GSDF (2030:59)

6.5 Johannesburg transit status quo

It appears that the country's transition to democratic governance in 1994 marked a watershed in the transport system of the City of Johannesburg. This deduction is reinforced by the argument that after several decades of an apartheid regime that segregated opportunities and jobs (CoJ, 2016:17), subsequent democratic governments have tried to redress these past injustices by deliberately shifting policy focus to public transport (Mokonyama & Schnackenberg, 2006:4), with the objective of increasing people's accessibility.

With the introduction of the country's first BRT system (the Rea Vaya BRT) and the Gautrain high-speed rail link that connects Johannesburg-OR Tambo and Johannesburg-Tshwane respectively (CoJ, 2013:25), the government is on the path of unlocking the enormous potentials of integrating a once divided city. There is also a Johannesburg metro-rail system that connects Soweto with the city center and other satellite towns, as well as Ekurhuleni and Tshwane (CoJ, 2013:8). The system transports large volumes of workers daily, which is reflected in peak overcrowding on some corridors (Midway-New Canada and Naledi) but it is both unsafe and unreliable (CoJ, 2013:8). According to the National Household Travel Survey (NHHTS) of 2013, 52.6% of households that used the train in Gauteng were dissatisfied with the distance between the train stations and their homes.

However, as part of the identified heterogeneous nature of these transport systems, the city is not responsible for the metro-rail whose poor quality and underperformance impacts significantly on the daily experience of many who use it for daily commute. In contrast, the city owns a metro bus company that serves thousands of passengers daily, but faced with similar problems like an ageing fleet. The mini-bus taxi, which today is the mostly used mode of public transport in Johannesburg, is privately owned and has the widest catchment area (CoJ, 2013:10). However, it is plagued with problems like insecurity, poor conditions of taxi ranks, as well as reckless drivers, which was the biggest threat identified by households in the NHHTS 2013 survey.

Incidentally, a third (33%) of all respondents for the GCRO QoL survey 2015 agrees that public transport has improved for them and their household over the past year (GCRO, 2015:38-40). Respondents in lower income groups report highest levels of public transport improvement, with notable progress in township areas such as Soweto, Thokoza/Katlehong/Vosloorus, Tsakane and Mabopane.

6.5.1. Modal Split in the study area

According to the Gauteng Household Travel Survey (GHTS) 2014, close to 90% of morning peak period trips in Gauteng are for work and education. 47.7% of trips were for education, 38.9% for work while other purposes such as looking for work, recreational, shopping and worship were inconsequential. However, the Gauteng City Region Quality of Life (GCRO QOL) survey conducted in 2015 revealed that residents of Gauteng travel largely for education and work purposes during peak hours (Figure 6.7), while work (38%) and shopping (28%) were the two main reasons why residents travel in Johannesburg (as indicated in Figures 6.8).

As seen in Figure 6.9, the mini-bus taxi is the dominant mode of transport for the longest part of the trips, followed by private cars. Rea Vaya BRT, Metrorail and Gautrain were a far cry from their ridership potentials. The National Household Travel Survey (2013) reveals travel time (32.6%) as the main determining factor for the choice of modes by households nationally, followed by travel cost (26.1%) and flexibility (9.2%), as indicated in Figure 6.10 below:

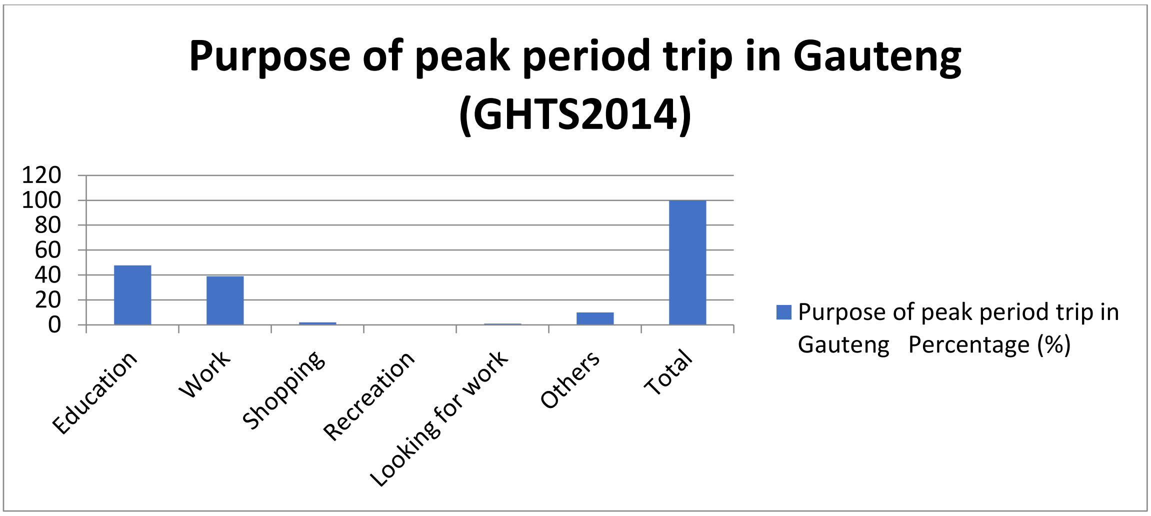


Figure 6.7: Purpose of peak period trip in Gauteng

Source: Own construction (2018) using data from GHTS 2104

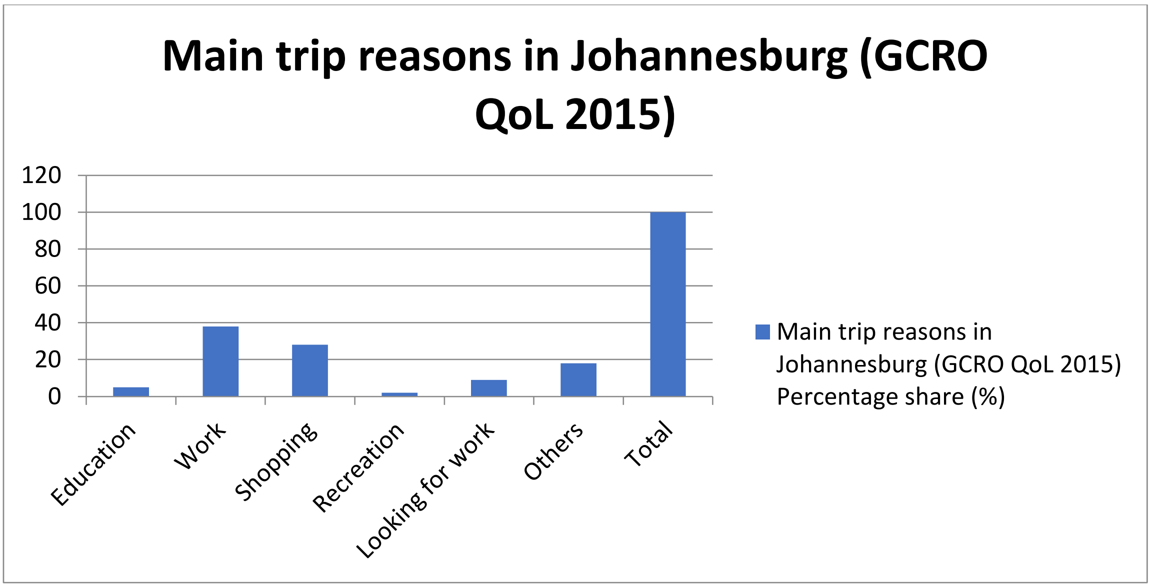


Figure 6.8: Main trip reasons in Johannesburg

Source: Own construction (2018) using data from GCRO QoL Survey 2015

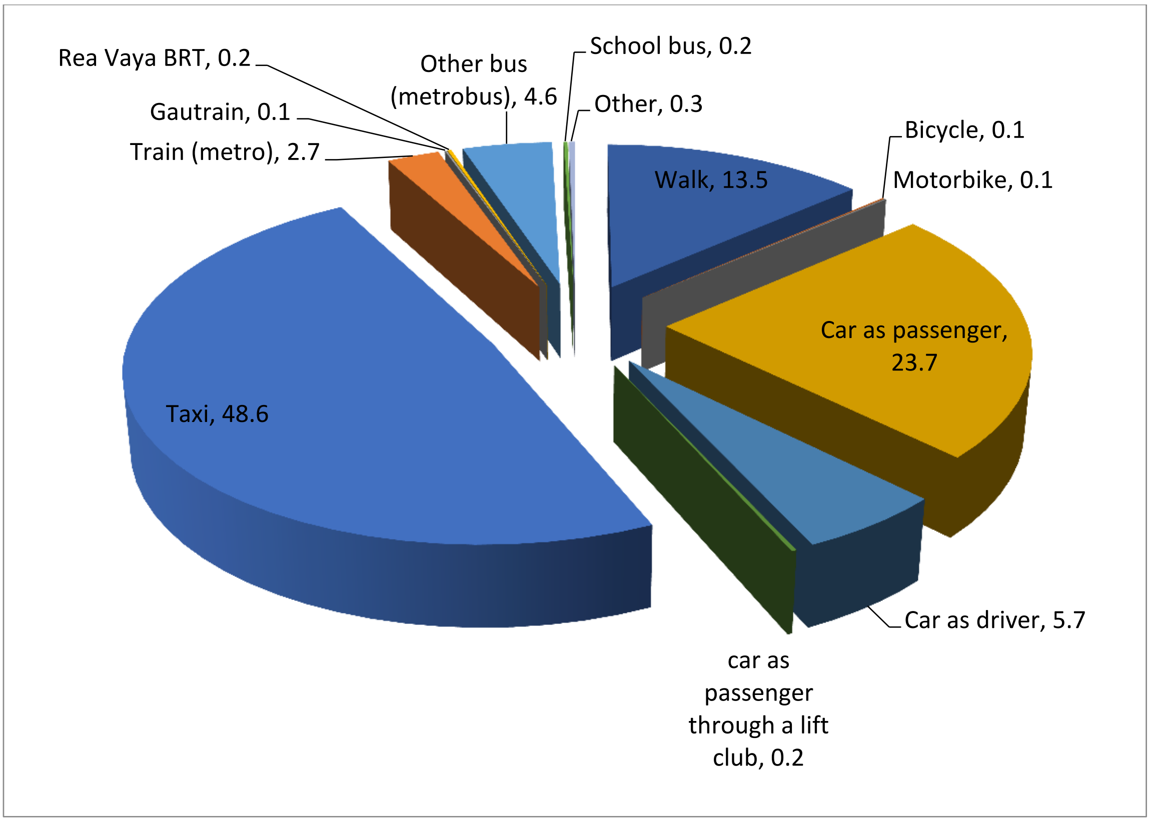


Figure 6.9: Johannesburg modal split for the longest trip (2013)

Source: Own construction (2018) using data from GCRO QoL Survey 2013

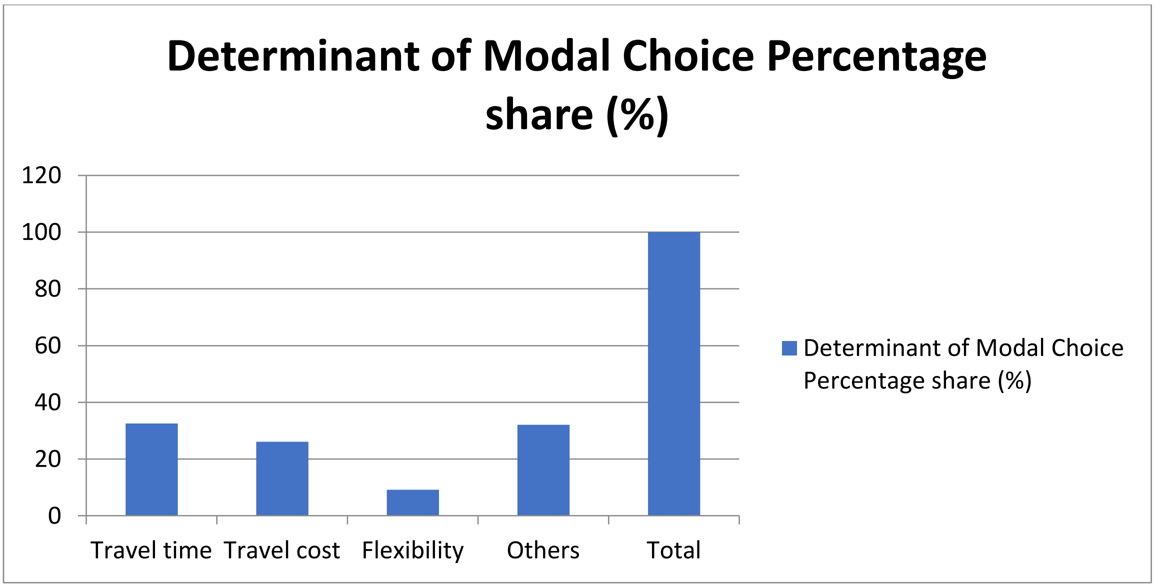


Figure 6.10: Determining factors of modal choice in South Africa

Source: Own construction (2018) using data from NHHTS 2013

It can be deduced from Figure 6.5 that the outcome is a huge departure from the 2003 survey where safety (48.4%) was the biggest influence followed by travel time (15.3%).

Historical trends in Johannesburg reveal a change in modal use by the lower income groups from publicly-owned public transport systems (i.e. bus and rail), to privately-owned public transport (taxis). There was a sharp increase in mini-bus taxi usage from 3% in 1975 to 41% in 2009, with a similarly significant drop in the use of other modes over the same period. Bus usage decreased from 22% to 4% while train usage declined from 20% to 8%. The middle income residents are more car-oriented with this reflecting in an increase in travel time of nearly 60% since 1980 (CoJ, 2011: 68). This intensive private car use has also been facilitated by continued urban sprawl (CoJ, 2011: 68).

Interestingly, public transport remains the dominant mode in Johannesburg, with 68.9% of the GCRO QoL 2011 survey indicating that they use it and only the remaining 31.1% indicating that they do not (GCRO 2011). Public transport trips are largely based on minibus-taxi (50.85%) and train (5.88%), with other bus (3.09%) the next most frequently used mode. In total, all modes of public and non-motorized transport make up 69.63% of frequent transport modes used by QoL respondents in the CoJ (Weakley & Bickford, 2015:3).

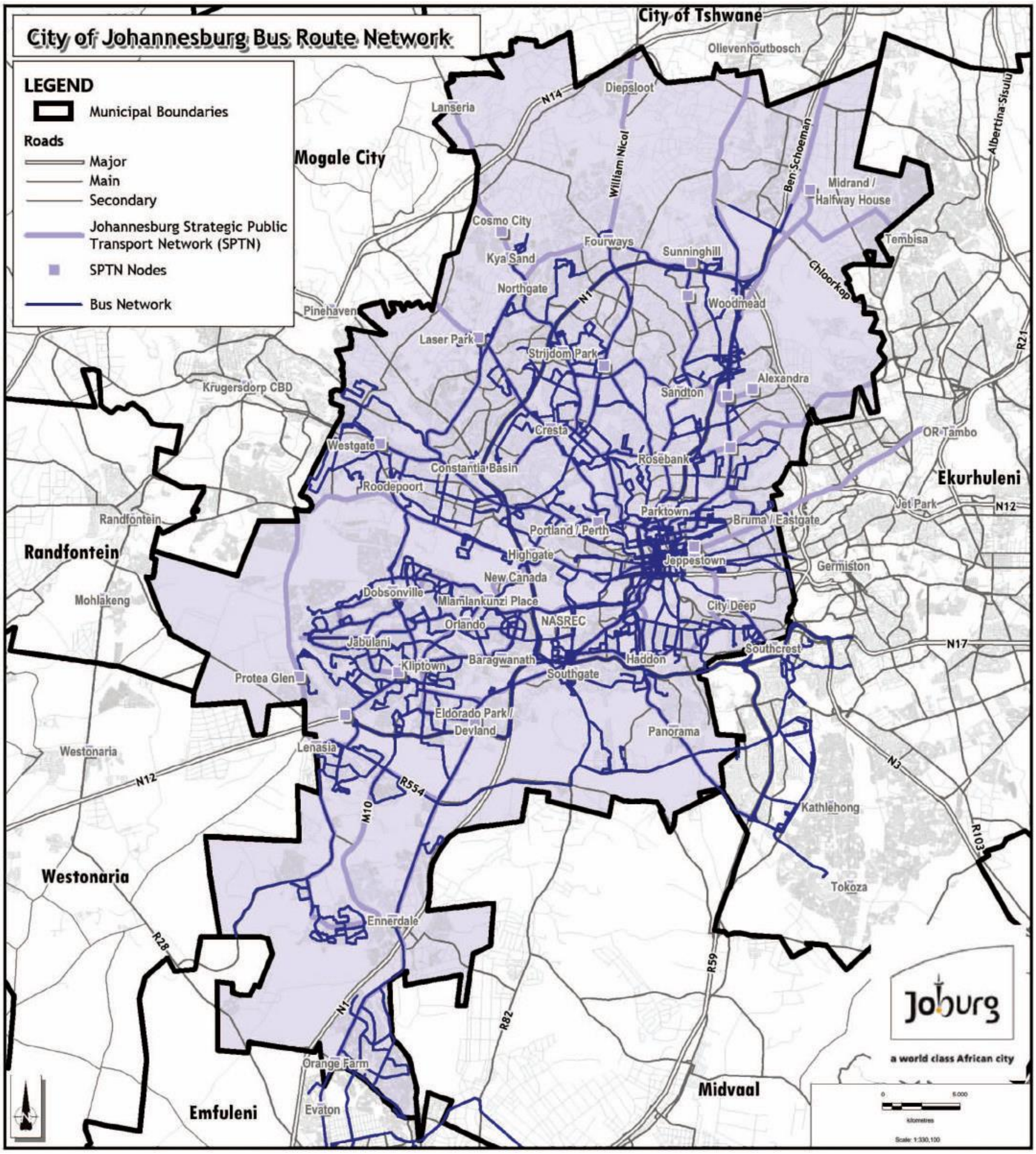
6.6. Johannesburg's public transportation system

Johannesburg's public transport network consists of a metro bus system with an ageing fleet, the mini-bus taxi, the Rea Vaya BRT, an under-performing metro-rail system and the modern Gautrain high-speed rail that connects the city with the OR Tambo International Airport (ORTIA) in neighboring Ekurhuleni metro and Tshwane (Pretoria) to the north. The provincial government has the following mandates: contracting authority for various bus services in the city; administers economic regulation of public transport through the issuing of operating licenses; in charge of vehicle licensing; owns and operates the Gautrain high-speed rail system; and builds public transport infrastructure on provincial roads.

The city government owns and operates the municipal bus service called Metro bus and the Rea Vaya Bus Rapid Transit (BRT) system. It builds and maintains the roads owned by the city and builds public transport infrastructure on city-owned roads and off-street.

6.6.1 The Metro bus

The city-owned metro bus company; together with other regular subsidized commuter bus services (subsidized by the Gauteng Department of Roads and Transport) had a total fleet of 1,200 buses in 2013 (CoJ, 2013:11). Depicted in Map 6.4, the average route length for the commuter bus route in Johannesburg is 27.2 kilometers. The regular bus services are contracted as follows: the Putco Soweto contract, the Eldorado Park contracts, the South Western Areas contracts (from Sedibeng, Ennerdale and Lenasia to Greater Johannesburg) and the Katlehong/Thokoza/Vosloorus/Boksburg contracts. There are also numerous other unscheduled bus operators providing services within, to or from Johannesburg. They provide services ranging from private hire, learner transport and inner-city coach operations.



Map 6.4: City of Johannesburg bus route network

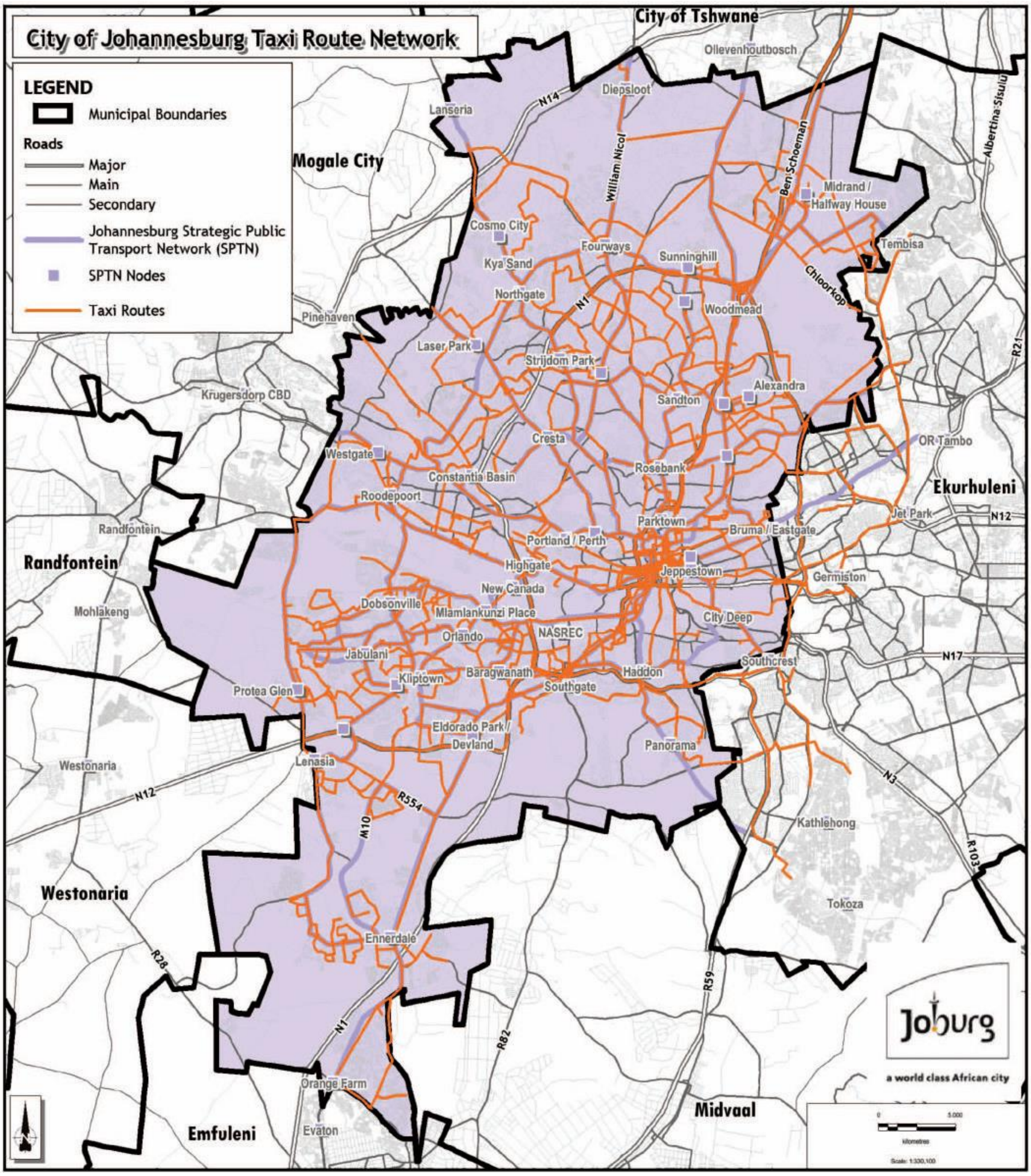
Source: CoJ (2013: 11)

6.6.2 The mini-bus taxi

The mini-bus taxi operations are overseen by 32 short-distance taxi associations. They control at least 1,013 different routes (both directions), operated from at least 450 different starting points (CoJ, 2013: 11). The average taxi route length is 17.8 kilometers, while the overall network is radial, but focused on the CBD. Many passengers are able to make their trips using one taxi all the way (about 65%) but 24% require a taxi-taxi combination and 11% involve transfers to trains or buses. The minibus-taxi emerged in 1976 in response to the shortage of public transport modes to move Black, Coloured and Indian residents located in the south to activity and growth oriented north area. They also provide much-needed mobility to residents located in the north western region of the city, which is 20-30 kilometers away from the urban core (Prim, 2016:55). Surprisingly, the taxi industry operated illegally prior to 1987, but its subsequent legislation attracted a number of public investments such as the provision of taxi ranks and facilities. (Mubiwa & Annegarn, 2013:13).

In addition, its rapid growth in Johannesburg and nationwide over the last four decades resulted from a lack of development and inadequacy of the bus and rail systems (Prim, 2016:55). This growth was also facilitated by its dynamic nature and an expansive catchment area. Its reach stretches across the 4 corners of the metropolitan region (as indicated in Map 6.5); and it appears that the concentration of taxis in Johannesburg is directly proportional to the service demand by the urban poor. The system conforms to the region's polycentric form, and because of its flexibility, it provides access to locations that are inaccessible to state-funded public transport systems. In addition the minibus taxi system may be more affordable because it is less capital intensive relative to other public transport systems (Schmidt, 2014:57-76).

According to the GCRO QoL Survey (2015), from the 30,000 respondents, 74% of taxi users in Gauteng were satisfied while only 15% were dissatisfied. The rest were neither satisfied nor dissatisfied. (GCRO QoL Survey 2015:40). This implies that taxi users are largely satisfied with the service provided by the minibus taxi industry.



Map 6.5: City of Johannesburg taxi route network

Source: CoJ (2013: 12)

6.6.3. Case study 1: The Rea Vaya BRT

The Rea Vaya BRT system, launched as a legacy project in 2009, partly to meet the mobility demands that would accompany the city's hosting of the 2010 FIFA world cup, is an ambitious transit initiative by the city government, and scheduled to be completed in three phases. It links the Johannesburg CBD and Braamfontein with Soweto. The first two phases (1A and 1B) are already completed while the last one (1C) is expected to be introduced towards the end of 2018.

The aim of the system was to provide an improved public transport system to marginalized areas in order to increase accessibility and reduce poverty. (Vaz & Venter, 2012:619). This ambitious initiative promotes the creation of an extensive network with links to informal settlements such as Diepsloot (Rea Vaya, 2014), Alexandra and marginalized areas to the south such as Lenasia, to development in the north. Its maiden network contained trunk routes extending from Ellis Park Stadium in the east to the CBD and Soweto.

The Rea Vaya BRT is operated by Piotrans (Pty) Limited, a shareholding company jointly owned by former owners of mini-bus taxis who scrapped their taxis to agree on the existing ownership structure with the city.

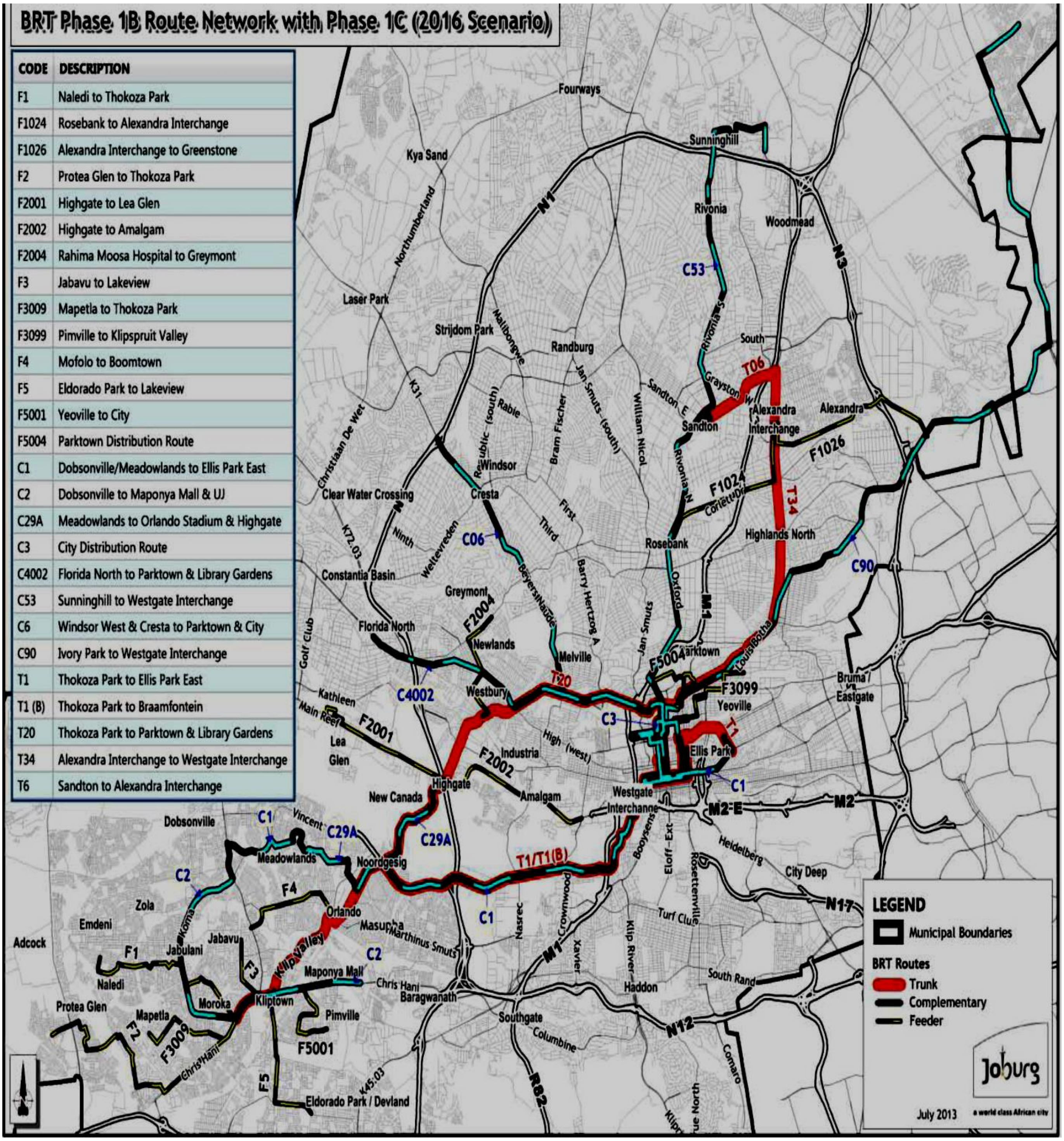
Rea Vaya routes are classified into three: trunk routes (T) on the main highways and between major destinations; complementary routes (C) running on circular routes that connect to trunks; and feeder routes (F) that radiate out from trunk routes to outlying suburbs. As of 2015, there were 21 routes and 58 stations. This comprised of 43.5 km of trunk services, 14.7 km of complementary bus services operating in both preferential and mixed traffic lanes and 75.8km of feeder bus services in mixed lanes (Scorcia & Munoz-Raskin, 2017:7).

On completion, Phase 1C will see a number of changes being introduced into the Rea Vaya model in respect of infrastructure, operations and integration with other modes. Map 6.6 shows a consolidated map of the three phases after full completion.

6.6.3.1. Rea Vaya Operational fundamentals

Besides the ownership structure, other operational features of the Rea Vaya BRT include pre-boarding fare collection and access control; a centralized control center using vehicle control technology; operator compensation based on vehicle-kilometers travelled rather than number of passengers served; and fares set by the city, not the operators. Others include large stations, level boarding, articulated and regular buses serving trunk corridors, complemented with buses circulating in mixed traffic for feeder routes.

Sadly, the Rea Vaya has not met its ridership forecast, with an average weekday ridership of 60,000 recorded as at 2017; when compared to an initial projection of 162,000 (Scorcia & Munoz-Raskin, 2017:9). It also has an average weekday passengers per bus of 217 and demand peak-to-base ratio (ratio of highest passenger demand at peak period to lowest demand at off-peak period) of 8.9, which are quite low when compared to Latin American Cities like Bogota and Lima (2-3), systems that inspired the Rea Vaya BRT. Its maximum loads are relatively low at 5,000 passengers per hour per direction (in 2014), only comparable to medium-sized Latin American Cities like Pereira and Bucaramanga with less than 1.5 million inhabitants (Scorcia & Munoz-Raskin, 2017:8).



Map 6.6: Rea Vaya BRT Phase 1C network for 2016 (including Phases 1A and 1B)

Source: CoJ (2013: 23)

The operational deficiencies, as well as the perennial competition from the minibus-taxi – as opposed to being a complementary mode – are responsible for the underperformance (operational) of the Rea Vaya. Other factors include uncompetitive fares relative to the taxis and Metrorail, limited catchment area, inefficient fare media, lack of real time information and an increase in the generalized transport cost of trips relative to the ex-ante situation. More importantly, Scorcia and Munoz-Raskin (2017:10) strongly suggest that the city's passenger travel demand pattern, which is an offshoot of its unique urban form, directly impacts the operational performance of the BRT. In addition to this, factors such as the city's long average trip distances, its high peak-to-base ratio, as well as the low concentration of passenger volumes – even in the peak – is responsible for Rea Vaya's high capital and operating cost.

However, in spite of these inadequacies, a few highlights have been achieved as according to the GCRO QoL survey 2015, there was a sizeable increase in daily BRT trips in Gauteng from 0.4% in 2013 to 2.1% in 2015. In Johannesburg, 185, 000 passengers that accounts for 5.8% of monthly commuters use the BRT. The BRT also recorded a remarkable customer satisfaction with 79% of the city's respondents and 83% of daily users (GCRO, 2015: 37). Only 5% of Gauteng respondents were completely dissatisfied.

6.6.3.2. Future expansion of Rea Vaya BRT

It appears that the transit-oriented development (TOD) policy initiative of the city (CoJ, 2013:43-45) that envisages growth in a network of public transport corridors is based on the Rea Vaya bus system and Gautrain stations across the city. According to the CoJ (2016:97-111), developments will be clustered on the Soweto-Sandton corridor, as well as the Randburg-OR Tambo corridor. This growth will link former black townships of Diepsloot, Soweto and Alexandra with the CBD and other major mixed-use nodes within the city, while promoting the corridors as locations for investment and residential densification in their own right.

In the same vein, the Rea Vaya BRT will serve as a backbone for the city's future urban public transport system. It has been chosen as the mass public transport mode for the city's busier corridors, to promote TOD and urban regeneration. With the objective of promoting bus based public transport and non-motorized transport, it can be deduced from Map 6.7a and 6.7b that the city plans to expand and improve the trunk routes of the Rea Vaya, and to accommodate its integration with other public transport modes (metro rail – MR and Gautrain – GT) and non-motorized transport. In this regard, it appears that the significance of the Park Station as the city's busiest public transport interchange may be reinforced to facilitate integration. For example, the route networks of the Gautrain bus, metro bus and Rea Vaya BRT are currently integrated at the Park Station. Therefore, Table 6.1 provides information on the routes, operating hours and the fare structure of the Gautrain bus, metro bus and Rea Vaya BRT in the Park Station area.

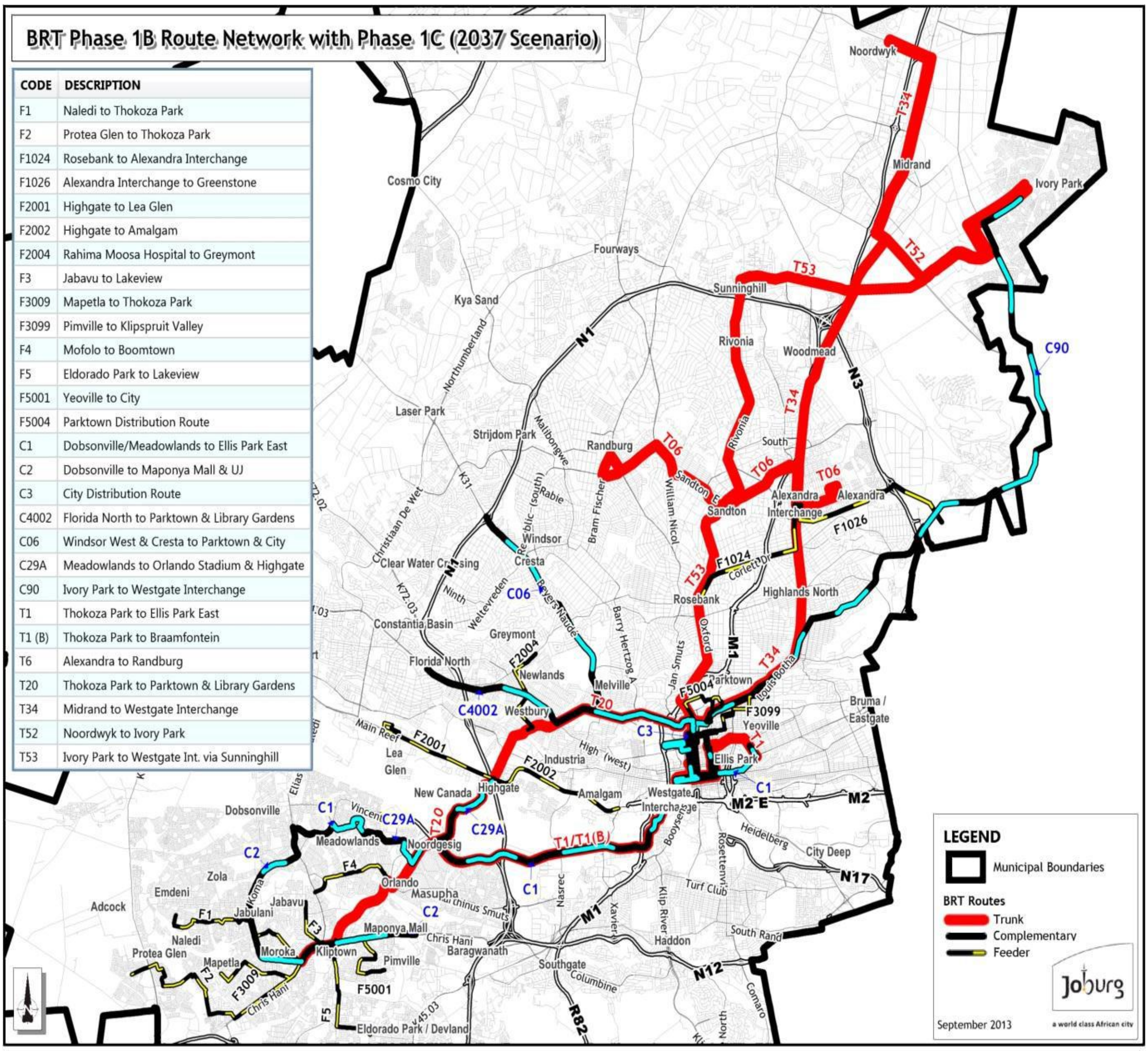
Table 6.1: Time table of bus services in the Park Station area

Mode	Route	Operating hours (Weekdays)	Fares		Frequency (Peak period)
			Lowest	Maximum	
Gautrain bus	J1 Parktown	5:25 - 20:21	R6 (rail user)	R20 (non-rail user)	Every 12 minutes
	J2 CBD	05:25 - 20:28			
Metrobus	412/413	06:00 - 17:35	R8.70	R12.20	
	66	06:00 - 18:50	R8.70	R12.20	
	67	07:20 - 17:10	R8.70	R12.20	
	32	06:05 - 17:55	R8.70	R12.20	
Rea Vaya	C1: Dobsonville - Ellis Park	04:50 - 21:00	Distance-based system		Every 5 minutes
	T1: Ellis Park - Thokosa Park	04:50 - 21:00			
	T1: Via Civic Center (Express service)	06:00 - 17:00			
	C3: Inner City Circular Route	06:00 - 20:30			

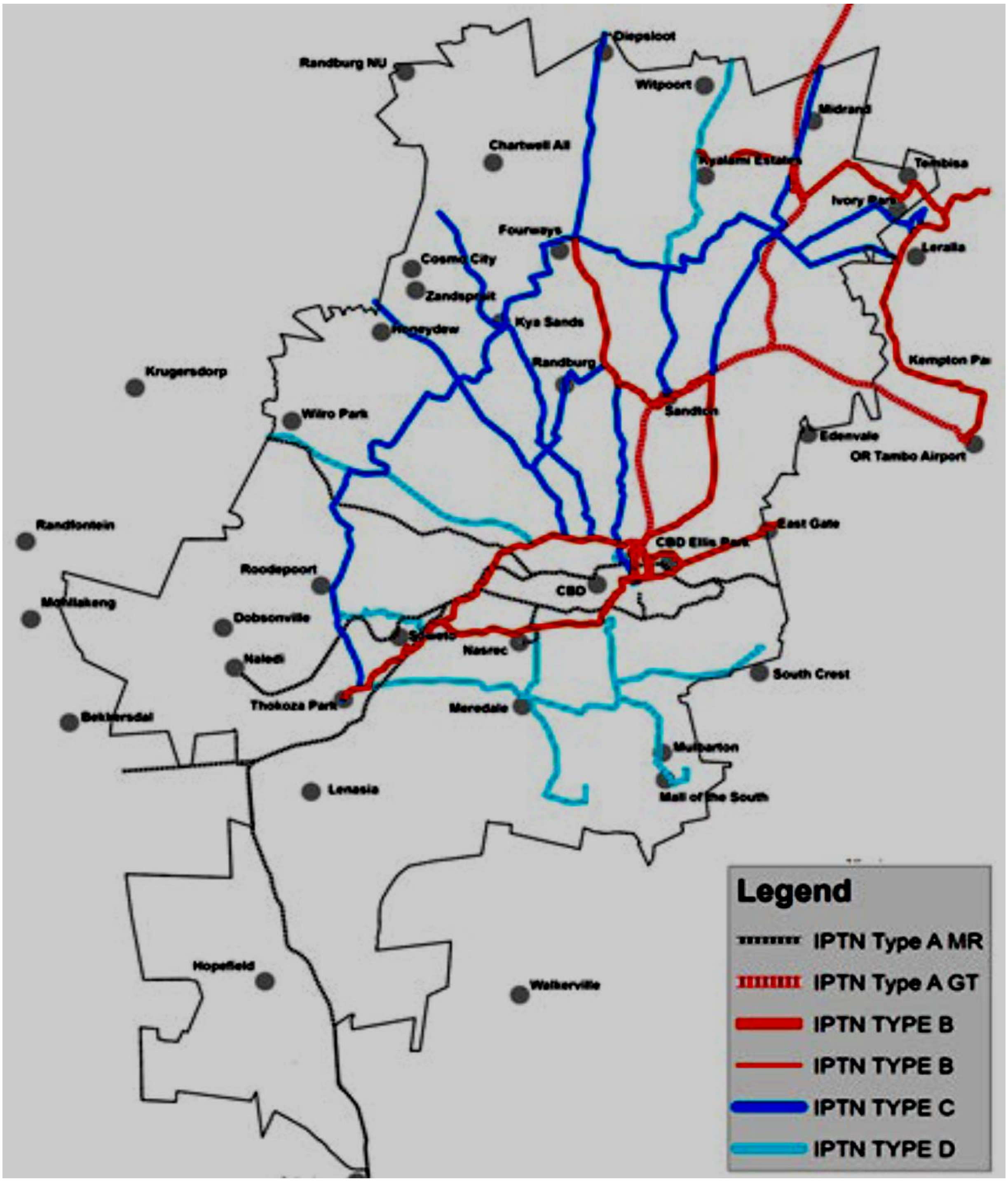
Source: www.reavaya.org.za

The components of the future integration of the Rea Vaya with other modes are (CoJ, 2013a:51):

- Integration of route network and services
- Integration of fare structures (fare harmonization)
- Integration of fare medium (integrated ticketing)
- Integration of infrastructure
- Integration of passenger information
- Integration of timetables
- Integration of branding



Map 6.7a: Rea Vaya BRT proposed Phase 1C extended network for longer term (2037) including Phase 1A and 1B
Source: CoJ SITPF (2013:25)



Map 6.7b: Trunk routes for Johannesburg Strategic Integrated Public Transit Network

Source: CoJ (2016:77)

Other detailed future improvements to the Rea Vaya include (Rea Vaya, 2015 and Rea Vaya, 2018b):

- Three interchanges for public transport integration to be built at Watt Street Alexandra, Sandton and Westgate to promote its integration with Metrobus, minibus taxi and metered taxi network.
- Part of the Rea Vaya Phase 1C infrastructure that will feature 30.5km of extensive walking and cycling paths in Alex, improved pavements along Louis Botha Avenue, and a dedicated cycle and walking path, with the completed iconic bridge (dedicated to pedestrians and Rea Vaya buses), from Alexandra to Sandton.
- A new depot is to be built for the Phase 1B operations in Booysens, south of Johannesburg. Two new depots will be built in Alexandra and Ivory Park for Phase 1C.

This integration is part of the nine policy thrusts developed by the city in its Strategic Integrated Transport Plan (SITP) 2013 for the short term (5 years from 2013 and long term to 2040). The thrusts also align with the City of Johannesburg Growth and Development Strategy 2040 and the imperatives described in the NDP and Public Transport Strategy.

6.6.4 Case study 2: Gautrain

As mentioned, the Gautrain is an 80-kilometer provincially-implemented modern, high-speed rail connection linking Johannesburg, Tshwane (Pretoria) and O.R Tambo International Airport (ORTIA). Five of its ten stations are in Johannesburg (Park Station, Rosebank, Sandton, Marlboro and Midrand), with access to and from stations through park and ride and via a feeder/distribution network of up-market buses serving a 5 kilometer radius of each station. It is operated by the Bombela Concession Company, as a Concessionaire under a private-public partnership (PPP) contract with the Gauteng provincial government.

The objective was to provide an intercity and airport service that would be attractive to existing car users and facilitates a transit-oriented development (TOD) intervention to crowd spatial and economic growth around its station nodes.

It is a transport flagship project that has managed to break societal barriers by bringing people from all walks of life together while providing a convenient, fast and efficient means of travel that is enjoyable and stress-free. Its construction attracted many controversies, especially because of the eventual escalation of the cost, but “it has become the leading public transport service provider in South Africa” (Bickford, pers. comm. 11 July, 2018). It has certainly changed people’s perception of public transport by painstakingly delivering a transformed travel experience to its daily users.

The Gautrain was introduced in three phases, with Phase 1 starting operations in 2010, just in time for the 2010 world cup hosted by Johannesburg and eight other cities. It serves as a link between Sandton and OR Tambo International Airport in Ekurhuleni and provides a commuter line between Rhodesfield (Ekurhuleni), Tshwane/Pretoria and Sandton. Subsequent phases began operations in 2011 and included a Rosebank station and Pretoria Station, with an additional phase at Park station, Johannesburg in 2012.

6.6.4.1. Gautrain operations

The Gautrain operations are tailored to translate passenger demand into a rail service that prioritizes service frequencies and train set configurations. There are three train services in operation (GMA, 2016: 74), as illustrated in Figure 6.8:

i. A General Passenger Service (GPS) on the North/South (N/S) line between Hatfield and Park Station

ii. A General Passenger Service (GPS) on the East/West (E/W) line between Rhodesfield and Sandton Station; and

iii. An Airport Passenger Service (APS) on the East/West (E/W) line between ORTIA and Santon Station

The Dedicated Feeder and Distribution (Bus) Service (DFDS) seldom assists the train operational system whenever there is a problem in operating a full end-to-end rail service. They operate mainly on weekdays and provide service for social events over weekends to promote its awareness and usage. In addition to its own dedicated feeder bus service, the GMA has reached agreements with the relative local taxi associations at Marlboro and Centurion Stations to provide Feeder and Distribution services (GMA, 2016:12).

The Gautrain has also matched expectations both in terms of performance and customer satisfaction. Measured by availability and punctuality, its performance as recorded in the 2015/2016 annual report of the Gautrain Management Agency is 98.5% availability and 94% punctuality respectively. With a total passenger trip of 15, 465,526 for the 2015/2016 financial year, the Gautrain recorded an overall growth of 3.73% in passenger trip, mainly driven by growth in the General Passenger Service (GMA, 2016:75). However, this is low compared to a growth of 9.32% for the previous year. This reduction in growth rate is an indication that Gautrain has reached the maturity phase of its service lifecycle (GMA, 2016: 76), thereby justifying calls for an expansion and integration with other transport modes. Approximately an average of 55,000 passenger trips on a weekday, 13,000 trips weekend and 19,929 feeder bus passenger trips daily were recorded for the year 2015/2016.

Interestingly, the GCRO QoL (2015) Survey recorded the highest level of customer satisfaction from Gautrain passengers at 94%, more than the 91% satisfaction rate recorded by private car users. Only 1% of responders were dissatisfied with the Gautrain. The system has also performed satisfactorily when taken in the context of its ability to stimulate crowd investments around its stations. It has been partly responsible for significant redevelopment in Rosebank and Sandton.

In spite of the outcome discussed above, it has been endlessly critiqued for only meeting the mobility needs of the middle and high income earners, with fares that remain beyond the reach of the poor. It is also heavily condemned for the high cost of development. As argued by Bickford (pers. comm. 11 July, 2018), the prospect of physically integrating the Gautrain with the Metrorail may not be accomplished because the Gautrain is on a standard gauge track while the Metrorail is on a narrow gauge track. He also opined that the decision to build the Gautrain on an entirely different track seems bizarre because it appears the provincial government wanted the two rail systems to exist separately.

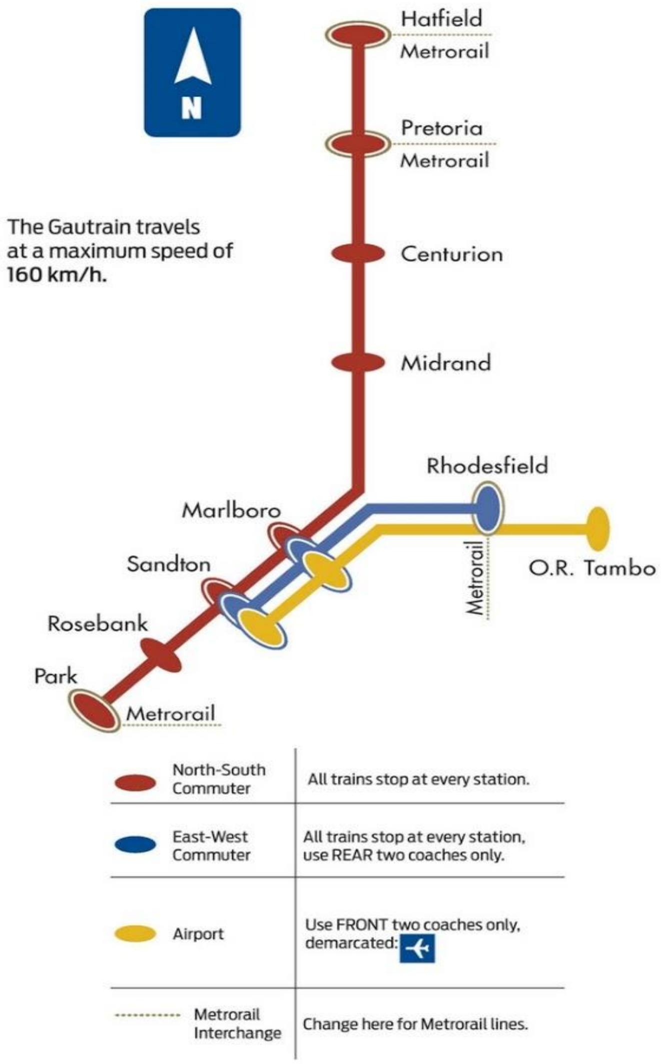
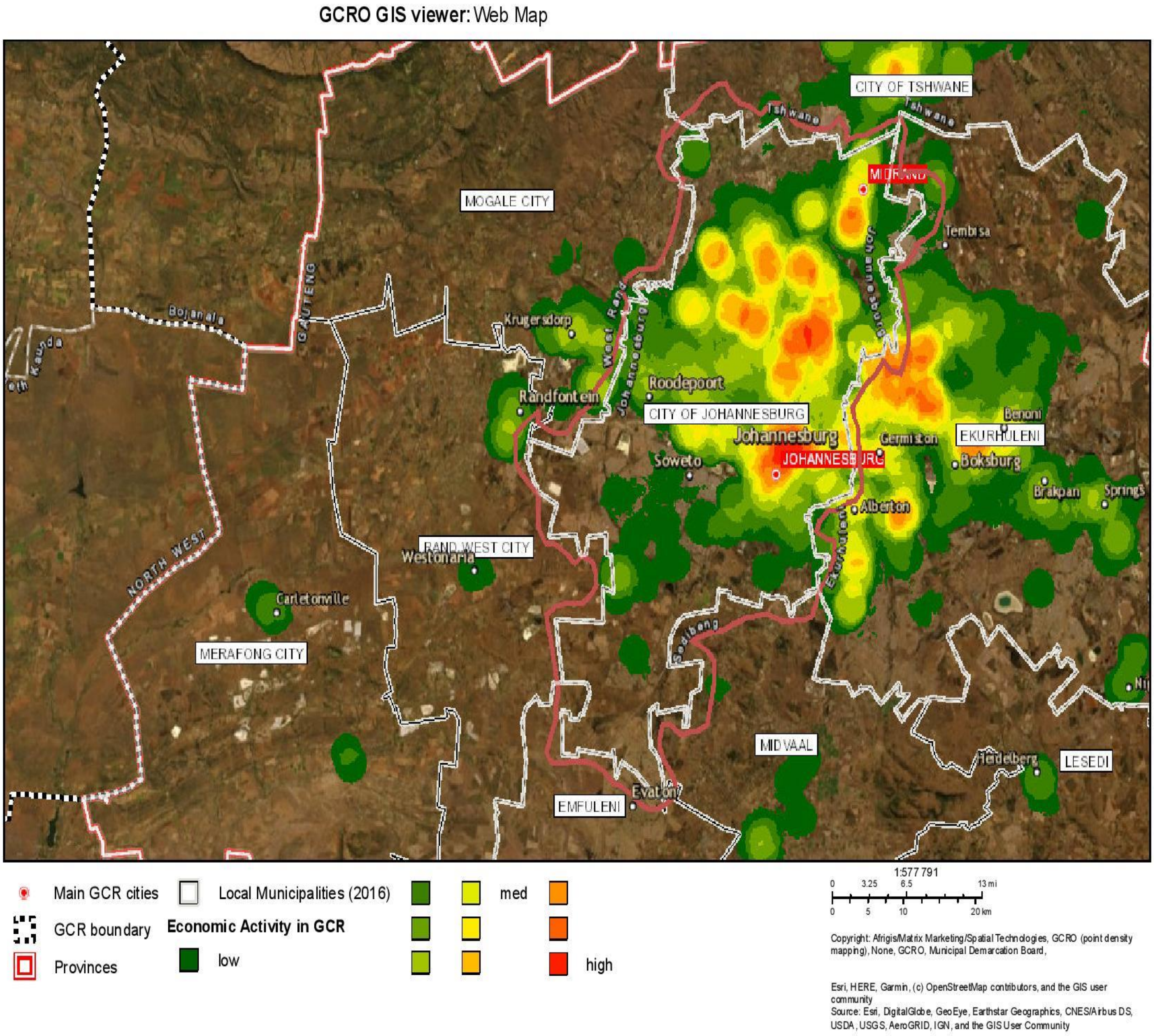


Figure 6.8: Gautrain service routes

Source: http://www.businesslive.co.za

6.6.4.2. Gautrain impacts on passenger transportation in the study area

The provincial government's introduction of the Gautrain further complemented the city's effort towards prioritizing mass transit provision. Through the Gautrain, the provincial government aims to alleviate traffic congestion on the N1 freeway between Johannesburg and Pretoria, by providing a fast and reliable alternative, while also enhancing Gauteng's economic growth (Gotz et al., 2014:92). If the Rea Vaya had failed to achieve a desired modal shift as earlier anticipated, the Gautrain became the symbol of what a viable alternative to the private car must look like. The periodic customer satisfaction survey gave a reflection of what has been achieved in this regard. The Gautrain has satisfactorily provided access to Gauteng's primary economic activity and formal employment nodes, which are a mixed-use triangle of nodes with footprints covering Johannesburg CBD, Midrand, Tshwane and OR Tambo International Airport inspired Aerotropolis in Ekurhuleni (see Map 6.8). The deduction from Map 6.8 is that the economic activities are from medium to high within the triangle and low in places outside (e.g. Midvaal, Tembisa, Brakpan, Springs, Randfontein and Westonaria).



Map 6.8: GCR economic nodes and formal employment coverage area

Source: GCRO GIS viewer (2018)

The future transport planning implications of the Gautrain is reflected in the Gautrain Management Agency's (GMA) commissioned feasibility studies (in 2013) for four Gautrain extensions (Venter, 2013). Though there are still widespread sentiments, such as arguments that the system ignored large parts of the province with significant residential populations, as well as the reinforcement of historical divisions by using public resources to provide for the needs of elites. The GMA plans to extend the network by 150km (in 2 phases) over the next 20 years. The new Phases 1 and 2 routes (Figure 6.9a & b) will include nodes like Randburg, Fourways and Soweto. Likewise, the Gauteng Premier in his annual address of 2017 affirms that the feasibility studies have been completed and approvals are in the pipeline from provincial and national treasuries (BusinessTech, 2017b). In addition, the GCR Integrated Infrastructure Master Plan (IIMP) 2030 hints at a new link from Mamelodi in Tshwane to Soweto, with intersections at new growth nodes like Laseria in Johannesburg (Gauteng, 2015).

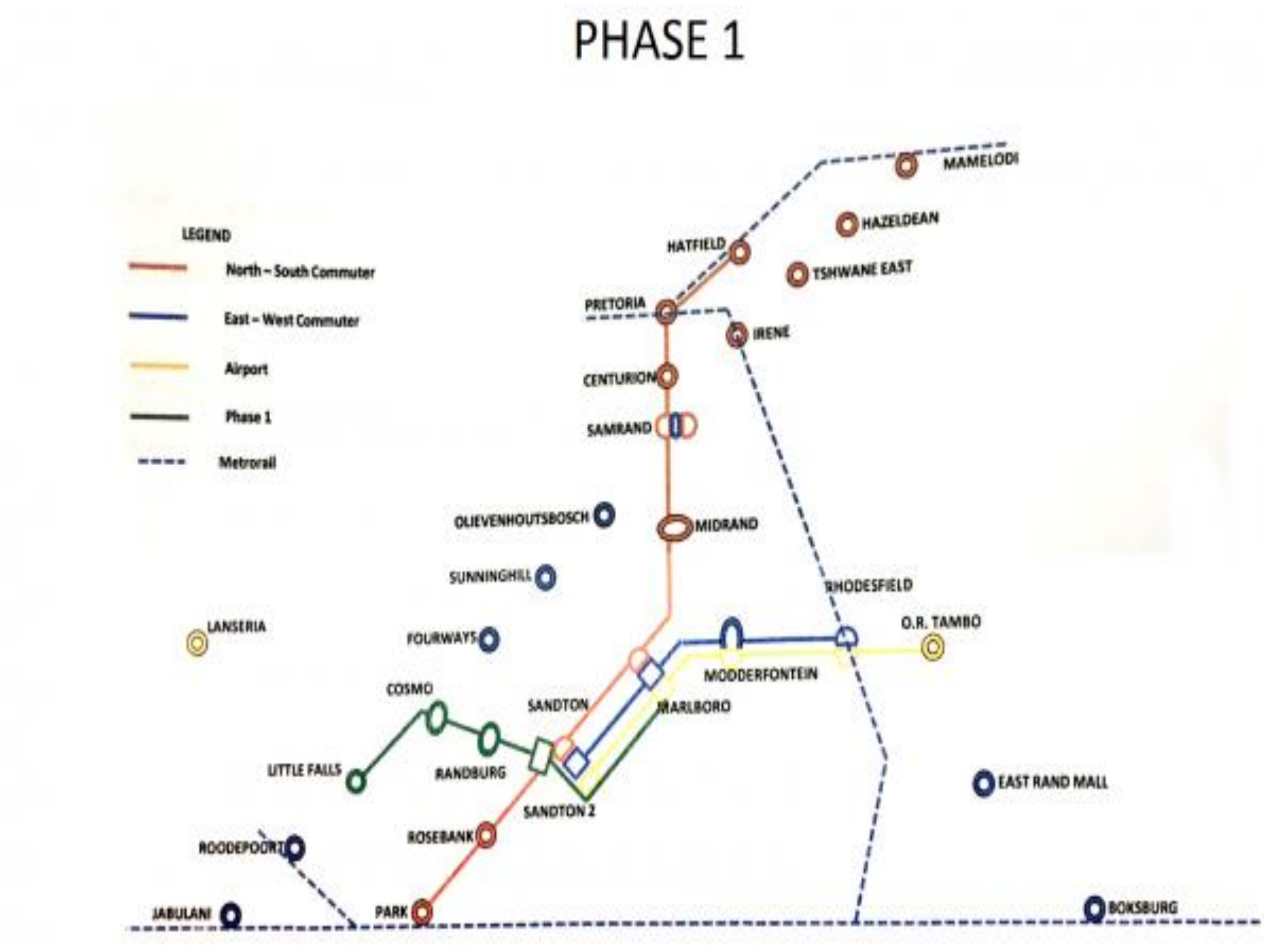


Figure 6.9a: Proposed Gautrain extension (Phase 1)

Source: BusinessTech (2018)

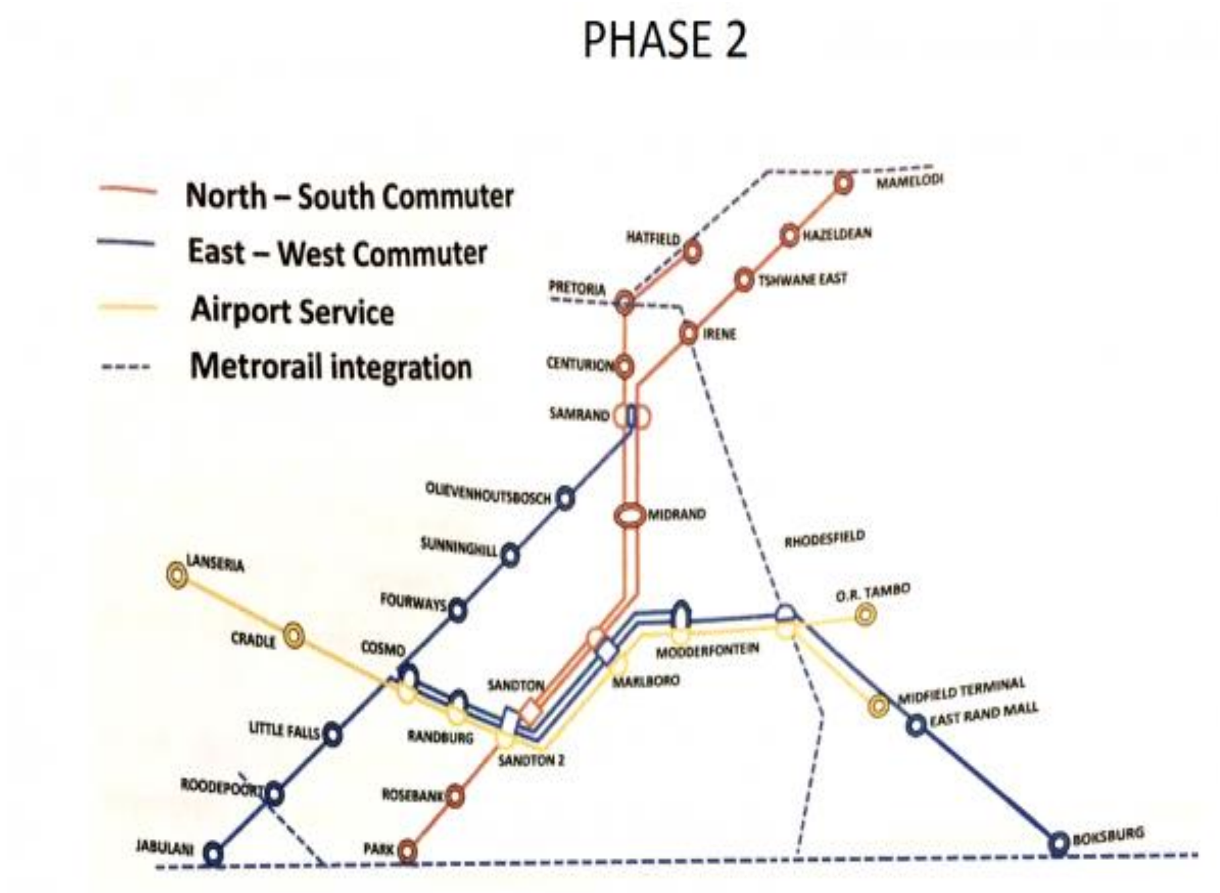


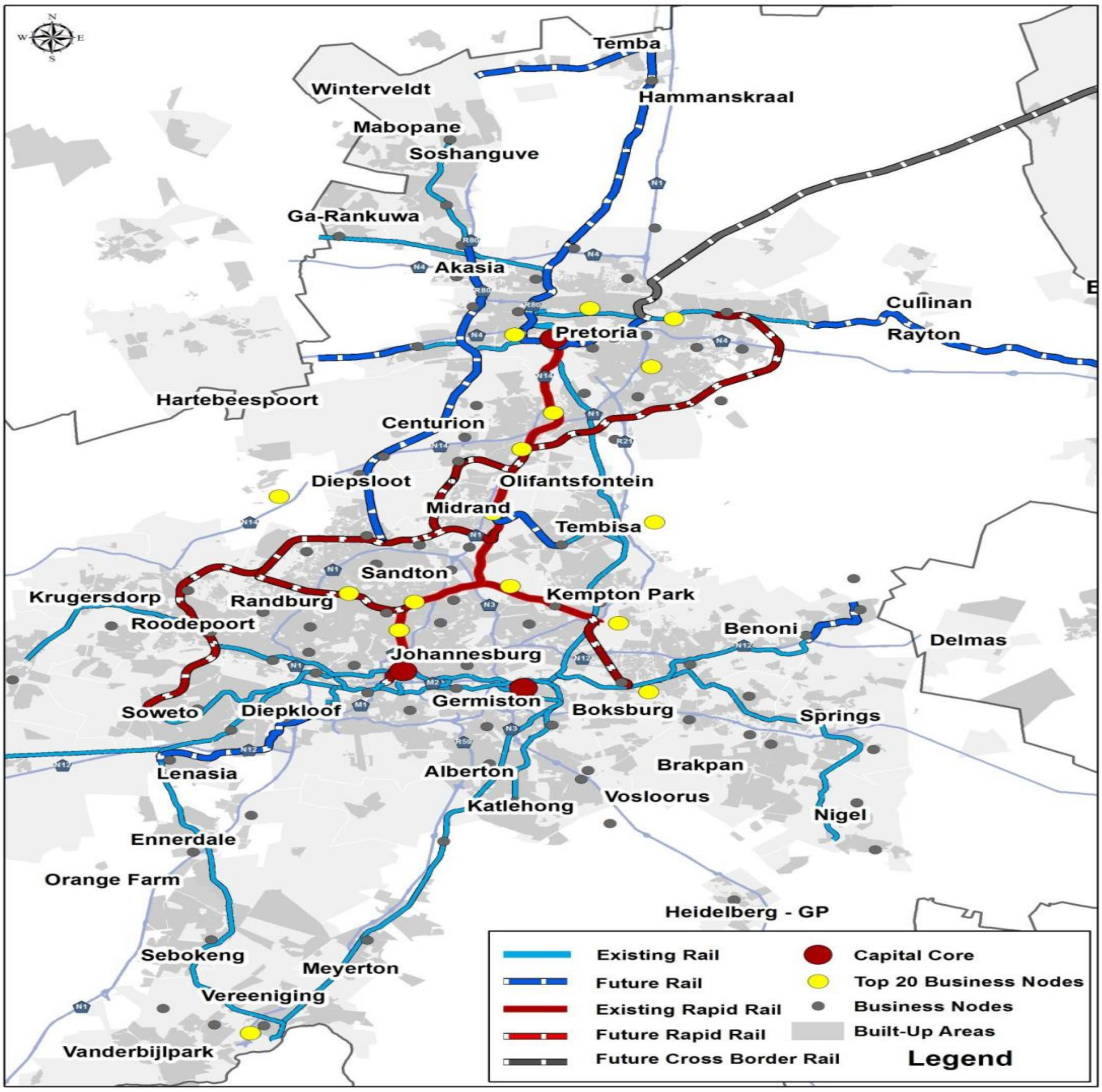
Figure 6.9b: Proposed Gautrain extension (Phase 2)

Source: BusinessTech (2017b)

In addition, the provincial government, through the 25 Year Integrated Transport Master Plan (ITMP25) is working to strengthen the Gauteng global city-region by promoting rail transport as the backbone of an extensive, integrated public transport system (Map 6.9). The Gautrain and its future expansions will provide the catalyst for the 25-year plan that will ensure equality and environmental preservation. Access to formal work destinations, which are concentrated in the core – Johannesburg CBD (mostly retail/office), ORTIA Aerotropolis (mostly industrial/commercial) and other economic nodes to the north of Johannesburg (Midrand, Sandton, Lanseria, Centurion and Tshwane), will be greatly enhanced. Against this background, it appears that the non-integration of the Gautrain and Rea Vaya BRT has profoundly limited the progress that could be achieved in this regard.

However, Johannesburg's SDF promotes the integration of Gauteng ITMP25 and metropolitan Strategic ITP by strengthening the connectivity between the three provincial cores (Johannesburg, Tshwane and Ekurhuleni), as well as facilitating nodal growth of top 20 business nodes and other smaller business nodes (such as Soweto, Westonaria, Vereeniging, Nigel and

Benoni). In this regard, it can be deduced that nodal development in Gauteng will be largely based on public transportation.



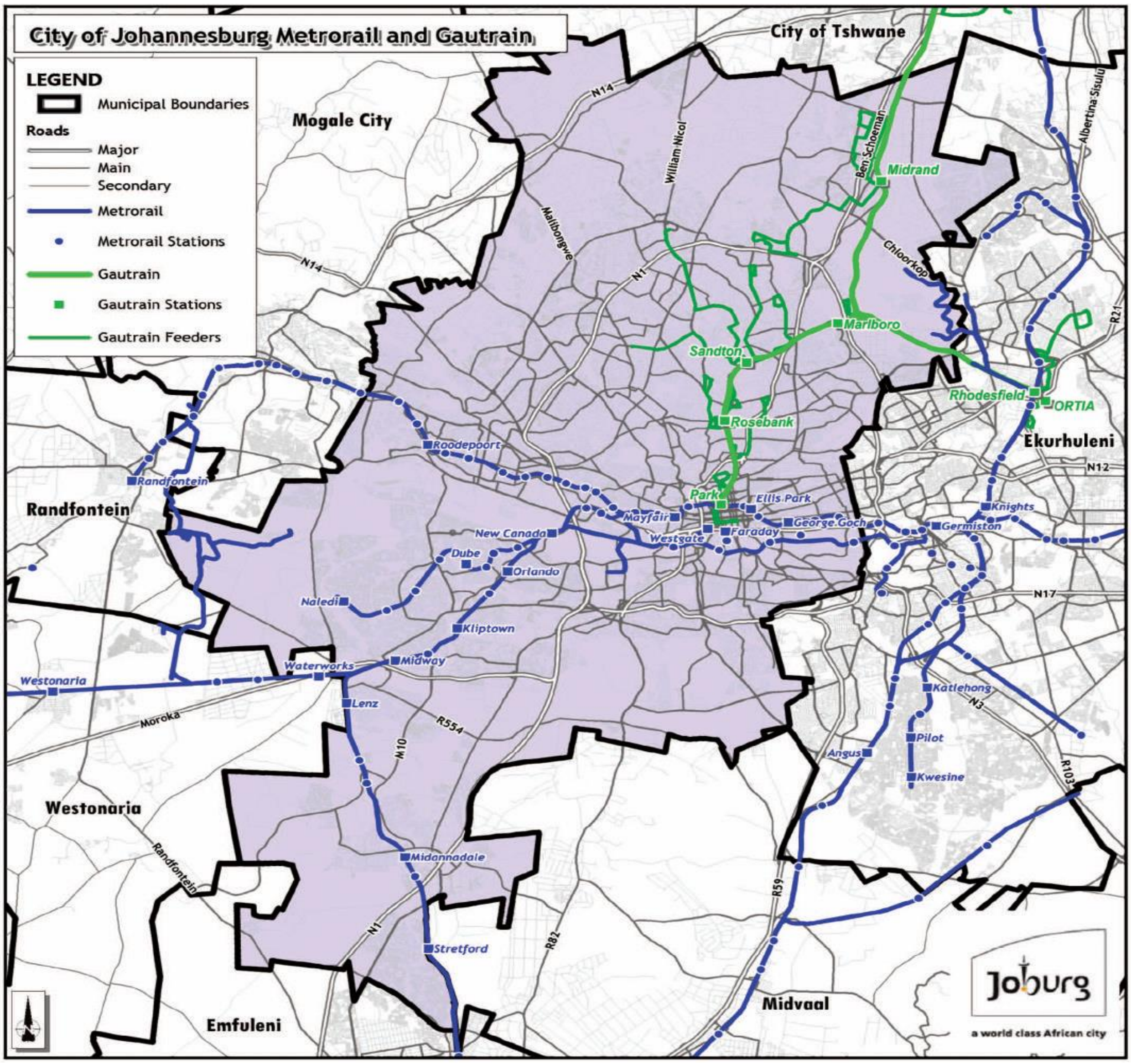
Map 6.9: ITMP25 proposed rail based public transport network

Source: Gauteng ITMP25:51

6.6.5 The Metro rail

Johannesburg's commuter rail operator, the Metrorail, owned and operated by the Passenger Rail Agency of South Africa (PRASA) chiefly connects Soweto, Randfontein and Vereeniging with the city center; links the city center to Ekurhuleni (Springs and Daveyton), and Tshwane (Pretoria) via Kempton Park, including the Pretoria CBD. The system was developed in the 19th century to transport people and goods, with further expansions occurring in the 1940s with the development of Soweto (Prim, 2016:54). The old-fashioned network is east-west aligned and concentrated in the south and south-west of the city. It has 55 stations, with the busiest being Johannesburg Park Station, New Canada, Lanlaagte, George Goch and Stretford. The Metrorail network, along with the Gautrain routes is shown in Map 6.10.

However, due to decades of neglect and under-investment, its effectiveness has been grossly compromised. The lack of investment has resulted in the failure of the system to provide access to the rich economic opportunities or residential areas in the north and north-western region of the city. It is also plagued with challenges like obsolete rolling stock and insecurity at stations and on board. But PRASA is currently undertaking a recapitalization process that will see the rolling stock and some of the existing railway stations being upgraded (CoJ 2014:7).



Map 6.10: City of Johannesburg Metrorail and Gautrain network

Source: CoJ (2013: 8)

6.6.6. Other Modes

There are also metered taxis mostly formally owned or sometimes operated by individuals whose roof lights indicate “taxi” rather than a company name. About 44% of metered taxis are individually owned (CoJ, 2013: 14). While some provide good service standards and value for money, others operate below expected service standards and not only dent the image of the City’s transport industry but also imperil its tourism potentials. It is mandatory for metered taxi vehicles to be equipped with a sealed meter in good working condition, to measure the cost of each trip. Metered taxi associations and members are required to register with the Gauteng Provincial Transport Registrar. The Registrar may regulate their fares, prescribe a grading system for their services and prescribe tests for drivers. They are also required to have an operating license.

Tuk Tuks are 3-wheelers whose operations are licensed by the Gauteng Operating Licensing Board (GOLB). Though the city’s former Integrated Transport Plan (ITP) did not support them, they have become both a source of novelty and concern. They are mostly used for last-mile trips as recently seen in East and West Africa.

6.7. The city’s natural environment and impact of transportation

The city’s natural environment provides many vital and valuable (socially and financially) environmental services, including air quality and storm water regulation. With a remarkable urban forest underpinned by an extensive wetland system, Johannesburg’s open spaces and natural assets are equally essential in its overall functioning as a city. Incidentally, just over a third of the city is in a natural or near-natural state (36%), with urban development (48%), agriculture (11%), and mining (5%) altogether covering the remaining 64% (CoJ, 2014:30). In a 2013 report by the GCRO, the value of these environmental services was given between R38.6 million to R77 million per annum. Their current value was also estimated to be between R966 million and R1.6 billion.

However, the city’s ecosystems are not adequately protected, with only 36% and 0.6% of the Municipality left as natural state and reserves respectively. In addition, the location of the country’s mining activity, heavy, industry, commercial enterprise and urban population in Johannesburg place a high pressure on the environment.

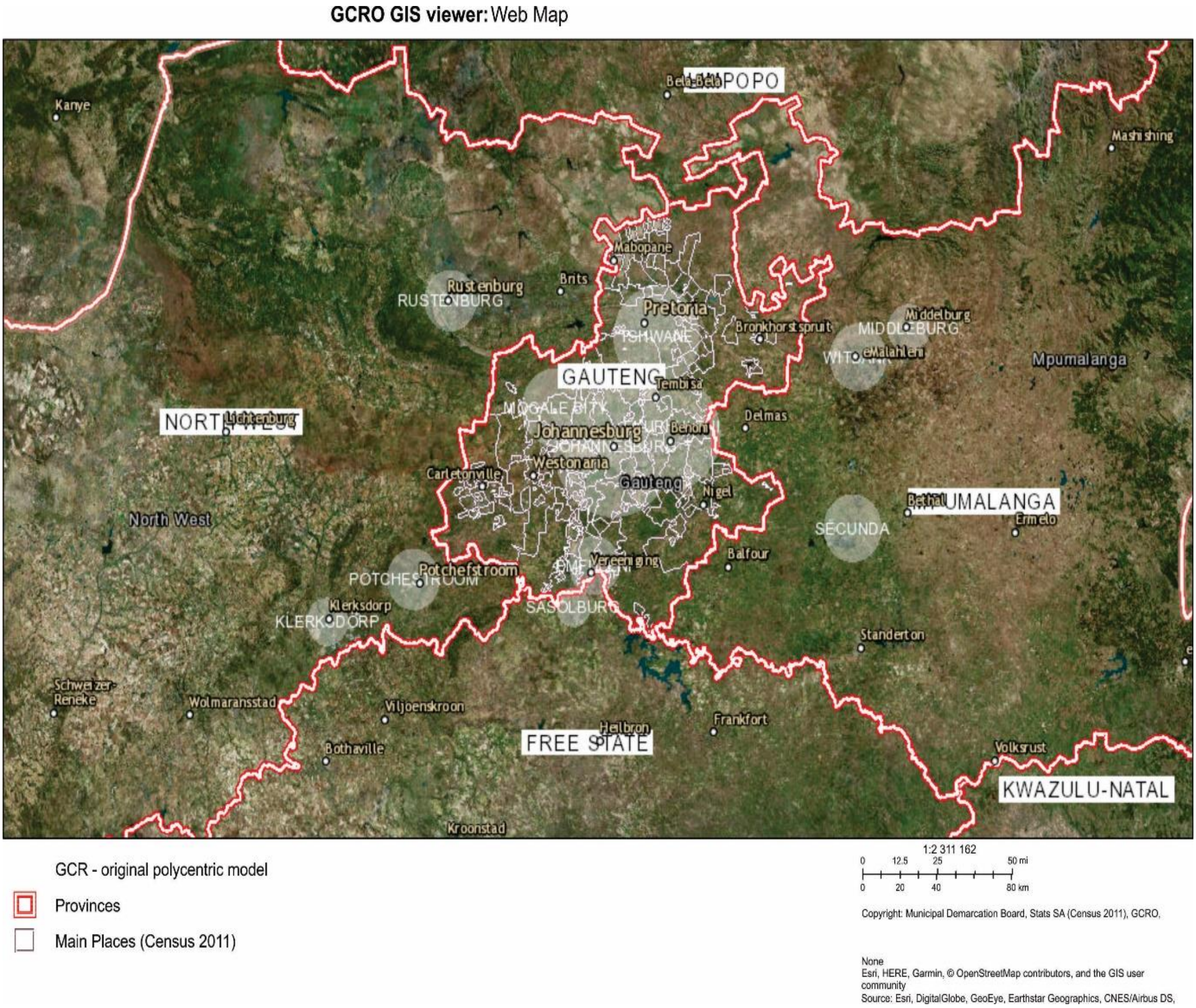
Furthermore, passenger transportation – with 9.3 GJ (gigajoule) per capital annually – has been a major contributor to the city’s carbon emission with significant implications for air quality, climate change and the natural environment (CoJ, 2016: 40). The high automobile dependency on small and inefficient vehicles in Gauteng has negative implications, in terms of carbon footprint, congestion and accidents. For example, the significant contribution by passenger cars to the CO and NOx emissions in Gauteng in 2015 was highlighted in the provincial government's review of the 2009 Gauteng Air Quality Management Plan (Chakwizira et al., 2018:91-92). When compared with some European (Paris, London, Berlin) or Asian (Hong Kong, Tokyo, Seoul) cities, Johannesburg's transportation energy intensity is much higher (CoJ, 2016:40). Mining and the city's coal-intensive industries have also exacerbated this situation.

In the context of the Gauteng city-region, the landscape reflects outcomes of historical mining development and infrastructure decisions taken for short-term gains, without an understanding of long-term consequence (McCarthy, 2010; Bobbins, 2015). There are indicators of degradation and risk, including mine-dumps and surrounding tracts of land that remain toxic after years of chemical exposure, and increasing water contamination – exacerbated by acid mine drainage overflowing from closed mines (McCarthy, 2010:50-51; Gauteng 2055:46).

6.8. Johannesburg in the context of the Gauteng City-Region

The Gauteng City-Region (GCR) is the economic hub of the manufacturing, tertiary and quaternary sectors of South Africa. "The concept of the GCR is that of an integrated functional economic region that transcends administrative boundaries and recognizes that Gauteng province lies at the hub of South Africa's globally connected economy" (Gauteng, 2014b: 9). Gauteng is dominated by its most recognizable cities of Johannesburg and Tshwane (Pretoria), but there are also a number of other significant urban centers. Most of these are inside the provincial boundary, but others are outside the administrative space of the Gauteng province.

According to the Gauteng City Region Observatory (GCRO) in its state of the GCR, 2011 report, "the GCR is not 'real' in that it does not have official borders, or officials, or a budget…but it is real when looked at socially, economically, environmentally and through other lenses". These other areas are connected to Gauteng through flows of people, goods, resources, information, services and infrastructure, which define the area as a functionally integrated polycentric city-region (Mubiwa & Annegarn, 2013:5). The GCR's polycentric nature is illustrated in Map 6.11.



Map 6.11: The polycentric nature of the wider Gauteng City-Region showing its main places

Source: GCRO GIS viewer (2018)

This extended GCR has a population of about 13 million people within 175 kilometers of central Johannesburg, with an economic footprint that extends beyond the borders of Gauteng into four other provinces – North-West, Limpopo, Mpumanlanga and Free State. Rustenburg, a global center of platinum mining is to the north-west; Potchefstroom and Klerksdorp, historically anchored – but now stagnated – on gold mining are to the south-west; Sasolburg, centered on the production of oil from coal is just across the Gauteng border to the south; and Witbank, Middleburg and Secunda, anchored on coal mining, iron and steel production and energy generation respectively are to the east. Most of the energy generated is exported to and used by Gauteng (Wray, 2010:39).

6.8.1. Spatial development and its constraints in the GCR

In spatial terms, the GCR brings together cities, towns and urban nodes that are linked together, although some of them are located in neighboring provinces. However, by drawing on the argument by Peberdy et al. (2017:24), that the core-periphery debate has deliberately excluded middle and low income countries, or that much less attention has been given to this relationship at national or regional scales; deductions will be made on the core-periphery interface from the GCR perspective. According to Peberdy et al. (2017:25, 194-195), because growth and development occur unevenly across the core and periphery, as a result of the roles played by the state, history and time; understanding the implications for the Gauteng city-region may lead to a reduction of existing spatial differences and inequalities.

It can be concluded that the core of the GCR comprises the three metropolitan municipalities of Johannesburg, Tshwane and Ekurhuleni (Mubiwa & Annegarn, 2013:6; Peberdy et al., 2017). However, it is argued that the core-periphery landscape of the GCR is unconventional because it is informed by apartheid urban geographies that purposely created racialized spaces with high-density settlements on the edges of cities (Pederby et al., 2017:25); while the low-density white suburbs at the core (Harrison & Todes, 2015:151) serve as the places of employment and work opportunities for residents of the peripheral settlements. For example, areas such as Soweto, Lenasia (Johannesburg) and Bophuthatswana (north of Pretoria) were either created or expanded to accommodate non-white residents (Mubiwa & Annegarn, 2013:12).

It thus implies that contemporary core-periphery outcomes in the GCR are informed by historical spatial development inputs that promoted segregation (Mubiwa & Annegarn, 2013:13), as well as post-apartheid housing development practice by the state that has increasingly reinforced sprawling by locating RDP houses at the peripheries (Angel et al., 2011:41; CoJ, 2016:57).

Based on the foregoing, post-apartheid (since 1994) spatial planning shifted to a more normative and strategic approach that promotes compact and integrated towns and cities. According to Harrison and Todes, 2015:152 the new approach would increase accessibility to urban opportunities for those previously excluded, through the promotion of higher-density nodes and public transport oriented corridors. With the introduction of the National Spatial Development Perspective (NSDP 2007) and its subsequent alignment with statutory spatial development frameworks (SDFs) at the provincial and municipal (linked to the municipal Integrated Development Plans) scales, municipalities were capacitated to direct future spatial development (Harrison & Todes, 2015:152; Peberdy et al., 2017:25).

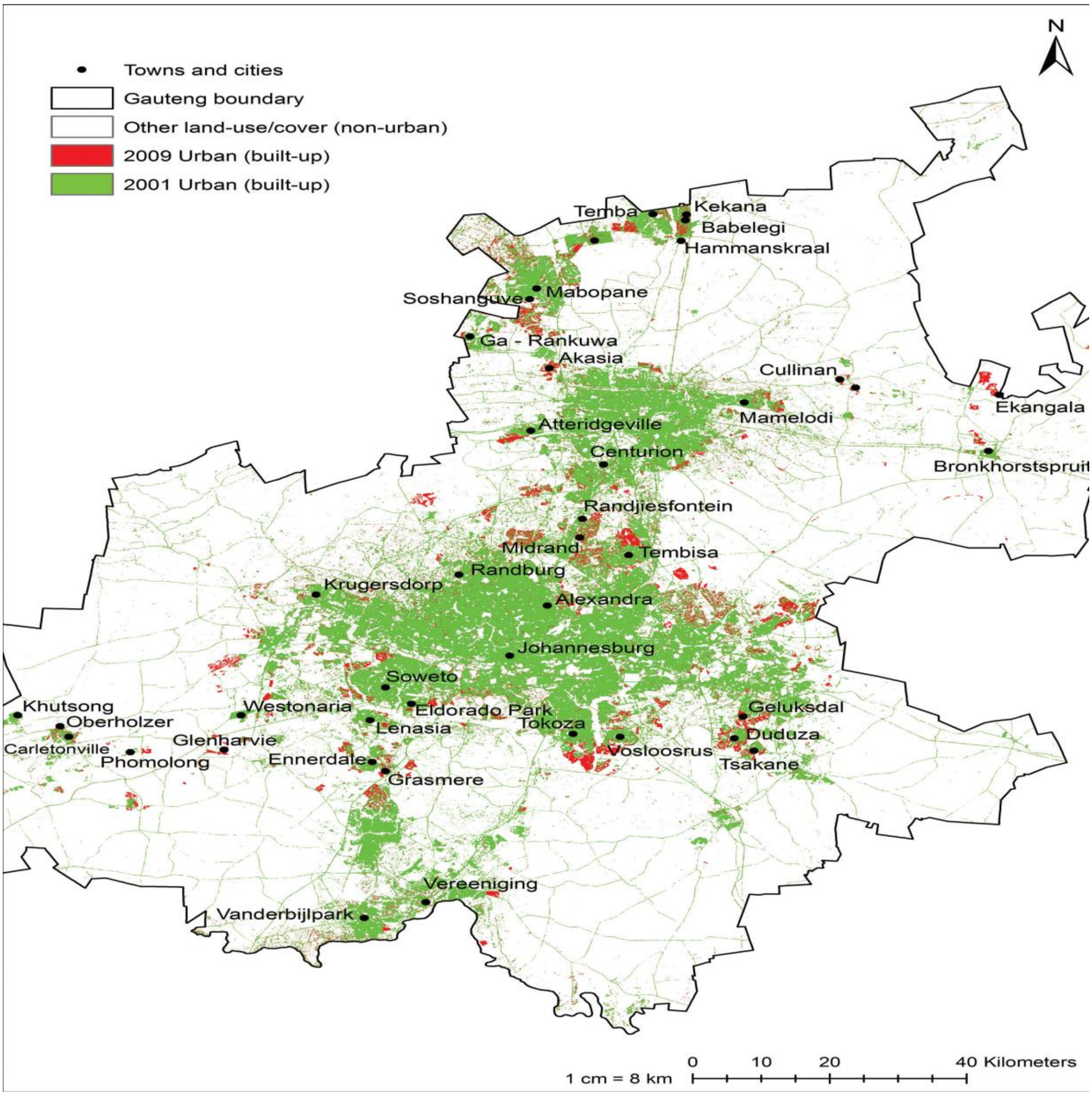
It can be deduced that the shift to public transport oriented corridor development underscores the significance of transportation in the core-periphery relationship. Although the relationship appears to be complex and sometimes contradictory (Peberdy et al., 2017:159), it is reinforced by historical spatial and urban planning deductions that corridor development is associated with the actual occurrence or focus of development initiatives along a route comprising bundles of infrastructure – most significantly a transport route (Priemus & Zonneveld, 2003:1-2; Warnich & Verster, 2005:344). From the GCR perspective, therefore, rapid movement in post-apartheid transport planning nexus that is informed by corridor development is largely responsible for major spatial change (Mabin, 2013:47-50). The transport planning is premised on road and rail network, with the rail networks focused on getting resources, workers and other supplies into the core, as well as distributing manufactured goods produced in the core around Gauteng and further afield (Peberdy et al., 2017:161).

In this regard, by doing a qualitative analysis of post-apartheid urban development between 2001 and 2009, Mubiwa and Annegarn (2013:27-28) highlighted strong ribbon development along transport corridors, with rapid expansions identified in nodes (Midrand, Rooihuiskraal, Irene and Centurion) on the Johannesburg-Pretoria freeway. According to them (Mubiwa & Annegarn, 2013), the most significant development during this decade was in the north-west of Pretoria (Brits-Garankuwa-Soshanguve-Mabopane area), with sprawl oriented north-westward expansion of Randburg and Diepsloot on the outskirts of Johannesburg (Map 6.12).

The land use orientation of the urban developments was a combination of residential (informal settlements, RDP housing, gated communities), industrial, office and associated shopping complexes (Landman, 2008; Chipkin, 2013:229, 245; Mubiwa & Annegarn, 2013:36; Harrison & Todes, 2015:157). Nevertheless, it can be deduced from the map that these developments appear to reinforce existing core-periphery interactions in the Gauteng province. This deduction is based on the argument that conceptions of core and periphery are relational and related to scale (Barton et al., 2008:28, 31; Caldeira, 2009:849-852). Therefore, areas defined as the peripheral may be core when considered relative to areas around them, the same way peripheral areas may exist within core areas, such as Soweto in Johannesburg and Soshanguve in Tshwane.

With regards to the spatial and movement impact, the deduction from the development patterns in Map 6.12 further underpins the conclusion that developments induced by freeways are sprawl-oriented, because freeways facilitate dispersion and consequent increase in the use of private cars. However, the period (2001-2009) from Mubiwa and Annegarn's (2013) analysis was before the implementation of the Rea Vaya and Gautrain, and in spite of the sprawling nature of developments, it can be argued that they were largely regionalized. This argument is reinforced by the fact that public housing programmes in Gauteng as at 2008 were dispersed and located far from major economic centers (Walters, 2018:6).

From the study by Walters (2018), developments appear to be regional, but their sprawling nature is reflected in the average distance to the nearest economic center; with those closest to Pretoria having a mean trip length of up to 25.7kilometers. This is in contrast to the spatial development impacts of the Gautrain, which has occurred significantly in the Sandton and Rosebank nodes – though they are largely localized (Gotz et al., 2014:93-121; SAPOA, 2016:16).



Map 6.12: Gauteng urban development (2001-2009)

Source: Mubiwa and Annegarn (2013:27)

Against the background of the freeway induced, but sprawl-oriented developments identified by Landman (2008); Chipkin (2013); and Mubiwa and Annegarn (2013), and the largely localized commercial-oriented developments around Gautrain's Sandton and Rosebank station (Gotz et al., 2014; SAPOA, 2016); it appears that the Gauteng SDF 2011 may stimulate improved outcomes, although its urban edge and compaction strategies are equally driven by land use-public transport integration based on nodal and corridor development (Chakwizira et al., 2018:88). In as much as the provincial SDF appears to be entrenching existing core-periphery relationships in the GCR, the argument is reinforced by the provisions for social and economic integration of periphery and the core, especially as reflected in local SDFs. For example, the theme of the strategic area frameworks (SAFs) developed for the Rea Vaya BRT corridors is compaction underpinned by mixed-income housing, as well as an affordable and accessible mass transit system premised on bus, passenger rail and NMT.

It can be concluded that post-apartheid spatial interventions up to this point have been focused on similar apartheid era objective of moving workers from the periphery to the core, and attempts at creating improved outcomes in this regard may reflect in shorter trips between home and work. However, according to Gotz and Todes (2014:131), in Johannesburg, it appears that the dislocation between people and jobs is getting worse. In order to mitigate this negative growth, Harrison & Todes (2015:154) promote the creation of municipal policies that consolidate existing orientation towards provisions for formal employment with informal economic activity and street trading. According to Wills (2009), informal economic activities are increasingly becoming a significant means of livelihood for the urban poor, especially in post-colonies, including South Africa. It appears that informal economic activities develop along points of disembarkation, on routes where stopping and loading occurs.

However, it can be argued that one of the factors essential for creating outcomes such as that contained in the corridor development frameworks of the Rea Vaya is for the GCR concept to be embedded within co-ordinated planning process across metropolitan areas, for example, in relation to transport and environmental management (Gauteng 2055:54). Such alignment of intergovernmental and institutional agenda across the GCR may limit current political and institutional haphazardness such as extreme vertical integration and extreme horizontal fragmentations (Harber & Joseph, 2018:21).

The essence of this argument is reflected in the existing haphazard outcomes, such as actions of developers and differing municipal orientations that: promote sprawling, and endanger the natural environment and already stretched infrastructure networks through approvals of plans for low-density housing developments. Other challenges relate to inadequate investment and funding framework, which translates to long turn-around periods for transformative and catalytic projects. In addition, the implementation of mass transit in the city-region is hampered by low population densities (Chakwizira et al., 2018:89). It can be deduced that a re-orientation towards compact growth and improved access to land for development purpose may induce higher densities, a factor that significantly influence mass transit outcomes.

It thus implies that state efforts alone may be insufficient to transform the core-periphery relationships in the GCR. Inclusive and sustainable housing arrangements, for example, should be driven by policy mechanisms that incorporate public sector and financial institutions (OECD, 2011). In the same vein, while empirical evidence by Clark (2012) pointed out three essential factors for improved outcomes in a global city-region such as Hong-Kong: densification and accessibility to affordable housing options, supported by an integrated infrastructure network driven by sound transportation, and elimination of crime and corruption; other approaches, such as a faster transition to an umbrella (provincial) transport authority to complement current initiatives and good intentions of the state (Chakwizira et al., 2018; van der Merwe, 2018:30-41; Walters, 2018:11) may equally promote improved outcomes.

While the views of Chakwizira et al. (2018) and van der Merwe. (2018) may inform the recommendations of this study, with significant relevance to the study area; it is argued that outcomes may be undermined by non-integration of transport planning and design decisions with spatial planning. Based on this reflection, it can be argued that the creation of the Transport Authority (TA), as highlighted by van der Merwe (2018) should incorporate all spatial planning and environmental management interests and concerns across the regional landscape. In practice, the complexities involved in such alignments may seem diverse, but in line with the proposition in Gauteng (2055:54), the basis for limiting current reactive approaches is to embed the GCR concept within planning processes across all jurisdictions.

6.8.2. Transportation and governance in the GCR

The GCR is highly automobile oriented, with passenger cars taking 73% of the vehicles registered in Gauteng province in 2015 (Chakwizira et al, 2018:90). There have been radical changes in the transportation landscape since 1994, with particular focus on public transport (Mabin, 2013:47), but the spatial form of the city-region has increasingly impacted on transport costs; because homes are often located far from places of work, while inefficiencies in public transport modes continue to promote private car oriented modal splits (Gauteng 2055:49; Chakwizira et al., 2018:94). In the same vein, it appears that the absence of an integrated metropolitan system that recognizes the polycentric spatial form of the GCR has significantly limited transport affordability and accessibility, as well as developments associated with nodal and corridor development – agglomeration economies, intra-regional trade and inter-firm linkages.

It can be argued that the access and affordability offered by transportation facilities are essential for the development of a city-region (Gotz et al., 2014:1). Although the BRT and Gautrain have been provided as a panacea to the challenge of accessibility and automobile dominance (most significantly), the minibus taxi remains the dominant public transport mode because of its ease of access (as depicted in Figure 6.10). This implies that the minibus taxi may be more affordable and certainly more accessible relative to the Rea Vaya BRT and Gautrain. Transportation affordability refers to the ability to make necessary journeys to work, school, health and other social services, as well as visits to family members or other urgent journeys; without having to curtail other essential activities (Carruthers et al., 2005:1-2). According to Litman, increased transport affordability can be stimulated by cost savings from transport costs, although only cost savings for lower income classes may be regarded as a real increase (Litman, 2013:5).

In line with these arguments on affordability in the transport sector, Serebrisky et al (2009:719) associate the percentage of monthly income or expenditure devoted to transport by poor families, measured against a standard benchmark considered affordable for families. From the various reflections, it can be argued that transport affordability is contingent on trip prices, and that preference is given to the ability of the low-income class to pay these prices, without sacrificing alternative needs. Therefore, it can be deduced that in addition to the relative accessibility of the minibus taxi, its dominance may equally be reinforced by cost savings to the users.

In the same vein, the Gauteng e-tolling system, inspired by the Gauteng improvement freeway programme, was implemented in 2013, to manage road space in Gauteng. However, it has been increasingly resisted by road users (with a default rate of approximately 78%) and other stakeholders (Peberdy et al., 2017:185; Chakwizira et al., 2018:45). The arguments have revolved around inappropriate economic funding model and inadequate consultation and participation during the planning and design stage.

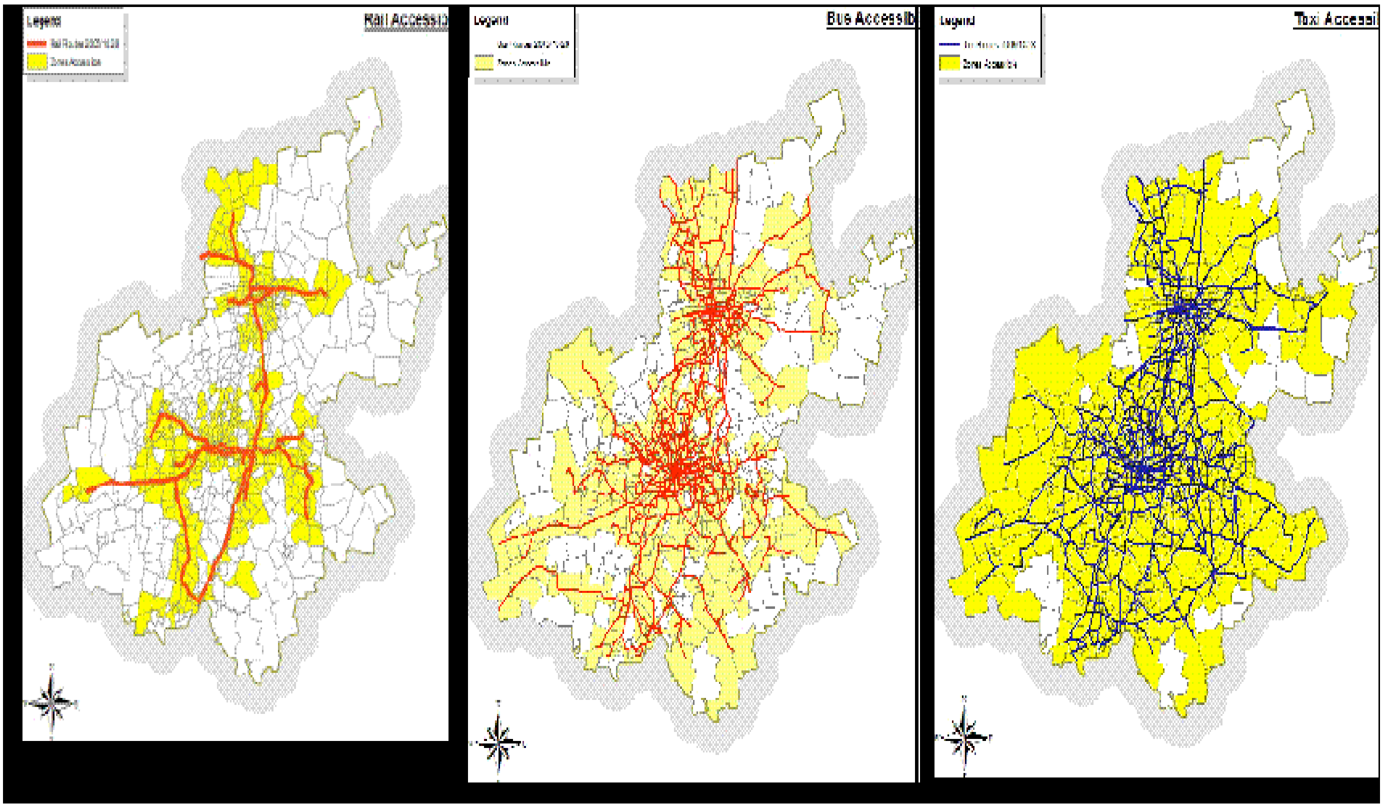


Figure 6.10: Transport access across Gauteng

Source: Gauteng 2055:50

However, it can be deduced that the fragmented nature of governance, institutions, policies, budgets and interests guiding sectoral investments and interventions (Gauteng 2055; Chakwizira et al., 2018:97), as well as non-integration of transportation and land use planning (Mabin, 2013:52) is largely responsible for the transport outcomes in the GCR. For example, the limited extent of horizontal collaboration within municipalities has impeded the effectiveness of climate change mitigation and adaptation efforts because many of the economic interchanges, flows of energy and material, as well as transport and carbon-relevant functions overlap jurisdictions (OECD, 2011).

In line with this argument, the fractured political and institutional landscape in the GCR is reflected in a profound lack of alignment and coordination among the respective municipalities, essentially in the development and implementation of their spatial development frameworks. These ambiguities are also seen in their collective handshake with the Gauteng Spatial Development Framework. Spatial development principles like compaction, densification, mixed-use and land-use transport integration are often variedly interpreted and applied (Gauteng, 2014b: 72). Though the SPLUMA 2013 makes provision for the provincial framework to coordinate, integrate and align those of its own departments and the municipalities (Gauteng, 2014b: 72). These inconsistencies are represented in Figure 6.11, showing a composition of the current municipal and/or district spatial development frameworks in Gauteng.

Likewise, the entrenchment of past approaches such as higher investments on roads and rails connecting the municipalities rather than enhancing mobility and accessibility within the municipalities, will continue to generate outcomes similar to historic 'peripheralisation' and segregation (Cronin, 2012). According to Lionjaga (2015:900), the integration of spatial and transportation planning may provide an impetus for improved outcomes. For example, the implementation of an urban form that is densified and intensified, underpinned by a viable and efficient public transport system which makes provisions for non-motorized transport such as walking and cycling can facilitate the regional integration of transportation and spatial planning.

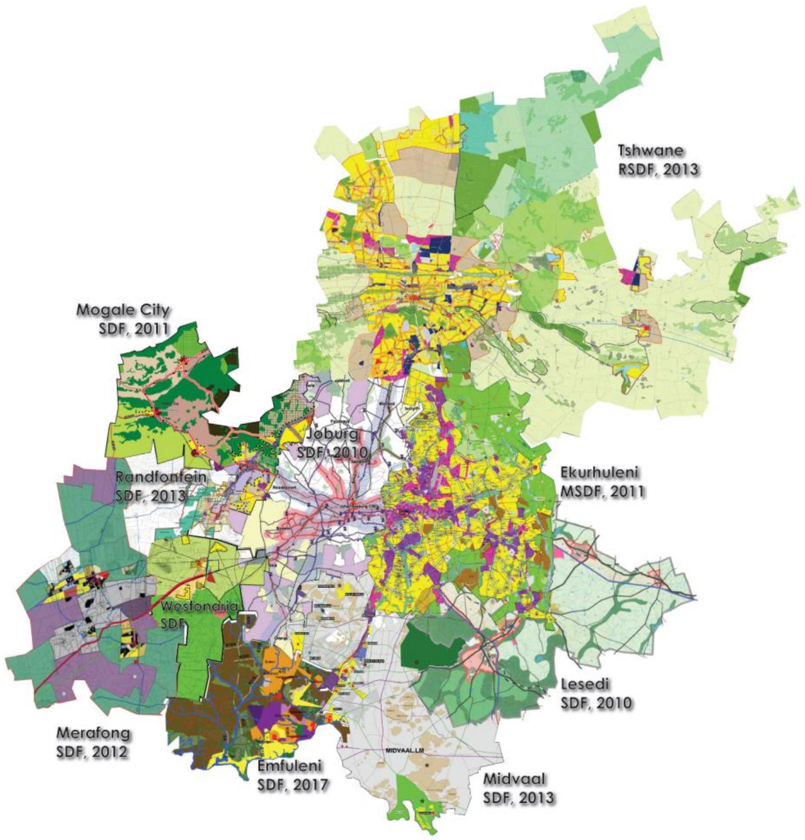
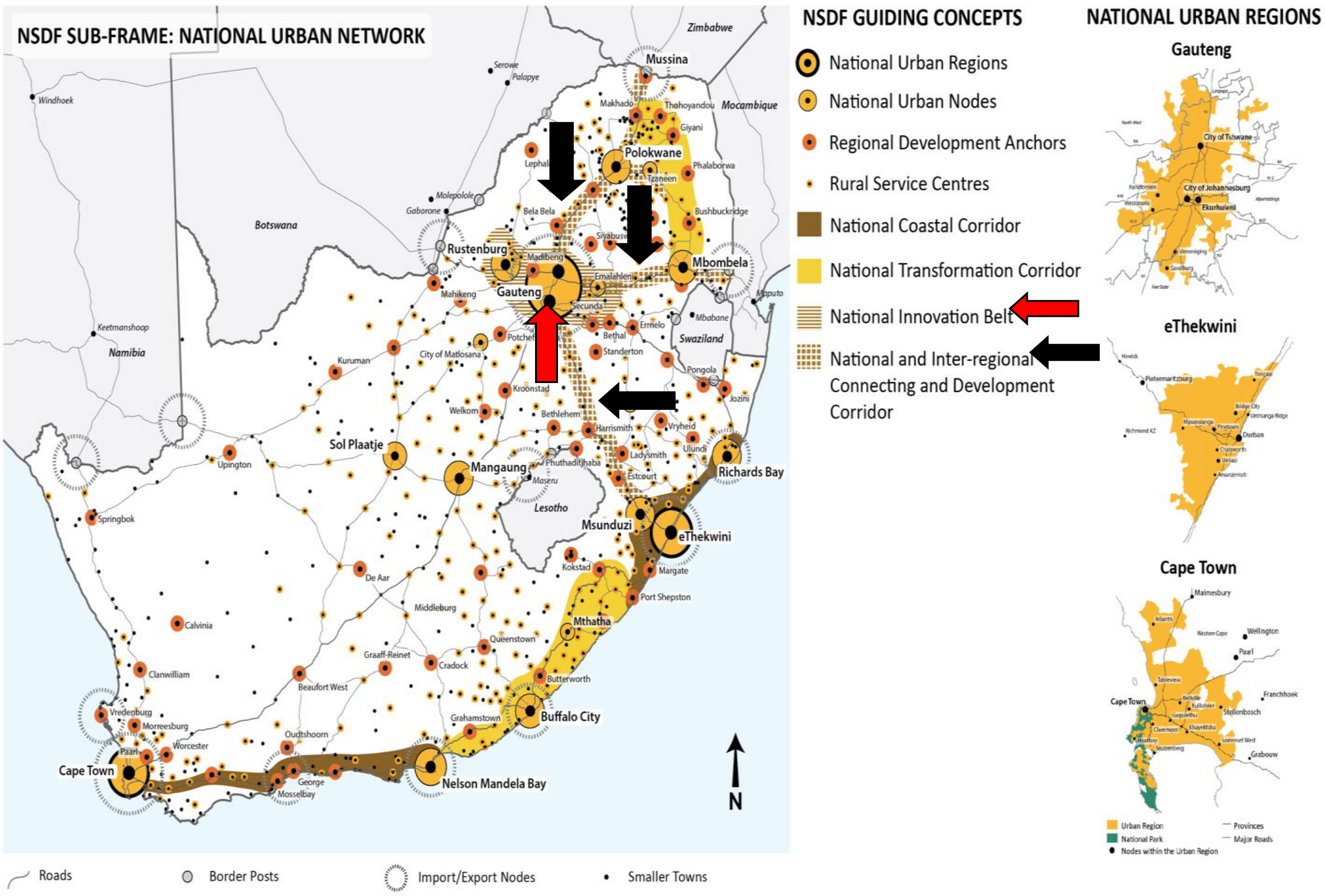


Figure 6.11: Composite Municipal SDFs in Gauteng
Source: Gauteng (2014b:73)

Although, earlier conceptualizations of the GCR were largely based on corridor development, such as the provision of the Gautrain to facilitate the growth of Pretoria-Johannesburg corridor (Mabin, 2013:48-50); it can be deduced that alterations in political, social and economic situations have profoundly impacted on spatial and transport planning trajectories. In spite of the weak outcomes, it is argued that the Gauteng City-Region can be entrenched by reinforcing the polycentric nature of the city-region, through corridor development, premised on consolidated nodal growth induced by transit oriented development. This is in line with the recognition of urban areas and regions as drivers of transformation and inclusive economic growth by the NSDF 2018. The framework holds that city-regions could promote transformation and inclusive economic growth through a high level of inter-connectivity between them that creates a national urban settlement network (NSDF Draft 2018:91).

The entrenchment of city-regions forms one of the guiding concepts of the NSDF Draft 2018, with the Gauteng city-region serving as the national hub of innovation, while three national urban nodes: Mbombela, Polokwane and Msunduzi are linked to the Gauteng urban region as corridors of national and inter-regional development (as illustrated in Map 6.13). This further underlines the significance of the study area, and the need for cooperative governance across jurisdictions in the Gauteng national urban region.



Map 6.13: National Urban Network Sub-Frame

Source: NSDF Draft 2018:111

In order to limit conflict of agendas in the GCR, as established in the argument above, Harber and Joseph (2018:22) identified four essential goals that should be simultaneously promoted (illustrated in Figure 6.12).

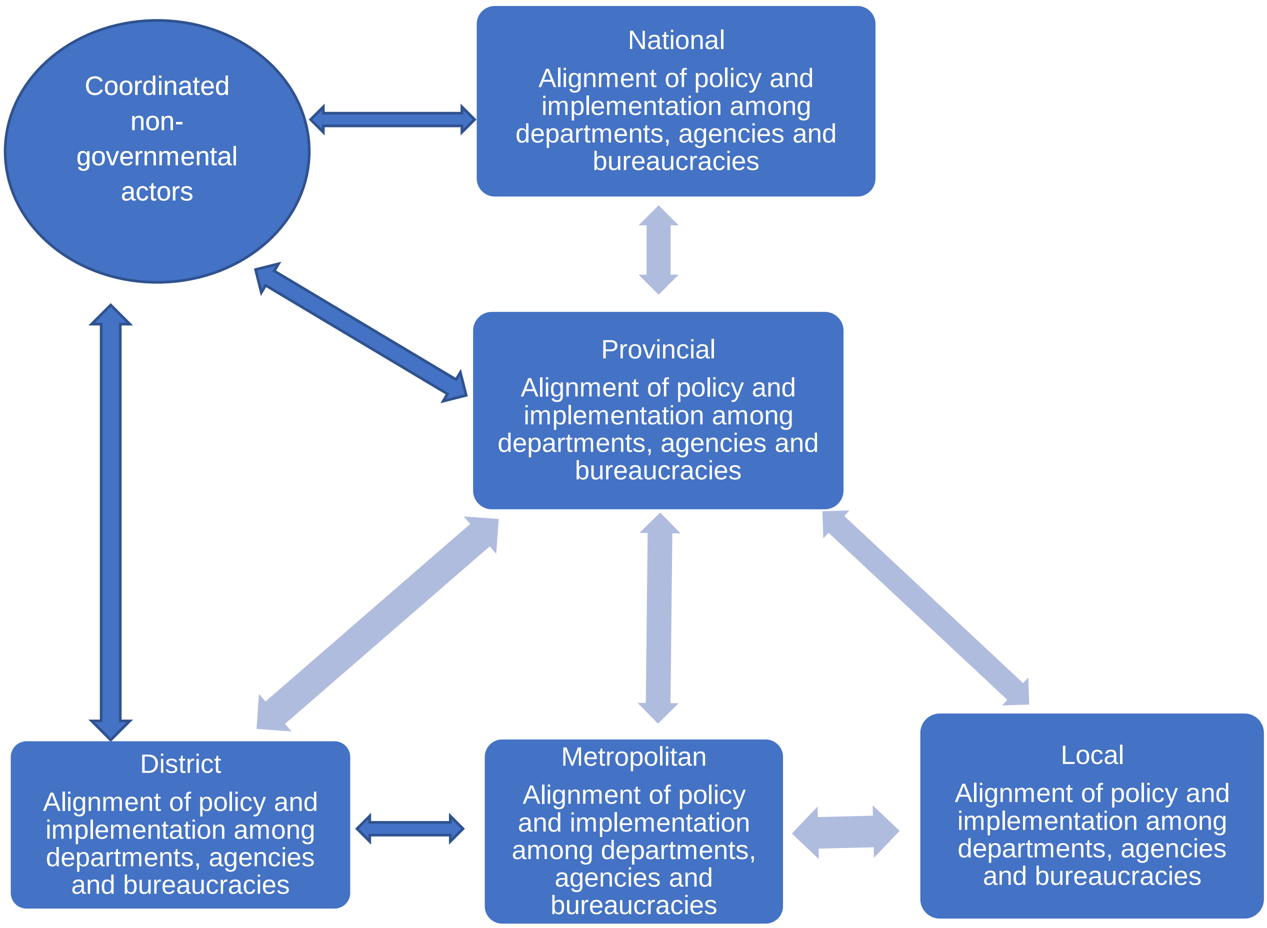


Figure 6.12: Promotion of vertical and horizontal integration in governance landscape

Source: Own construction (2018) as adapted from Harber and Joseph (2018:22-23)

It can be deduced from Figure 6.12 that: (i) horizontal integration across municipalities; as well as (ii) departments and bureaucracies; is as important as (iii) vertical alignment of policy and implementation among the three spheres of government (national, provincial and local). However, it is imperative to accommodate the constitutional provision for relative independent decision-making power of each sphere. In the same vein, (iv) non-governmental actors such as residents, professionals and the private sector (developers, financial institutions) may impact outcomes in much the same scale as the public sector.

In line with the above argument for cooperative governance in the GCR, the NSDF Draft (2018:123) highlights the following, as crucial actions that must be taken to reinforce the strategic investments in national and urban growth regions:

- The promotion of the IUDF and DHS Master Plan in rapidly urbanized urban areas, with a focus on financially viable human settlement development and regional-scale collaboration that incorporates the private sector, civil society and the city government.
- Enhancement of coordination between the planning, implementation and maintenance of long term infrastructure such as national water storage, road and rail network.
- Provision of dedicated support from the national and provincial departments responsible for municipal and spatial planning, for capacity building in the generation of energy, construction and creation of transport infrastructure at the local level.
- Provision of support to municipalities to facilitate catalytic development, spatial transformation, and inclusive growth, through urban land reform and the timeous release of suitable land in the right places.

6.9. Conclusion

Since its establishment as a gold mining settlement in 1886, the City of Johannesburg has gone through decades of economic, spatial and environmental transformation to become an economic hub with influence at a regional and global scale. The most influential phase of its history is the apartheid years, which shaped its historical and existing spatial and transport landscapes. The chapter provided insights in this regard, by reinforcing arguments such as the use of rail transport as the earliest mode of public transport that linked the peripheries to the core. Subsequently, the entrenchment of apartheid policies informed the growth in road infrastructure, associated with declining investments in rail transport because it was believed to be more capital intensive.

It was argued that the sprawled nature of the city was induced by apartheid spatial policies that created high-density peripheries for non-white residents, while it was reinforced by the increasing investments in road infrastructure. Meanwhile, policy changes after democratization catalyzed desegregation and polycentricity, with the growth of new economic nodes such as Sandton, but the chapter pointed out that the polycentric nature is inverted. This is largely reflected in a job-housing mismatch informed by a contrast of densities, where jobs are clustered at the core while dispersed residential densities are highest in the periphery.

The transport sector has witnessed remarkable investments from the provincial and metropolitan governments, and this has enhanced the growth of public transport in Johannesburg and the Gauteng City-Region. These investments are evidenced in the Rea Vaya BRT which connects Soweto to Johannesburg CBD; and the Gautrain, established by the provincial government to change residents' travel experience and stimulate economic growth. However, there have been mixed outcomes, significantly regarding daily ridership and modal distribution, and it was established that the minibus taxi grew rapidly to become the dominant mode of public transport in the study area.

Although the Rea Vaya BRT and Gautrain are limited by conventional factors typical of developing country cities, the city's unique urban form together with its passenger travel demand pattern have likewise, largely impacted on the operational output of the Rea Vaya.

However, with recent ambitious TOD driven policy initiative, the city government, as well as the provincial government, are determined to drive compact polycentric development, using the Rea Vaya, PRASA metro rail and the Gautrain as platforms upon which to build a compact city that would optimize land use-transport synergy. In the same vein, the metropolitan SDF and ITP, which are informed by Gauteng SDF and the Gauteng 25-Year ITMP, are premised on public transport oriented nodal growth that further entrenches existing business nodes and promote the emergence of new ones.

Imperatively, it was concluded that all spheres of government within the Gauteng city-region need to eschew the principle of cooperative governance, and a departure from existing fragmentations, while a strong integration of land use and transportation should become embedded into decision-making processes across jurisdictions. The research findings will be discussed in the next chapter.

CHAPTER 7: EMPIRICAL RESEARCH OUTPUTS AND RESULTS

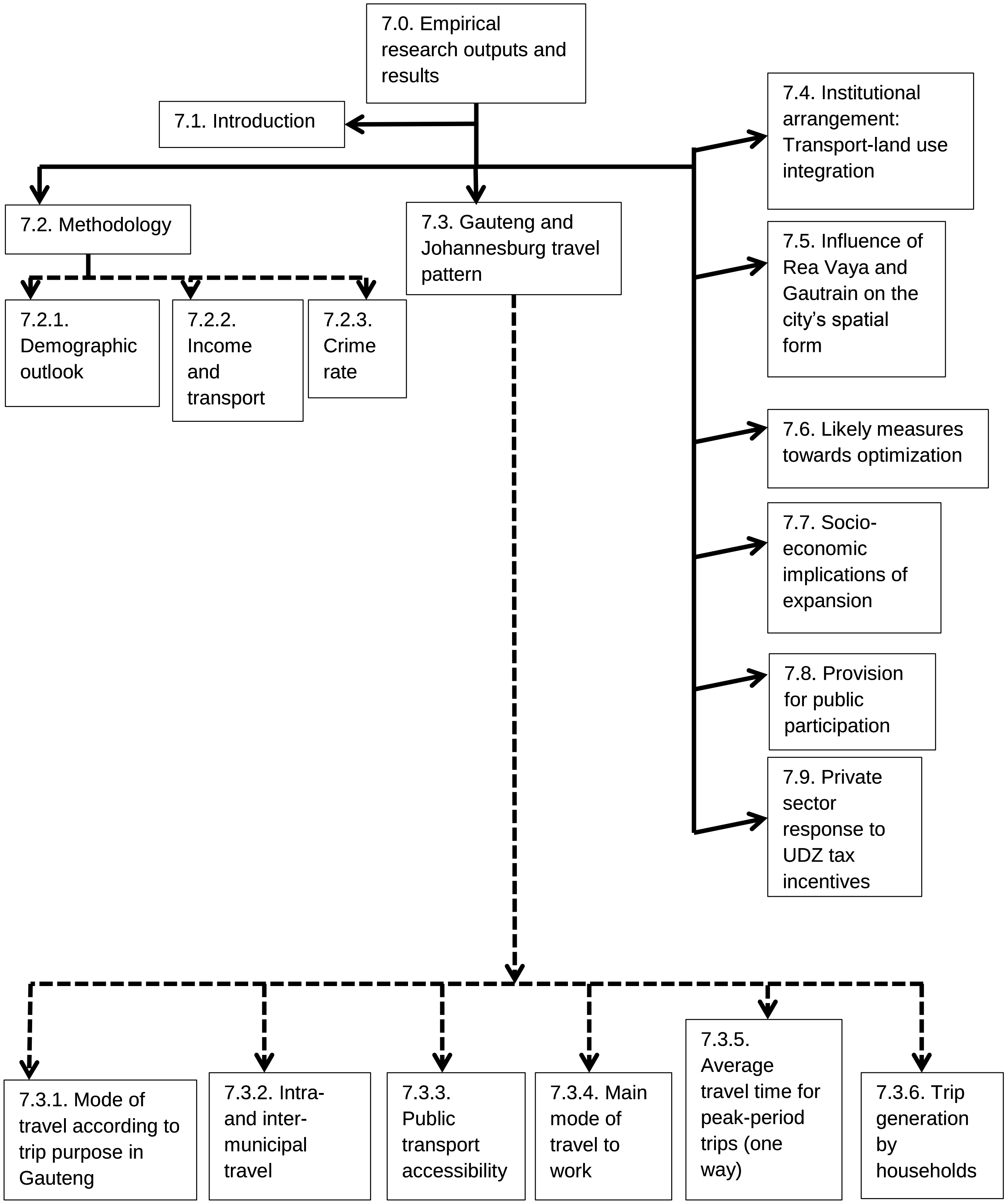


Figure 7.0: Layout and footprint of chapter 7

7.1. Introduction

This chapter transcribes the information obtained from questionnaires and the databases mentioned under research methodology providing insights on the research aim and objectives. Further understanding is also provided from policy documents and surveys that the CoJ is using to define its existing spatial and transport conventions.

7.2. Methodology

By drawing from the provisions of the Gauteng SDF and CoJ SDF, it can be argued that future spatial outcomes in the GCR may be facilitated nodal and corridor development premised on public transport. Essentially, the Gautrain and Rea Vaya BRT will be integrated with the metro rail to provide a platform for the smart growth oriented approach. However, the motivation behind the BRT is the need to reinforce the significance of pro-active integration of transport and land use, while the Gautrain is selected because it provides access to the three primary cores of the GCR. Likewise, it is implied that BRT and Gautrain are the preferred modes for spatial integration of the GCR, though it is argued that all decision making process should incorporate their cost and benefit analysis.

The catchment areas of the Rea Vaya and Gautrain were used as the study area to gain a first-hand perspective of their interface with station nodes. Subject to data availability, the transport/economic nodes used for this research are Soweto, Johannesburg (Inner city), Alexandra, Midrand, Rosebank/Parktown/Randburg and Kempton Park (Rhodesfield) (Table 7.1). Quantitative data was obtained from Quantec and StatsSA to describe the demographics of these nodes. To ensure uniformity, data was extracted in the context of administrative regions and sub-regions (in some cases) rather than on a ward basis. This way, the interface is measured in a broader sense, rather than breaking down these nodes into wards or neighborhoods contexts. Kempton Park (Ekurhuleni) was included because it is home to the Gautrain Rhodesfield Station, while others were selected because they have a presence of either Rea Vaya or Gautrain stations; or a combination of both in some cases.

Table 7.1: Respective regions (on route network) and areas used for data extraction

Node	Areas
Soweto	Diepsloot, Dobsonville, Eldorado Park, Meadowlands East, Meadowlands West, Pimville, Roodepoort South, Soweto
Johannesburg (Inner-City)	Johannesburg, Johannesburg South
Alexandra	Alexandra, Halfway House, Modderfontein, Waterval
Randburg	Randburg, Sandton, Rosebank, Parktown

Midrand	Midrand, Diepsloot, Leeukop, Rivonia
Kempton Park	Bupsfontein, Birchleigh, Clayville, Kempton Park, Olifantsfontein, Rhodesfield, Tembisa

Source: Own construction, 2018 as adapted from Quantec

In addition, the values for these regions were then compared to the averages for their respective metro municipalities, i.e. CoJ Metropolitan Municipality in the case of others and Ekurhuleni in the case of Kempton Park (Rhodesfield). Additional data was extracted from Regional Explorer (REX); City of Johannesburg and Gauteng Spatial Development Frameworks; Gauteng Integrated Transport Master Plan; the City of Johannesburg Strategic Integrated Transport Plan Framework; the National Household Travel Survey 2013; and the Gauteng Household Travel Survey 2014. Qualitative data was also obtained from public institutions like the South African Cities Network (SACN), Johannesburg Roads Agency (JRA), Gauteng Department of Roads and Transport (GDRT) and the City of Johannesburg Metropolitan Municipality (CoJMM) by the use of closed-ended questionnaires. Impacts on transport planning is ascertained by measuring the interface of the two modes with the demographic outlook of the regions (within their route network); residents' travel pattern; the level of collaboration among the various government institutions responsible for the provision of public transport, vis-à-vis their association with the private sector; their funding source(s) and limitations faced; their orientation towards the provision of public transport (and NMTs) and their level of engagement with residents in communities affected by project implementation; impact of project implementation on heritage sites; and the associated impact of crime (rates) on residents' perception of Rea Vaya and Gautrain.

The findings will be followed by conclusions on the spatial planning impacts, premised on historical and existing land use patterns around the station nodes. This also provides an understanding of growth patterns over the last decade, and an insight into the direction being taken by both the private and public sector to optimize the land use-transport potentials of these areas. With particular reference to the TOD initiative of the municipality, the impact of the Rea Vaya BRT and Gautrain since their implementation will be determined.

Under recommendations, the conclusions made form the basis for providing useful insights on the likely outputs from maximizing the potentials of the two modes. The city's unique transportation demand pattern and the associated spatial nature that creates it will also inform the study recommendations. Against this background, it is imperative to describe the two systems on the basis of their networks to gain a clear understanding of the catchment areas that formed the exact study area for this research. This is followed by a description of research findings to provide understanding of the impacts identified. Table 7.2 below gives a summary of their route networks, while the combined route network map for Rea Vaya Phases 1A-C was given in Figure 5.14. The Gautrain network was also illustrated in Figures 5.15 and 5.16.

Table 7.2: Rea Vaya BRT and Gautrain catchment areas

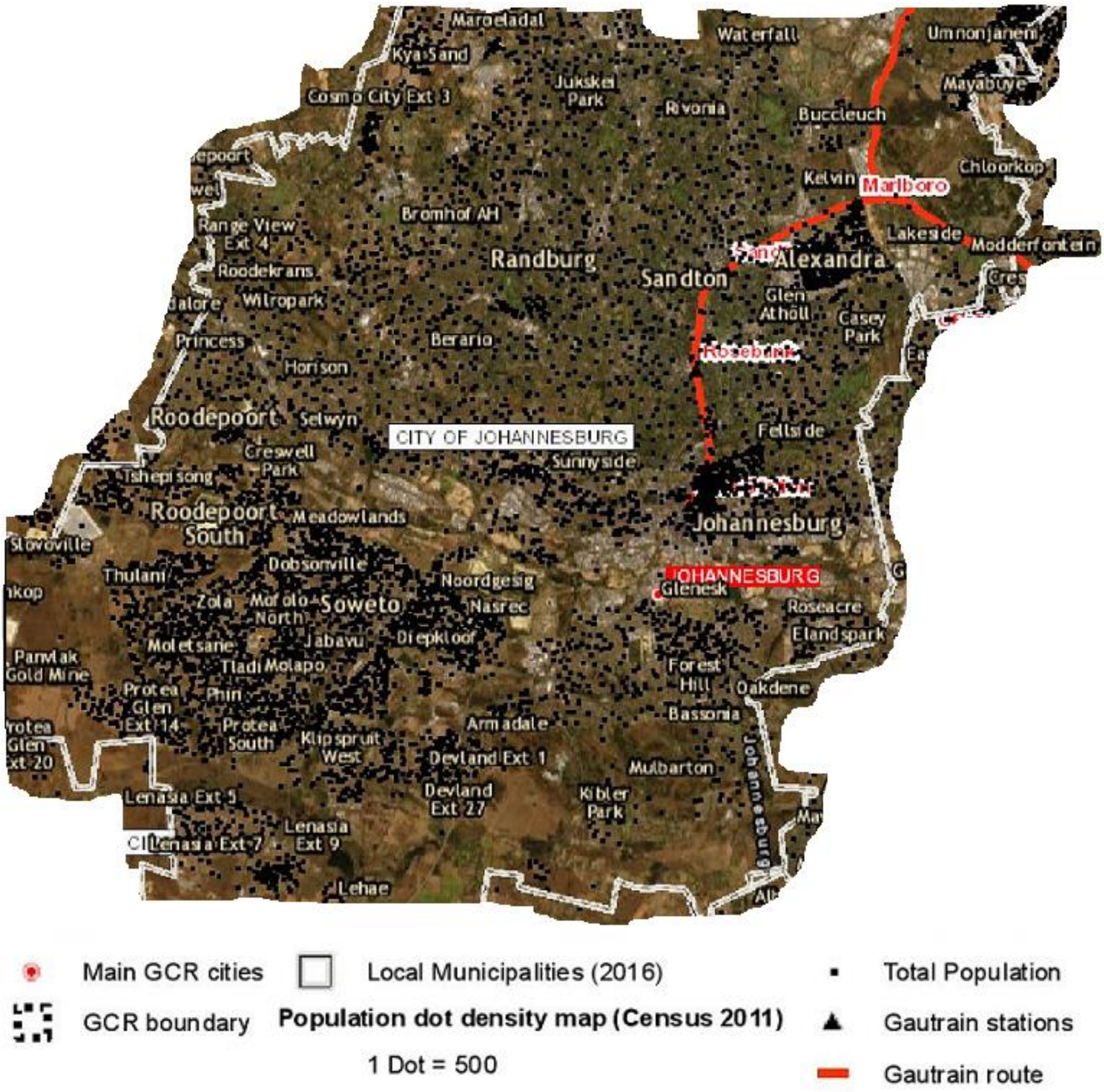
Mode name	**Details**	**Trunk route length (km)**	**Catchment area (trunk route)**
Rea Vaya	Phase 1A	25.5	Thokoza ParK (Rockville, Soweto) - Ellis Park (Inner City)
	Phase 1B	18	Soweto - Noordgesig - Coronationville - Westdene - Parktown - Braamfontein (CBD)
	Phase 1C (begins operations October 2018)	17	Inner City (CBD) - Ivory Park-Alexandra - Sandton - Rosebank
Gautrain	Ten stations (linking CoJ CBD, Tshwane and Ekhuruleni)	80	Park Station, Rosebank, Sandton, Marlboro, Rhodesfield, OR Tambo, Midrand, Centurion, Pretoria, Hatfield

Source: Own construction (2018)

7.2.1. Demographic outlook

The total population, population density, number of households, average household size, and household density for 2011 (last population census) and 2017 were obtained to provide an insight into: changes since the last census, and the trend since the inception of the Rea Vaya and Gautrain. The townships of Soweto and Alexandra have the highest population density, a factor that may have strongly influenced the provision of the BRT for the residents. It is also lsrgely due to the unique spatial form of South African cities where public transport services are usually “designed to serve the perceived need to assemble labour from the suburbs and satellite low-income dormitories to centralized workplaces” (Weakley and Bickford, 2015: 13).

As established in literature, and recently in a South African context, by Weakley and Bickford, 2015; population density is a needed impetus for a successful public transport system. Besides, in spite of the various limitations of the Rea Vaya, such as its high peak to base ratio, the high population densities of these two townships (Soweto and Alexandra) (Map 7.1) – especially when compared to the average for the metropolitan municipality – may significantly influence outcomes, if properly combined with other factors such shorter trip distance and agglomeration of activities. Though Alexandra has the lowest population (total), and is the smallest at 139.715km^2, it has the second highest population and household densities. These relationships are therefore presented in Figure 7.1 and Table 7.3.



Map 7.1: Population densities at Alexandra, Johannesburg Park Station (CBD) and Soweto
Source: GCRO GIS viewer (2018)

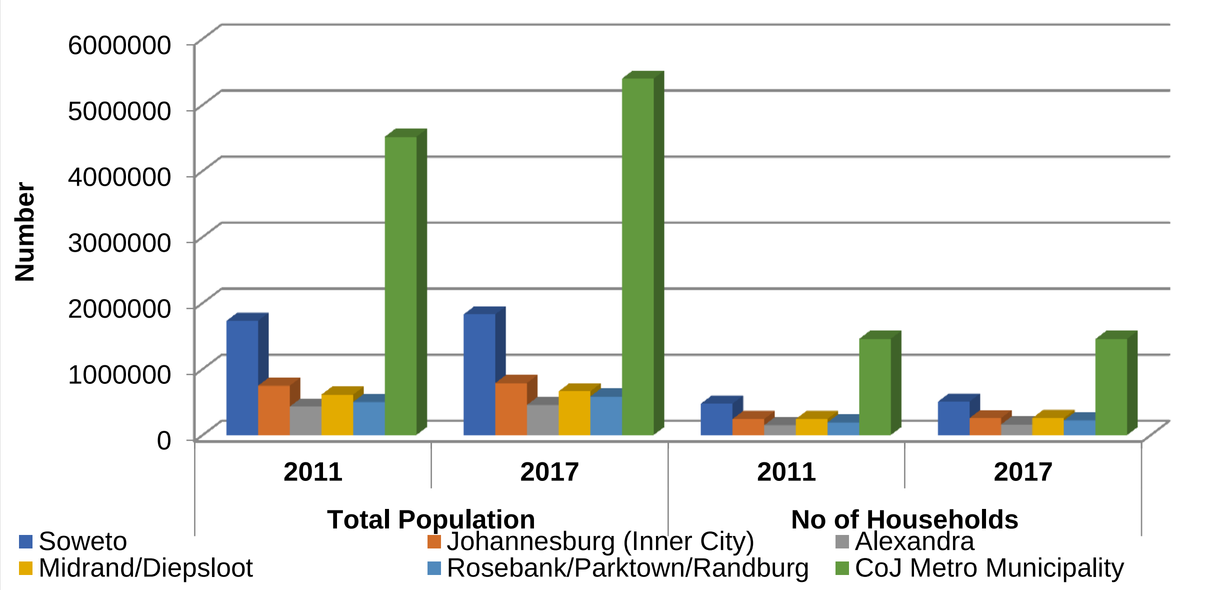


Figure 7.1: Total population and number of households (HH)

Source: Own construction (2018) using data from Quantec

Table 7.3: Area, population density and household (HH) density

	2011			2017		
Region	Area (km^2)	Population density (People/km^2)	Household density (HH/km^2)	Area (km^2)	Population density (People/km^2)	Household density (HH/km^2)
Soweto	242.122	6,428.10	1,758.30	242.122	7,554.10	2,090.30
Johannesburg (Inner City)	284.089	2,362.70	785.5	284.089	2,775.40	903.8
Alexandra/Sandton	139.715	2,740.20	961.5	139.715	3,265.50	1,143.20
Midrand/Diepsloot	288.147	1,777.50	687.7	288.147	2,299.80	901
Rosebank/Parktown/Randburg	241.185	2,074.00	801.4	241.185	2,422.00	925.6
CoJ Metro Municipality	1,644.98	2,744.60	885.4	1,644.98	3,280.60	1,061.10
Kempton Park (Rhodesfield)	622.783	1,143.90	384.6	622.783	1,328.20	451.3
Ekurhuleni Metro Municipality	1,975.31	1,595.30	504	1,975.31	1,810.80	577.2

Source: Own construction (2018) using data from Quantec

In terms of growth trend over the 6 years (2011-2017), the Midrand/Diepsloot region had higher continuous growth rates in population density (26%) and household density (27%) than the average for the City of Johannesburg Metropolitan Municipality. The closest to Midrand/Diepsloot is Alexandra/Sandton region, which has an equal continuous growth rate in population density (18%) with the metropolitan municipality. Similarly, Kempton Park's (Rhodesfield) continuous growth rate of 15% (population density) and 16% (household density) exceeds the metropolitan average of 13% (population density) and 14% (household density) respectively for Ekurhuleni. Alexandra/Sandton's growth implies there was in-migration of middle-income (or upper middle income) earners, a situation that may exacerbate the traffic congestion on the nodal corridor due to increased private car use. Future public transport solutions premised on population and household densities projections must incorporate this observation. Figure 7.2 provides further insight into the respective continuous growth rates for each region.

Furthermore, Soweto has the highest working age population as well as the highest numbers for both total employed and those employed in the formal sector. However, the inverse is the case when considering the fraction of the working age population that is presently employed in the formal sector (see Table 7.4). The formal sector comprises of firms and workers who are engaged in legalized economic activities. Such firms are legally incorporated companies or corporations that keep their accounting books and pay their taxes. Since it is a well-organized sector, it demands some level of expertise/professionalism or higher education from potential employees. As illustrated in Figure 7.3, Soweto has the highest unemployment rate at 52%, followed by Alexandra at 36%. They are both higher than the metropolitan average of 28.3% (CoJ, 2017:17). This may be the result of the average level of household education which is second lowest (9.3% have higher degree) when compared with other regions. This figure is only second to Alexandra's 6.2%.

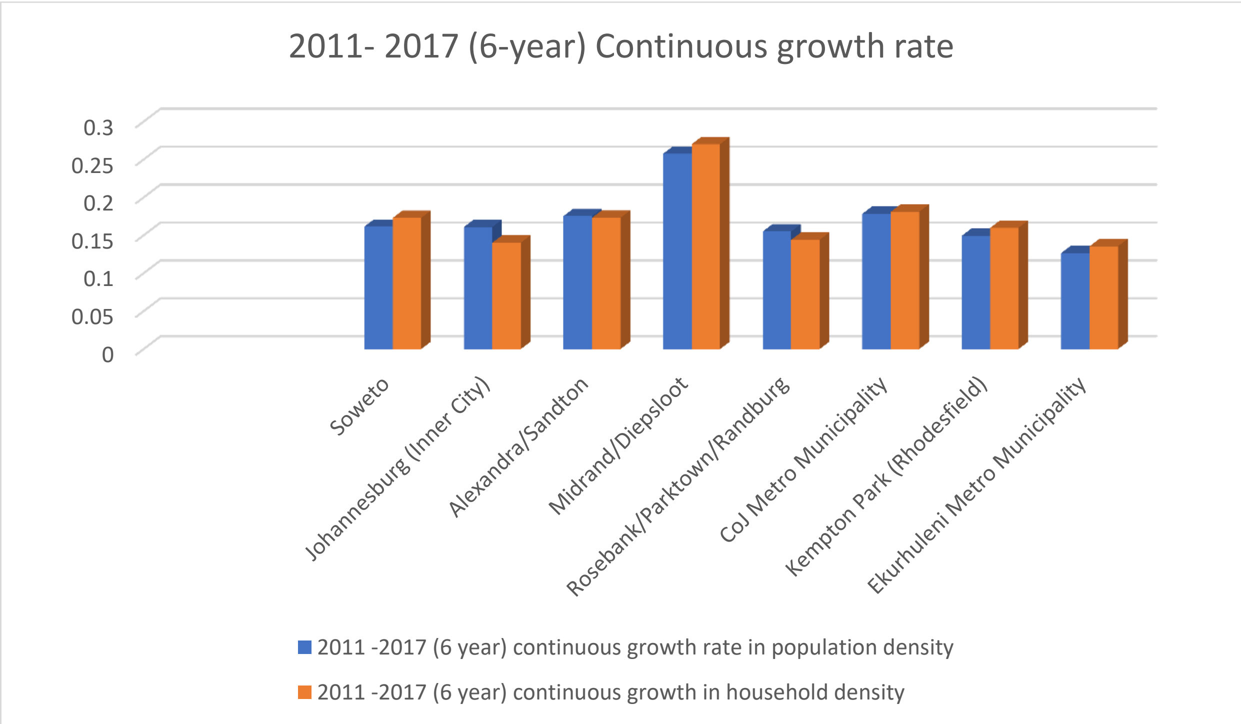


Figure 7.2: 6-Year continuous growth rate for each region

Own construction (2018) using data from Quantec

The level of education determines the nature of jobs that will be attracted to the households and since Johannesburg's formal sector growth has historically gravitated towards the inner-city and northwards (Todes, 2012:159), Soweto's reality is associated with the households' inability (due to low level of education) to attract formal jobs and high population due to in-migration. Randburg, with the lowest unemployment rate (11%), has a working population with 42.6% educated up to higher degree. Soweto's distance to the economic nodes at the center and further north (trip length to inner-city and Sandton are about 27km and 40 km respectively) is another factor that can be responsible for the high unemployment rate, because it truncates agglomeration economies, which is only achieved when labour is close to jobs.

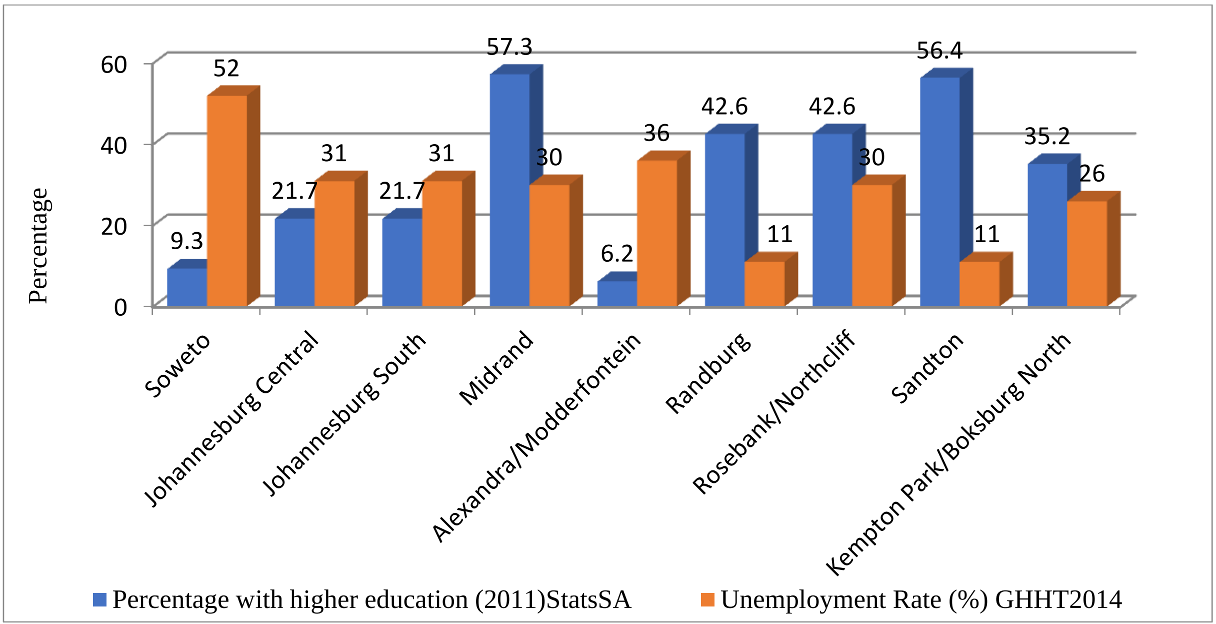


Figure 7.3: Level of education and unemployment rate

Source: Own construction (2018) using data from StatsSA and GHHTS (2014)

Table 7.4: Formal workers as a percentage of working age population

Region	Working Age Population	Formal Workers	Percentage of working age population with formal jobs (%)
Soweto	1,248,942	373,366	30
Johannesburg	592,243	258,502	44
Alexandra	327,093	134,580	41
Midrand	483,869	202,172	42
Randburg	424,377	252,441	59
CoJ Metro	3,814,772	1,542,864	40
Kempton Park	613,351	263,017	43
Ekurhuleni	2,553,382	1,027,013	40

Source: Own construction (2018) using data from Quantec

7.2.2. Income and transport

The differences in average monthly income across nodes are a reflection of the historic income inequality across Johannesburg. Soweto and Alexandra have the smallest incomes and spend the least on transport and rent. It has also been established in literature, as well as the NHHTS (2013:51) that private car users spend more on transport than users of public transport. However, when taken in the context of a percentage of the disposable income spent on transport (especially to work), the low income earners in Soweto and Alexandra spend higher. Nationally, up to 50% of low income households spend more than 20 percent of their monthly income on public transport, while the extremely low-income earners (R1-R500) spend as much as 35 percent of their monthly income on work commutes (DoT 2005:24-25). In addition, NHHTS 2003 reveals that majority (55%) of train users in national context spend less than 11% of their monthly income on public transport, while 55% bus users and 60% taxi users spend more than 10% (global standard) of their income respectively (DoT, 2005:26). This is in spite of the subsidies on these modes, and is a far cry from what is globally acceptable. According to the Gauteng Household Travel Survey, 2014, close to 45% of commuters in the province spend more than 10% of their monthly income on transport. This is a sharp increase from the 30% that was recorded in the NHHTS 2003 (Gauteng, 2014a:14-15).

Intriguingly, the observed income inequality within regions is another factor that impacts on the ridership abilities of the two transport systems. Alexandra (R6, 045 per month) and Sandton (R10, 862 per month) are two adjacent neighborhoods with a high level of income variance (Figure 7.4). In addition, because the high-income earners in Sandton have not seen the Rea Vaya as a viable alternative to their private cars, they may only be attracted to the Gautrain which was coincidentally provided to meet the needs of people in that income bracket.

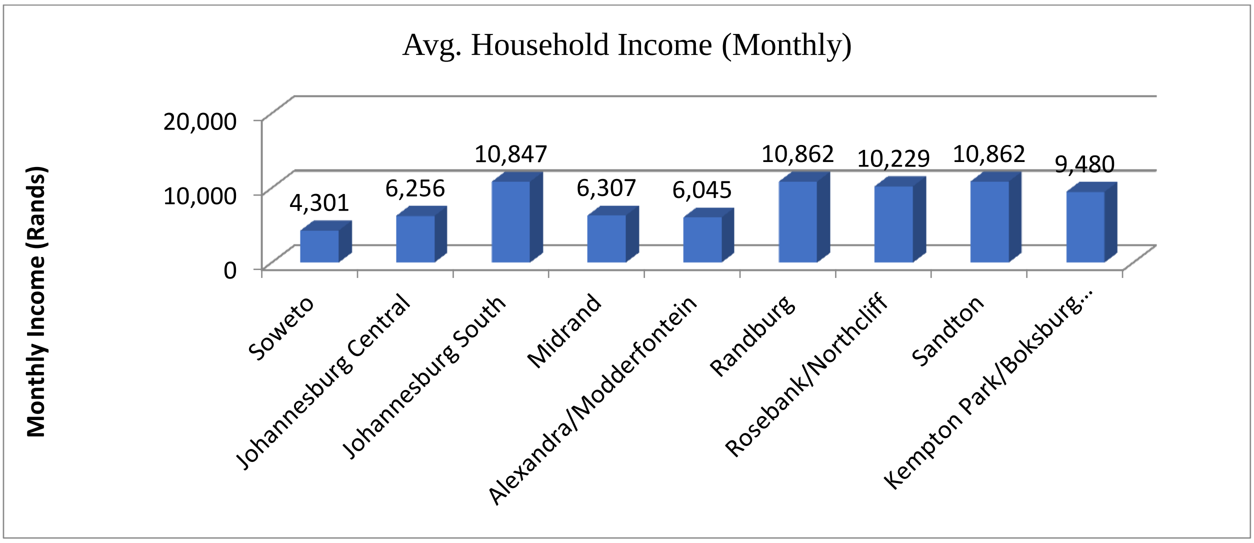


Figure 7.4: Average household income by sub-region

Source: Own construction (2018) using data from GHHTS 2014

7.2.3. Crime rate

The frequency of crime is believed to be a factor that shapes people's perception of the two public transport systems. Besides, perception is essential for achieving the desired modal shift to formal public transport, especially in places like Sandton, Midrand and Kempton Park. However, crime rate (2017) is highest in these high income areas and lowest in Soweto. Although Soweto's crime rate is still high when compared with what is internationally acceptable. The commercial nature of these high-income areas makes them vulnerable to the daily influx of people, some of who incidentally may have motives other than work or business. From Figure 7.5, the inner-city, which is the city's economic core, has the highest, followed by Sandton, Midrand and Kempton Park.

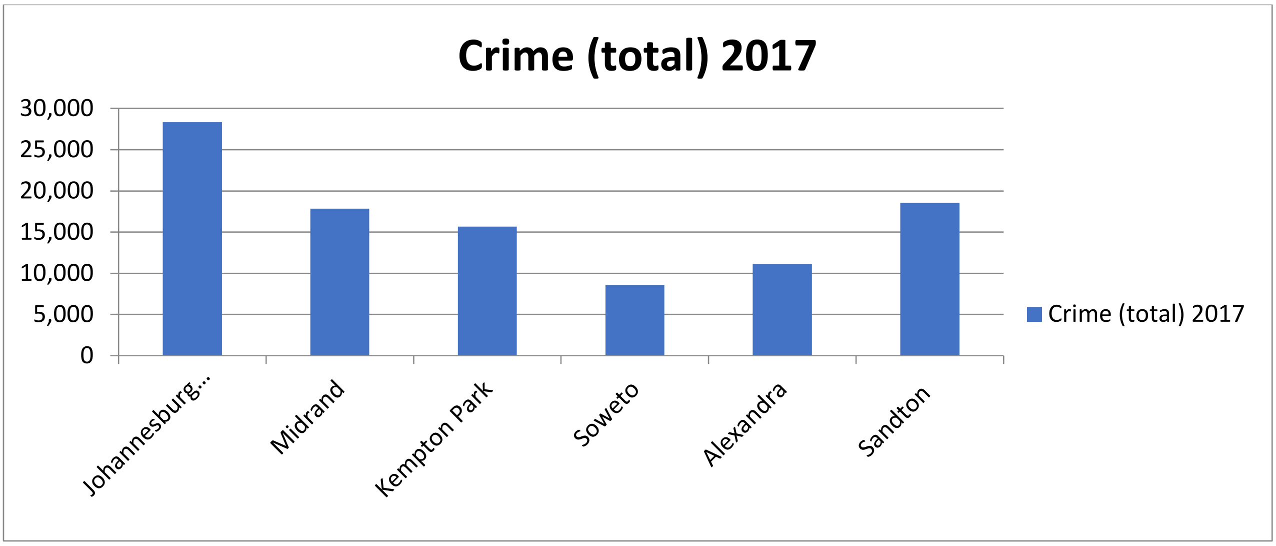


Figure 7.5: Crime rate by administrative region

Source: Own construction (2018) using data from StatsSA)

7.3. Gauteng and Johannesburg travel patterns

The data for this section was obtained from the National Household Travel Survey 2013, the Gauteng Profile of the same survey and the Gauteng Household Travel Survey 2014. The data was used to explain provincial and municipal travel patterns, and to understand what likely solutions can be provided going forward. Educational and work trips were used as benchmarks for measuring residents' travel patterns for the province and key sub-regions of the CoJ. Furthermore, because both trips entail a two-way traveling between origin and destination, which is often home and school/place of work, this reflects on the findings and conclusions of this research.

7.3.1. Mode of travel according to trip purpose in Gauteng

The National Household Travel Survey 2013 (NHHTS 2013) and the Gauteng Household Travel Survey 2014 (GHTS2014) revealed that besides educational trips (47.7%), work trip (38.9%) is the dominant peak-period (06.00-09.00) trip among Gauteng residents. Both trips are dominant in the morning on weekdays, and they are dominated by those who walk all the way (34.0%), followed by the minibus taxi and car users (as driver) at 21.9% each. Rea Vaya had a mere 0.3% trips, while 1,808 Gautrain trips were inconsequential at 0.0% (Gauteng, 2014a:23). However, these figures were taken in the context of Gauteng Province. In the CoJ, minibus taxi was the dominant public transport mode, taking up to 71.14% of the total daily trips to work by public transport (StatsSA, 2014:36).

For a typical weekday in Gauteng in 2014, 62% of private car trips and almost half (45%) of train trips were for work commute, while 81% of bus trips were for educational purpose (Table 7.5). Most pedestrians (78%), metered taxis (56%) and lift club users (52%) were also learners (Gauteng, 2014a:24).

Table 7.5: Travel mode according to trip purpose

Trip purpose	**Bus**	**Car**	**Minibus taxi**	**Train**	**Lift club**	**Metered taxi**	**Walk all the way**
Education	81%	21%	30%	39%	52%	56%	78%
Work	16%	62%	52%	45%	40%	34%	13%
Shopping	0%	2%	4%	0%	0%	6%	1%
Other	3%	15%	14%	16%	8%	4%	8%

Source: Own construction (2018) adapted from Gauteng (2014a: 24)

7.3.2. Intra- and inter-municipal travel

Most weekday trips in Gauteng in 2014 were intra-municipal, with the City of Johannesburg generating the highest at 3.9 million daily trips. Ekurhuleni was next at 2.5 million trips, followed by City of Tshwane at 1.9 million daily trips (Table 7.6). Inter-municipal trips were highest between the CoJ and Ekurhueni, with the CoJ having the highest number of trips originating from outside Gauteng.

Table 7.6: Daily (weekday) travel within Gauteng

Origin	Number of trips	Destination
City of Johannesburg	3,985,785	City of Johannesburg
	48,892	City of Tshwane
	131,845	City of Ekurhuleni
	52,698	West Rand and Sedibeng
City of Tshwane	1,911,613	City of Tshwane
	33,203	City of Johannesburg
	9,325	City of Ekurhuleni
	1,507	West Rand and Sedibeng
City of Ekurhuleni	2,543,914	City of Ekurhuleni
	153,842	City of Johannesburg
	24,198	City of Tshwane
	9,265	West Rand and Sedibeng
West Rand and Sedibeng	505,643	West Rand and Sedibeng
	23,310	City of Johannesburg
	1,537	City of Tshwane
	1,686	City of Ekurhuleni

Source: Gauteng, 2014a:21

This is a confirmation of Johannesburg as the destination of choice for economic and educational activities/opportunities. The trip generated daily within the CoJ is more than double of that which was recorded for the City of Tshwane. It is clear that the majority of the workforce in Tshwane reside in the city. The industrial nature of Ekurhuleni and the OR Tambo International Airport corridor are the two factors responsible for its over 2.5 million daily trips. Figure 7.6 is a representation of the transport flows into and within the three Gauteng metros according to the 2011 QoL Survey data.

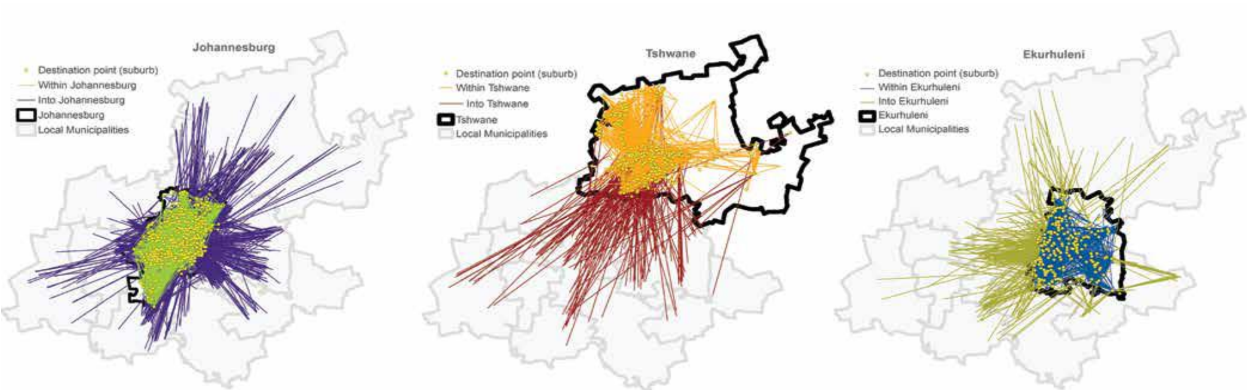


Figure 7.6: Transport flows into and within the three Gauteng metros (2011)

Source: Gotz et al (2014:10)

Most of the inter- and intra-municipal trips into the CoJ are to either Johannesburg CBD or Sandton, the two biggest destinations for CoJ workforce. A high number of trips from Ekurhuleni to Johannesburg CBD are made using the train (40%). The private car accounts for half (50%) of the trips while the minibus taxi takes a mere 10% (Simpson et al, 2012:64). The minibus taxi, which is Gauteng's dominant travel mode, is responsible for most trips within municipalities, while the private car is the mode of choice for inter-municipal workforce. Its usage has increased by up to 80% in corridors connecting two municipalities (Simpson et al, 2012:89). Table 7.7 gives an insight on the modal shares for inter- and intra-municipal travel in the employment nodes within Gauteng.

Table 7.7: Modal shares of traveling (intra- and inter-municipal) within Gauteng

		Modal share (%)				
Origin	**Destination**	**Walk**	**Taxi**	**Car**	**Bus**	**Train**
City of Johannesburg	Johannesburg CBD	18	48	27	0	7
	Sandton	13	36	45	3	3
	Soweto	20	62	11	0	7
	Randburg	9	32	48	9	2
	Centurion (Tshwane)	0	17	83	0	0
	Tshwane CBD	0	17	83	0	0
	Germiston	0	34	0	33	33
	Alberton	0	100	0	0	0
City of Tshwane	Tshwane CBD	9	43	36	7	5
	Centurion (Tshwane)	0	21	70	9	0
	Johannesburg CBD	0	20	60	20	0
	Sandton	0	0	83	17	0
City of Ekurhuleni	Johannesburg CBD	0	10	50	0	40
	Sandton	0	50	50	0	0
	Randburg	0	0	100	0	0
	Boksburg	11	38	49	0	2
	Benoni	2	49	49	0	0
	Germiston	2	44	42	0	12
	Alberton	3	42	50	3	2
	Springs	9	47	44	0	0

Sources: Own construction (2018) adapted from Simpson et al, 2012:48-88

7.3.3. Public transport accessibility

According to the Gauteng Profile of the National Household Travel Survey 2013 (NHHTS 2013), majority (43.6%) of public transport users in the province spend less than 5 minutes to reach their first public transport and 17.2% walked for more than 15 minutes. The metro rail (train) has the highest walking time before access at 19.0 minutes, the taxi at 8.7 minutes, while the metro bus has the least at 6.1 minutes. Meanwhile, the average walking time at the start of work trip for the Rea Vaya is 8 minutes and the Gautrain has the least at 5 minutes, both lesser than the provincial average of 9 minutes. In addition, commuters' household income appears to be inversely related to walking times to public transport at the beginning of work trips and to the final destination (at trip end). This is attributable to their proximity to the stations, which is a result of their ability to afford the residential properties closer to the stations. A research by SACN (2016:13-14, 24) underpins this assertion by revealing a cluster of higher income groups around the Diepkloof station in Soweto. Population density was also highest as you move out from the BRT station. This may be as a result the high rental values of properties around the BRT station, thereby leading to low population density induced by non-affordability by the low-income group. With regards to the high-income earners clustered in the station area, it is deduced that their income class affords them a higher spending power.

The average walking times are influenced by the urban intensities (residential, job and built densities) along the public transport corridors. SACN's (2016) observation of higher densities away from the Diepkloof Rea Vaya Station reflects South Africa's departure from acceptable standards, where the number of people living and working close to a public transit is clustered within 500 meters, 1km and 2km radius. Residential and job density analyses done within the Corridors of Freedom catchment areas revealed that more than 83% of residents and jobs are located beyond 2km from the Rea Vaya corridors. It is more worrisome that the analyses were inclusive of the projected phases of the Rea Vaya BRT (CoJ, 2016: 60-61). Such limitation, together with the presently segregated land use patterns along the corridors can impair accessibility, discourage modal shift and limit the benefits associated with public transport investment. The waiting time for the first public transport varies geographically, but 13% (mostly metro and urban residents) of the 1.6 million workers interviewed waited for more than 15 minutes.

Furthermore, Table 7.8 reveals that the average walking time to branded public transport modes for educational trips is highest for the train (20 minutes), Rea Vaya (17 minutes), Gautrain bus (13 minutes) and Gautrain (11 minutes), well above the provincial average of 7 minutes. The Rea Vaya and Gautrain are less accessible for learners than other public transport modes. They equally had the highest walking time to final destination (at trip end). Such accessibility issues can influence user's choices because they remain uncompetitive with the minibus taxi (7 minutes) and metro bus (6 minutes).

Table 7.8: Walking time for peak-period trips by branded public transport modes

	Work trip		Education trip	
Mode of travel	Average walking time at the trip start (minutes)	Average walking time at the trip end (minutes)	Average walking time at the trip start (minutes)	Average walking time at the trip end (minutes)
Bus (Rea Vaya BRT)	8	9	17	13
Bus (other)	9	9	6	5
Minibus taxi	9	8	7	7
Gautrain	5	6	11	11
Gautrain bus	7	6	13	6
Metered taxi	7	7	5	8
Other	12	10	10	7
School bus	6	5	5	4
Train (metro)	19	14	20	17

Source: Gauteng, 2014a:29-30

7.3.4. Main mode of travel to work

Table 7.9 provides an insight into the dominant mode by sub-regions in the City of Johannesburg and Kempton Park. It shows the modal share of each mode in each region. About one out of every two work trips in Midrand makes use of the Minibus taxi, making it the sub-region with the highest taxi users for work trips. Randburg (75%), Roodepoort (62%) and Kempton Park (62%) are the highest private car users with up to 6 to 8 out of every 10 work trips making use of the car. Interestingly, the townships of Orange Farm, Soweto and Diepmeadow and Diepsloot are dominated by people who use the taxi or walk all the way to work. About half (46%) of the working population of Orange Farm walk to their jobs. They are equally the highest users of the metro bus and metro train.

This is a reflection of the informal nature of the economic landscape of these townships and the low income levels of those who travel out of the regions for their day job. Soweto (12%) is only after Johannesburg CBD (23%) and Sandton (18%) as the provider of employment within the CoJ (Simpson et al, 2012:60-61), but most of these jobs are certainly informal. The informal workers walk all the way because they either live not far from work (within the region) or are not able shoulder transport costs from their meager incomes. Others have to travel with metro bus (Rea Vaya on few occasions) or the moribund and unsafe metro rail because it is either a personal choice or due to the unaffordability of the private car.

Alexandra appears to have more middle income earners than the other townships, with 31% of its work trips taken by private car users. Johannesburg Central has a similar trend to the townships with fewer car users (16%) and more pedestrians (36%) and taxi (37%) users. The train users observed in Midrand and Northcliff/Rosebank are mostly the middle-income earners who have shifted to the Gautrain because these regions do not have the presence of the metro rail.

Table 7.9: Main mode of travel to work by node/sub-region

Node	Minibus taxi	Walk all the way	Car	Metro Bus	Train	Bicycle	Other
Diepsloot	34%	30%	29%	2%	0%	0%	5%
Midrand	49%	13%	28%	4%	3%	0%	3%
Alexandra/Modderfontein	36%	26%	31%	3%	1%	0%	3%
Randburg	6%	15%	75%	1%	0%	1%	2%
Roodepoort	11%	19%	62%	4%	0%	0%	4%
Northcliff/Rosebank	12%	25%	53%	5%	2%	0%	3%
Johannesburg Central	37%	36%	16%	3%	3%	0%	5%
Johannesburg South	14%	15%	57%	7%	2%	0%	5%
Diepmeadow	33%	35%	15%	9%	3%	0%	5%
Soweto Doornkop	32%	39%	12%	10%	5%	0%	2%
Orange Farm/Ennerdale	23%	46%	12%	8%	8%	0%	3%
Kempton Park/JIA/Boksburg North	9%	17%	62%	3%	4%	1%	4%

Source: Own construction (2018) adapted from Gauteng (2014a: 25-27)

7.3.5. Average travel time for peak-period trips (one way)

The average travel time for the province increased between 2003 (32 minutes) and 2014 (46 minutes). Implicitly, there was an increase in traffic congestion in Gauteng, most of which have occurred from trips within and between municipalities. The increased average travel time (provincial) and the 80% increase in private car trips between 2000 and 2014 are a testament to the growth in traffic congestion. A growing occurrence in Gauteng, signaling economic growth but equally counter-productive if managed poorly (Simpson et al, 2012:18). The metro rail had the highest average travel time (01:20:12), while the bus and minibus taxi had travel times of

00:55:43 and 00:59.21 respectively. Walk all the way (00:33:37), the private car (00:45:03) and the motorcycle (00:31:40) had the least travel times.

Travel time was one of the three factors that determine modal choice in the country, and it must be prioritized by role players in transport and spatial planning if the push from private car (which presently is one of the least) must be accomplished in the long term.

7.3.6. Trip generation by households

Provincially, the average trip number per household per day increased with income growth for all trip purposes except for educational purposes (Gauteng 2014a:32-33). This implies that people in the townships make fewer trips than the middle to high income earners. Kempton Park (home to Gautrain's Rhodesfield Station) generates the highest trip (1.43), followed by Johannesburg South (1.3) whose trip generation doubles that of Johannesburg Central (0.65) despite their proximity. The gap in trip generation between Johannesburg Central and Johannesburg South is certainly due to the income inequality between them. Although the townships have higher number of households, their high unemployment rates is a limiting factor in their ability to generate trips.

In addition, Midrand (0.94), Randburg (0.77), Johannesburg Central (0.65), and Diepmeadow (0.62) generate fewer trips than the provincial average of 0.98 (see Table 7.10).

Table 7.10: Average trip generation by households

Node/Sub-region	Number of Households	All Trips	Going Home	Work	Education	Shop	Other
Diepsloot	79,357	1.05	0.06	0.46	0.38	0.02	0.13
Midrand	127,323	0.94	0.01	0.44	0.25	0.11	0.13
Alexandra/Modderfontein	75,978	1.15	0.05	0.51	0.38	0.04	0.17
Randburg	100,354	0.77	0.03	0.43	0.18	0.03	0.1
Roodepoort	124,986	1.24	0.04	0.66	0.38	0.05	0.11
Northcliff/Rosebank	79,612	1.11	0.05	0.52	0.35	0.03	0.16
Johannesburg Central	107,983	0.65	0.04	0.35	0.18	0.02	0.06
Johannesburg South	90,476	1.3	0.04	0.61	0.43	0.02	0.2
Diepmeadow	207,807	0.62	0.03	0.19	0.29	0.02	0.09
Soweto Doornkop	301,449	1.05	0.03	0.26	0.55	0.02	0.19
Orange Farm/Ennerdale	143,246	1.24	0.04	0.28	0.73	0.04	0.15
Kempton Park/JIA/Boksburg North	165,112	1.43	0.04	0.81	0.47	0.01	0.1

Source: Own construction (2018) adapted from Gauteng (2014a:33-35)

Intriguingly, the townships of Orange Farm, Soweto and Diepmeadow generate more educational trips than work trips. This is in contrast to other sub-regions, where close to or more than half of all household trips were for work purposes. Work trips in Orange Farm and Soweto are less than half of their educational trips (see Figure 7.7).

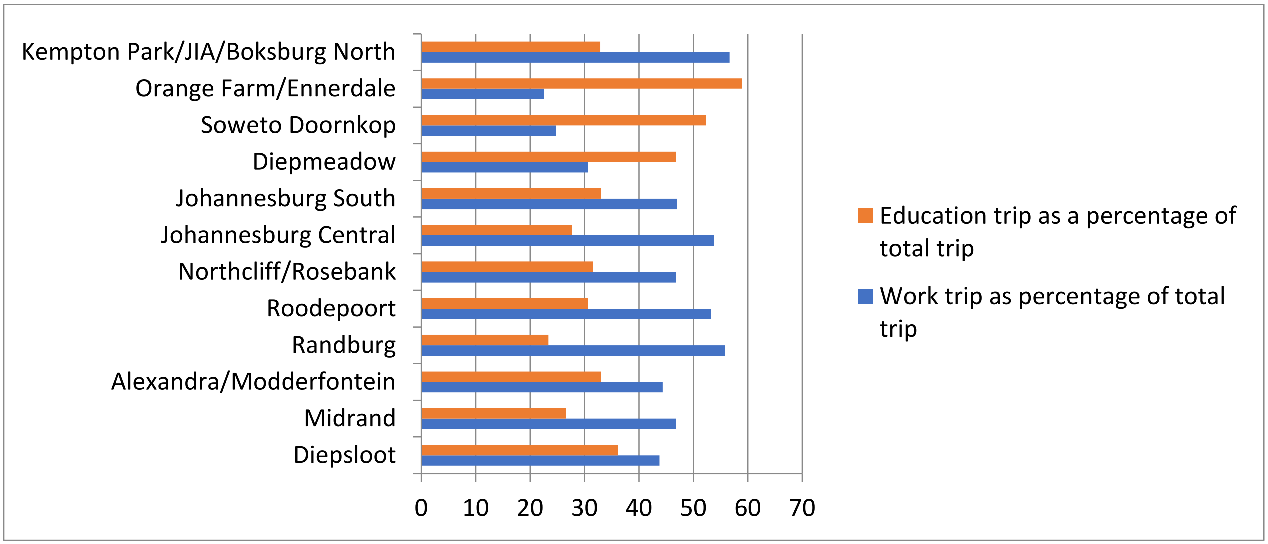


Figure 7.7: Education and work trips by sub-region

Source: Own construction (2018) using data from Gauteng (2014a)

7.4. Institutional arrangements: transport-land use integration

The mandate of promoting the integration of transport and land-use primarily belongs to the state, which must frequently engage citizens and the private sector at both planning and implementation stages. The need for a mutually beneficial relationship between transportation and urban planning institutions cannot be overstated (Curtis, 2008). However, South Africa's current institutional arrangement is highly fragmented and it is one of the challenges faced in the nation's public transport landscape (Simpson et al., 2012:25). This fractured institutional arrangement is reflected in the CoJ, where different spheres of government are responsible for different public transport mode, an argument reinforced by Walters (2014:7). A situation further exacerbated by a fragmented funding structure (Walters, 2014:7-8).

In order to avoid the conflict of agenda generated by such fragmentations, some authors have suggested that institutions from both transport and urban planning should be integrated under one umbrella (Bickford, 2013:7; Walters, 2014:9). This umbrella institution will take the form of a transport authority (TA) that will consolidate functions, physical and human resources across the three spheres of government, together with an amalgamation of the fractured funding streams.

In this regard, questionnaire respondents were drawn from institutions responsible for transportation and urban planning in the City of Johannesburg. They include (see Table 7.11): the Programme Manager of the South African Cities Network (SACN); an Assistant Director at the Gauteng Department of Roads and Transport; a Deputy Director at the Gauteng Department of Roads and Transport; a Transport Economist at the Gauteng Department of Roads and Transport; a Knowledge Manager at the Johannesburg Roads Agency; and a Senior Specialist in transport and spatial planning at the City of Johannesburg Metropolitan Municipality.

Table 7.11: Overview of questionnaire respondents

Name of institution	**No of respondents**	**Specialization**
South African Cities Network (SACN)	1	Research and advisory in transport and spatial planning
Gauteng Department of Roads and Transport (GDRT)	3	Provincial roads and transport implementation
Johannesburg Roads Agency (JRA)	1	Municipal roads
City of Johannesburg Metropolitan Municipality (CoJMM)	1	Municipal spatial and transport planning/research

Source: Own construction (2018)

They were asked to describe their institutional mandates out of a likely five options that include transportation and land use planning. While they are all (100%) involved in transportation planning/provision; only 60% of them combine it with spatial planning functions. Implicitly, optimal outcomes may be unachievable because every transport planning/provision decision directly or indirectly impacts on allocation of space. Every public institution that has a mandate for transport must equally contribute to spatial planning decisions. Likewise, economic growth – like increased economic activity at the neighborhood level and reduction of poverty – is often associated with progressive land use-transport decisions, and it is essential to make provisions for regular measurements. This can help in achieving anticipated outcomes. Incidentally, a mere 40% of respondents combine economic development functions with their transport mandates.

Interestingly, because of the importance of the private sector, especially at the execution (investment) stages, all the respondents have formal engagements with private organizations. This arrangement can be expanded to promote uniform/unitary decision making, and can be the first step towards producing a single organization that oversees national, provincial and municipal transport-land use functions. To increase funding, all spheres of government must increase private sector involvement in transportation initiatives (Simpson et al, 2012:24-25), because the government is equally obligated to provide other infrastructure (housing) and services like health and education. This underpins the Moving South Africa and the NDP's call for attracting large private sector operations and funding to transport infrastructure investments.

However, a closer observation of these relationships reveals that Bombela Consortium (Gautrain operator) enjoys better inter-agency interface than two other similar organizations responsible for specific transport or spatial projects, namely Piotrans Property Limited (Rea Vaya operator) and Corridors of Freedom (CoF) Champions. While 100% of respondents formally engage the Bombela Consortium, only 50% and 66.7% of them are recorded for both Piotrans and the CoF champions respectively. Similarly, the Gauteng City Region Observatory (GCRO), Johannesburg Transport Department, Johannesburg Roads Agency and Gauteng Planning Division enjoy the same patronage with 100% of respondents having relationships with each of them.

7.5. Influence of Rea Vaya and Gautrain on the city's spatial form

The City of Johannesburg, through the spatial (SDF 2010) and transport (SITPF 2013) components of its Integrated Development Plan aims to achieve a TOD driven compact polycentric city that is closely stitched together with an integrated transport system that is equally aligned with provincial growth trajectories. The Gautrain and Rea Vaya have formed the bedrock for this ambitious drive and this study seeks to obtain professional assessment from questionnaire responders on how the two public transport modes have been able to stimulate any change(s).

The SACN Programme Manager and the Senior Specialist at the City of Johannesburg Metropolitan Municipality believe that the two modes have facilitated spatial transformation (mixed-use and infill development) but have faired averagely regarding the promotion of open spaces. However, as established in literature, such changes are often not immediate. It could take more than a decade before the physical (land use) impacts of such transport projects become visible, especially on a city scale. This is usually due to factors like the time needed to complete a transaction for brown and greenfield acquisition, resistance from neighboring users, sites usually too small for large developers (SACN Programme Manager, pers. comm, 07/11/2018), planning approvals and funding for such capital intensive projects.

This is the case with the Rea Vaya which has been unable to stimulate changes in land use along its corridor, as seen in the research by SACN (2016:18-22). The authors observed that apart from a shopping center on Immink Drive that was built (post-Rea Vaya) to replace an informal settlement, the only visible change seen was increased economic activities along the street.

Essentially, the Gautrain corridors have contributed more to this phenomenon, with notable growths observed at stations like Rosebank, Sandton, Pretoria and Midrand stations. It has impacted positively on land values (Bickford, 2013:14), induced a growth in residential property developments and stimulated an increase in retail centers and office space creation (GMA 2015:17-18). In a research done by Mushongahande et al (2014), they found evidence of accelerated property development and increasing mixed-use in Rosebank, Midrand and Pretoria station precincts, though with significant variations in the extent of applying TOD principles. The vibrant Rosebank had transformed better than the slower-growing Midrand and Pretoria precincts.

The private real estate developers they interviewed for the research affirmed that real estate fundamentals (based on demand and supply forces) drive property development and ultimately determines the success of a TOD undertaking. In addition, because this spatial transformation is private sector driven, the city government must ensure there is a shift from granting development approvals to not only the large private sector investors, but also to the SMME property investors who will implement smaller scale development projects. The government must also be willing to understand the peculiarities of such players and promote incentives that can ease their entries into the TOD property market (SACN Programme Manager, pers. comm, 07/11/2018).

On the preservation of heritage sites, 60% of respondents agreed that the two transport systems have had negligible (i.e. sites remain unchanged) impacts on the city, while 40% believed they have preserved the city's unique cultural resources. Heritage Impact Assessments were done for the two modes and adequate provisions were made for their preservation.

7.6. Likely measures towards optimization

Respondents were asked to choose from possible measures that can enhance performance of the two modes. Interestingly, 100% of them believe inter-modal integration will promote optimization while 80% agreed that improved service will help in this regard. In contrast, 66.7% believed that off-peak discounts and improved subsidies can support the Rea Vaya and Gautrain to achieve their project objectives (see Figure 7.8). Incidentally, lack of integration is another limitation faced by public transport in South Africa (Simpson et al., 2012:24). The very low inter modal changes during work trips, as revealed by the national and provincial travel surveys is a reflection of this limitation. The 27.9% (CoJ) and 25.5% (Gauteng) workers who had to connect at least once during work trips (StatsSA, 2014:40) would be mostly train users where almost 5 out of every 10 users (45.9%) had to make at least one transfer.

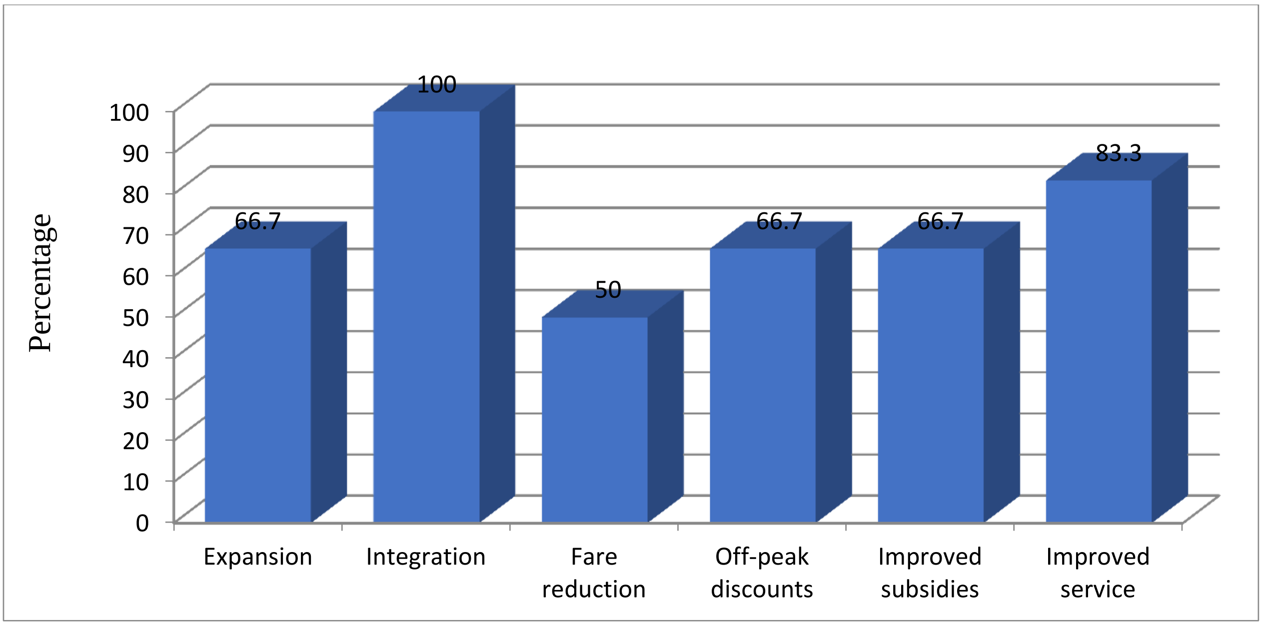


Figure 7.8: Respondents' view on likely measures for optimal performance of Rea Vaya and Gautrain

Source: Own construction (2018)

Similarly, 80% of respondents agreed that their organizations have strong orientations towards the provision of public transport. This is an essential part of providing transport solutions, as institutional players are only able to influence a change based on their convictions.

However, the Programme Manager of SACN strongly opined that these optimization measures are only achievable in the context of Rea Vaya BRT, due to his strong reservations for the Gautrain. He argued that the government only compounded public transport challenges, as opposed to providing solutions to what had existed before Gautrain was introduced. He also firmly believes that its integration with the metro rail may never occur because they are constructed on two different gauge systems.

7.7. Socio-economic implications of expansion

While the Rea Vaya has not met its ridership projections (as discussed in chapter 5), it is still in a growth stage, with its Phase 1C recently being completed. There have also been arguments that the ridership capacity may not be optimized until the catchment area is significantly increased and other operational factors are addressed. Conversely, the Gautrain is believed to have reached its optimal daily ridership capacity (GMA Report) and regardless of its selective user target, it has demonstrated that modern public transport solutions can thrive in a South African context. On this premise, respondents were asked to provide likely outcomes of future expansions of the Rea Vaya and Gautrain. There were 14 likely outcomes from which they were required to subjectively provide anticipated impacts. These likely impacts were derived from literature and are definitely not exhaustive. From Figure 7.9, 100% of respondents believe future expansions will increase accessibility and densification, with a similar growth in mixed-use pattern. This underpins the theme of this study and CoJ's ambitious drive of using integrated public transport to achieve a spatial rebirth – to a compact polycentric city model. 83% agreed that expansions will lead to better productivity by citizens, reduced sprawls, increase opportunities, improve well-being promote economic agglomeration. 50% of respondents did not agree that increasing the coverage areas of the Rea Vaya and Gautrain can promote equality, increase spending power, reduce private car use or induce land value capture.

Sadly, two of the pillars of the city's reorientation towards public transport promotion are to end historical inequalities associated with spatial fragmentations and to stimulate a pull towards public transport. However, 50% of respondents, who are all spatial or transport planning professionals, opined that expanding these two transport systems may not be the panacea to these entrenched anomalies. Their concerns are similar to questions that have been asked in literature on how the Rea Vaya and Gautrain have impacted on poverty reduction or the promotion of social equity and inclusion. Rea Vaya fares are believed to be beyond reach of extremely low-income earners, and uncompetitive with metro rail (Vaz & Venter, 2012:628), which remains the country's cheapest public transport mode, in spite of its unsafe and near-obsolete nature. Middle income (R2, 501-R8, 000) earners were the dominant users (almost 60%) of the Rea Vaya in the Soweto corridor, as revealed by a research done by Vaz and Venter (2012).

Furthermore, as revealed by the Gauteng Profile of the National Household Travel Survey 2013, travel cost is the most influential factor for household modal choice in CoJ, Tshwane and Ekurhuleni (StatsSA, 2014:6). Rea Vaya's appeal may be strengthened if fares are reviewed to reflect current realities. A 27km trip from Soweto to Johannesburg costs R14.00 on the minibus taxi, while a similar 25.1-35km trip on the Rea Vaya is also R14.00 (Table 7.12). In addition, Rea Vaya's fares are worked out according to distance travelled, with the amount charged per kilometer decreasing with an increase in trip length. Conversely, the minibus taxi's flexibility is reflected in its fare structure, with fares mostly dependent on the corridor's level of affluence. A point of reference from Table 7.13 is the Soweto-Johannesburg corridor, which is the second longest distance (27km), but whose fare (R14.00) is considerably low compared to the affluent Sandton-Midrand corridor (R20.50) with a shorter distance (16.5km).

Table 7.12: Rea Vaya's fare structure as of 1 July, 2018, (reflecting decrease in fare/km with increased trip length)

Journey length (km)	2017/18 fares (Rand)	Approximate R/Km fare	2018/19 fares (Rand)
0-5	7	1.4	7.5
5.1-10 (3)	8.5	0.85	9
10.1-15	10.5	0.7	11
15.1-25 (1)	12.5	0.5	13
25.1-35 (2)	13.5	0.38	14
More than 35	14.5		15
Single trip card	15		15.5

Source: Rea Vaya (2018a)

Table 7.13: Minibus taxi fares reflecting price flexibility subject to corridor affluence

Origin	Destination	Approximate distance (km)	Price (Rand)	Approximate R/Km
Johannesburg	Pretoria	65	40	0.62
Sandton	Midrand	16.5 (1)	20.5	1.24
Soweto	Johannesburg	27 (2)	14	0.52
Pretoria	Mamelodi	24.3 (1)	14	0.58
Johannesburg	Sandton	15.2 (1)	12	0.79
Alexandra	Sandton	7.3 (3)	11	1.50

Source: BusinessTech (2017a)

Likewise, the failure of Rea Vaya to stimulate the anticipated modal change from private car use has been associated with limited network and its non-flexible nature as cited by minibus taxi users (Ubisi, 2016:83). Incidentally, flexibility was one of the three dominant determinants of modal choice in the 2013 national travel survey.

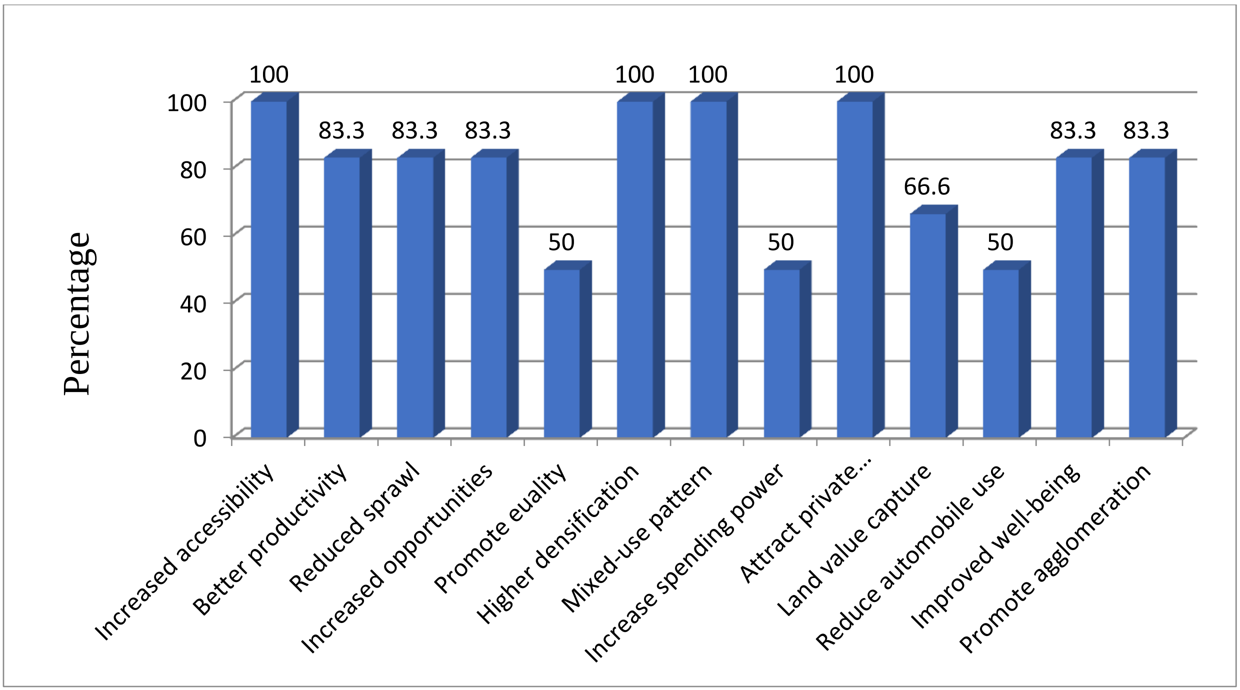


Figure 7.9: Frequency of respondents' views on likely outcomes from future expansions of the Gautrain and Rea Vaya BRT

Source: Own construction (2018)

7.8. Provision for public participation

It is essential for institutions with transport and spatial planning mandates to engage with all key players in the communities hosting their projects. In a South African context, such players include property owners/tenants, public transport users, private car drivers, pedestrians, business owners and the ubiquitous minibus-taxi owners and drivers who have perennially seen new public transport initiatives as a threat to their source of livelihood. Although public participation is entrenched in the country's constitution, there is still the belief in literature that the citizens are disenfranchised on matters that directly impacts on their daily lives (Heyns & Luke, 2013:1). Heyns and Luke (2013) suggested the use of public opinion polls as a tool to bridge the existing disconnect that authors like Friedman (2012) and Raghavan (2012) rightly claim exists between transport policy objectives and public expectations.

This study aims to establish the extent of the interface between respondents (institutions) and the public, especially in their line of work. They were asked to describe their level of interaction with the public, especially those directly affected by their operations. 50% of them believe they strongly engage with host communities while only 16% think they have a very strong interface with the target population affected by the execution of their mandates. The rest agreed that they do not connect with the public at both the planning and implementation stages of their mandates, as the interface is either weak or very weak. Such lack of communication, and other limitations to policy implementation and coordination (i.e. fragmented planning and funding system) have resulted in “a large section of the population being disorientated on which sphere of government is responsible for the provision of transport” (Heyns & Luke, 2013:6).

Similarly, in a research done by Ubisi (2016) on the social impacts of Rea Vaya BRT on residents of Moroka, Soweto, it was observed that a mere 15% of respondents claimed to have prior knowledge of the BRT project before commencement of construction. Interestingly, these 15% had some form of political or employment connection with the city. It was established that residents were not consulted at the planning stage, contrary to claims by the government (Rea Vaya publications) that the planning involved extensive public participation. The minibus taxi drivers appeared to be the only section of the host community that was not disenfranchised (Ubisi, 2016:67-68).

As a result, a strong interface with all role players in the public sphere appears to be the only acceptable remedy for such disconnections between institutional players and the public. Although the CoJ has taken positive steps by organizing public engagement sections, like the Corridors of Freedom interactive sections and exhibitions done for residents of Brixton, Auckland Park and Westdene from February 20-25, 2017 (Northcliff Melville Times, 2017); there is a need to do more by way of reducing ambiguities associated with institutional fragmentations and a higher frequency of interactions with every facet of the public.

7.9. Private sector response to Urban Development Zone (UDZ) tax incentives

The two respondents from the City of Johannesburg Metropolitan Municipality and the SACN were asked if the private sector has responded to the government’s introduction of tax incentives in the Urban Development Zone (inner city). It is a stimulus measure from the government for private sector investment in bulk high-rise residential properties in the inner city. However, they both think that the response has been poor. An assertion that is also buttressed by Todes (2012: 163 who believes that private developers have not responded well to the density bonus imitative of the city’s Growth Management Strategy (GMS) because they fear that developments might exceed market demand. In addition to the above views, Todes (2012) further cautioned on the shortage of infrastructure for such development capacities due to budget constraints and historical underinvestment.

7.10. Conclusion

The research findings were presented, with focus on: the catchment areas of Rea Vaya BRT and Gautrain; the existing travel pattern in Johannesburg and Gauteng; and a presentation of information obtained from questionnaire respondents. The next chapters will discuss the conclusions and recommendation from the study.

CHAPTER 8: CONCLUSIONS

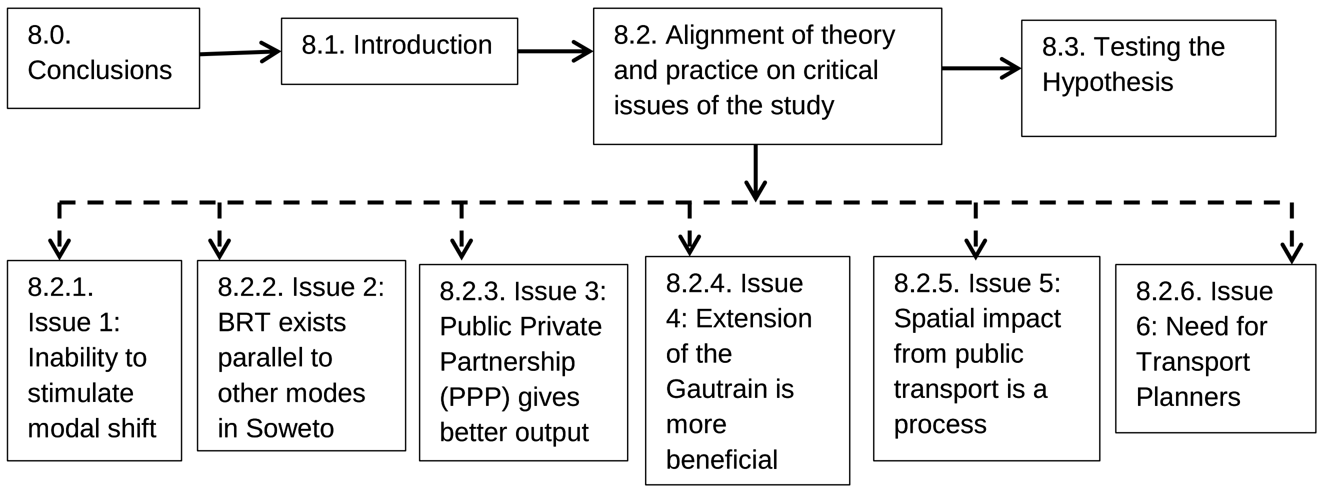


Figure 8.0: Layout and footprint of chapter 8

8.1. Introduction

Post-apartheid spatial and transportation planning in South Africa has been shaped by a new policy approach that prioritize integration of once divided urban areas and provision of improved public transport systems (illustrated in Figure 8.1) that facilitate access to economic opportunities for previously marginalized townships. In this regard, the City of Johannesburg has demonstrated changes such as: the infiltration of non-white residents into areas previously exclusive to the whites; implementation of the Rea Vaya BRT to connect its biggest township (Soweto) to the CBD; the minibus taxi recapitalization programme, with the objective of reducing carbon emission; identification of the Public Transport Management Area and Consolidation Zone as the nuclei of the city's future public and private investments; and alignment of its TOD imperatives with the existing three formal public transport modes (Rea Vaya BRT, Metro rail and Gautrain).

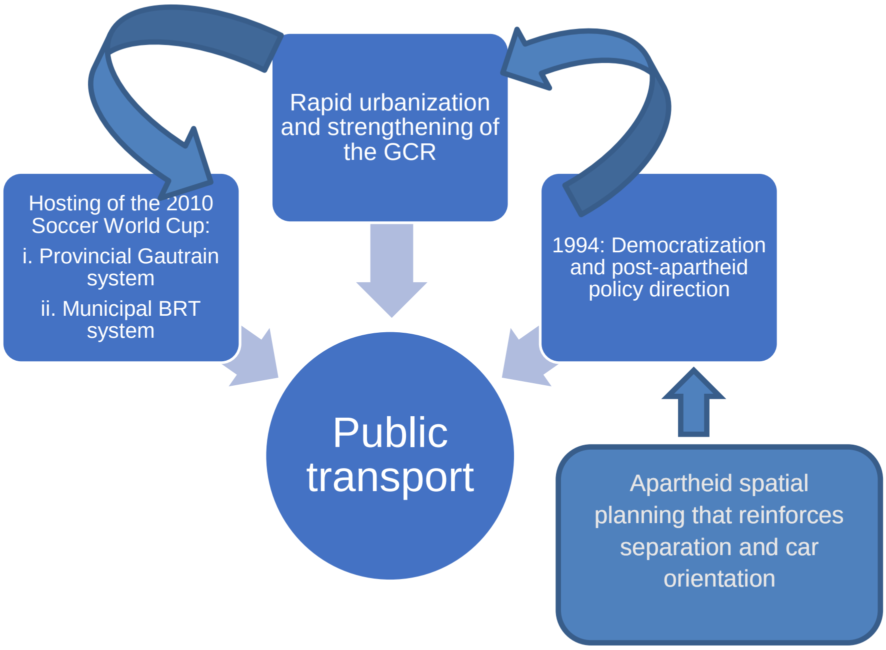


Figure 8.1: Milestones in Johannesburg's gravitation towards public transport

Source: Own construction (2018)

However, the historically entrenched job-housing mismatch that was a hallmark of the apartheid era has hampered the overall output of the BRT. The impact of the BRT on a local scale has been undermined by the absence of public and private investments necessary for such transformations. Although its existing and future corridors, combined with the existing Gautrain corridors have become the bedrock of the city's spatial planning that seeks to reinforce the post-apartheid policy direction.

The research provided insights into residents' travel patterns and how much the BRT and Gautrain have become incorporated into their modal choices. Against this background, the study propounds that residents' travel pattern is informed by factors that include income, employment status, nature of the job, accessibility of the travel mode, distance to employment opportunities for job seekers and availability of the different modes. It is evident that the Rea Vaya has struggled with ending the dominance of the minibus taxi, and though there have been reasonable sentiments surrounding the Gautrain; its strong institutional setup remains a catalyst to the achievement of the planning objectives.

The impact on transport planning is determined by the abilities of the two modes to influence (i) residents travel pattern and (ii) the city's changing planning trajectories. Against this background and with reference to the city's Strategic Integrated Transport Plan Framework (SITPF), the Strategic Area Frameworks for the Corridors of Freedom and the Urban Design Frameworks for the five Gautrain station nodes; the researcher has drawn useful conclusions. In the same vein, the alignment of theory and empirical findings is articulated to identify possible theory-practice gaps.

8.2. Alignment of theory and practice on critical issues of the study

The background to the study is informed by its theoretical framework that highlights post-apartheid spatial planning as the beginning of spatial and transport planning transformation in South Africa. Sustainable urban transportation was articulated as the panacea to the inadequate public transport provisions and haphazard spatial developments in developing countries. The central theme realized that sustainable public transport profoundly influences the land-use, transport and environmental management interface, with outcomes that are more acceptable when juxtaposed against the private car oriented cities like Johannesburg. Cases of cities with, or on the path of integrated public transportation were presented to establish a link between what is observed in countries belonging to the same stage of development as South Africa, and Johannesburg’s approach to spatial and transport transformation.

Although Brisbane is a developed country city, and in spite of fierce competition from the private car, it demonstrated that improved outcomes from public transportation can be facilitated by institutional and physical integration of different modes. In the same vein, reflections from Ahmedabad, India imply that context-specific planning and design process reinforced by strong public participation, institutional and physical integration with competing modes can largely facilitate better outcomes. It became apparent that there is a need for a strong policy and legislative framework to guide all role players in the provision of extensive public transport.

The highly fragmented and complex nature of the policy and legislative framework in a South African context was highlighted in the research (illustrated by Figure 8.2). This is attributable to a lack of clarity that resulted in different interpretations until the promulgation of SPLUMA (2013) and its Regulations (2015). SPLUMA has empowered the local sphere of government and it became the overarching policy that guides the country in the space, sector, time and institution perspective (illustrated by Figure 8.3). Statutorily, each municipality must approve and adopt a single land use management scheme for its entire area within 5 years from the enactment of SPLUMA. At the municipal level, institutional and sector alignment is promoted by SPLUMA through the statutory Integrated Development Plan. The research revealed that the overlapping nature of the different sector plans is guided by their uniform conformity to the municipal IDP. Both the municipal ITP and IEM are linked to the SDF, and the relationship is guided by SPLUMA.

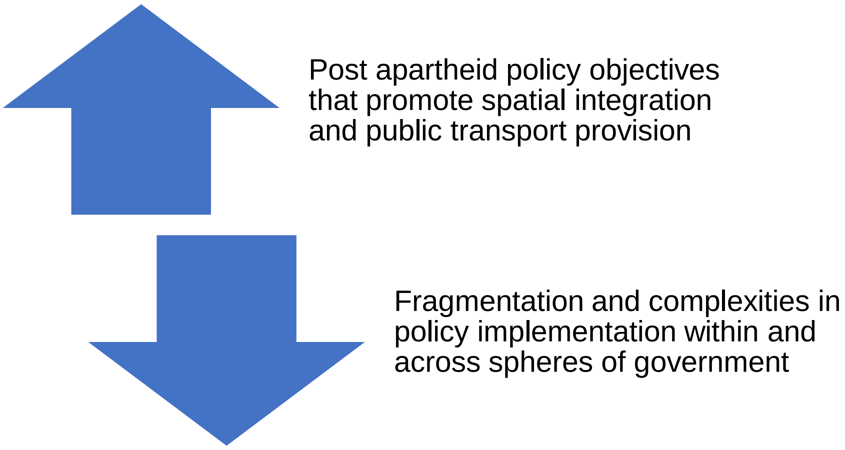


Figure 8.2: South Africa's conflicting landscape before the promulgation of SPLUMA

Source: Own construction (2018)

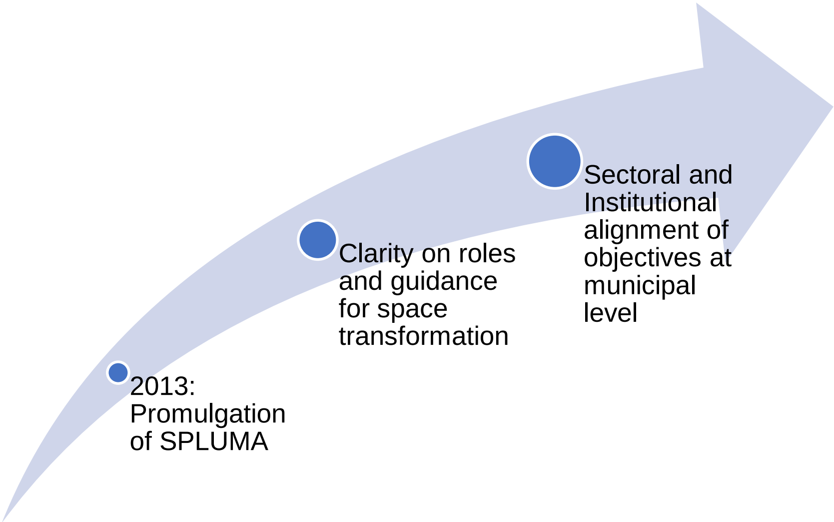


Figure 8.3: South Africa's upward trajectory since the promulgation of SPLUMA (2013)

Source: Own construction (2018)

To give effect to SPLUMA, each municipality will have to: approve and publish context specific by-laws, as well as establish a Municipal Planning Tribunal to determine land use and development application within its jurisdiction. The core contents of SPLUMA are graphically presented in Figure 8.4.

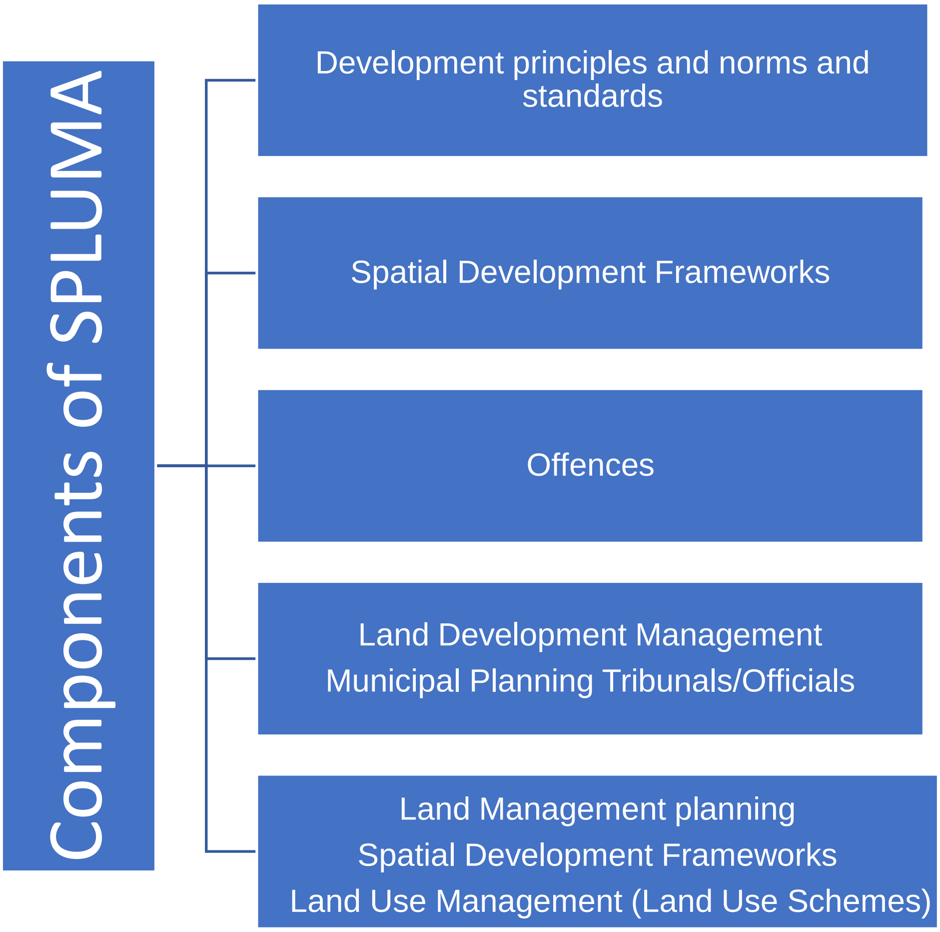


Figure 8.4: Components of SPLUMA

Source: Own construction (2019)

Regarding the case study under scope (CoJ), its SDF is premised on managed growth in strategic areas of the city, underpinned by multi modal transportation and a land use pattern that promotes public transport and NMTs. The study established that the spatial transformation of Johannesburg is a process that must consolidate differing institutional objectives and strongly incorporate all levels of the private sector.

A strong case was made for intermodal integration as a key impetus towards the achievement of institutional, sectoral and policy objectives. Though the Rea Vaya is yet to catalyze spatial transformation and has also not met its ridership projections, the study affirms that it continues to influence the city's transport planning with the recent implementation of the Phase 1C. Incidentally, the research revealed that such commitment to policy objective has not been supported by a first-hand understanding of residents travel pattern – a key transport planning component. Future expansions and provisions of similar projects should be premised on reports from provincial and household travel surveys (e.g. GHHTS & NHHTS) because they provide useful insights in this regard.

Similarly, the catchment areas of the first two phases of the Rea Vaya have been unable to stimulate spatial change because they are outside of the city's northern part, an area that has attracted the most private sector investment in the last 10 years. The conclusions drawn for the critical issues identified are given below:

8.2.1. Issue 1: Inability to stimulate a modal shift

The Rea Vaya BRT and the Gautrain were implemented to provide for the need of separate income categories. While the Gautrain has enhanced mobility between the Gauteng's three major metros and the OR Tambo International Airport (especially along the Randburg-OR Tambo corridor), the private car is still the dominant mode used for inter-municipal trips. Trips between Ekurhuleni and the City of Johannesburg are the highest of such trips, mostly due to clusters of service, retail, commercial and industrial employment nodes. The Gautrain is presently at the maturity phase of its service lifecycle, but the freeways linking the three metros are still characterized by private car congestion at peak periods. Implicitly, the system lacks the capacity for the daily inter-municipal peak-period commutes. Its ability to attract the anticipated private car users is directly related to its catchment area and peak-period capacity. Figure 8.5 is an illustration of the city's complex formal public transport landscape.

The Rea Vaya has emerged as a link between historically marginalized townships (especially Soweto) and economic nodes like the CBD and Sandton. The city has implemented the first three phases and its potentials can be realized if teething problems like non-flexibility, non-integration and unstable price regime can be addressed. However, ridership is presently a far cry from projected numbers and it is still beyond the reach of the extremely low income earners. They are left with options like walking and the Metro rail, which remains Johannesburg's cheapest public transport mode. Though most users of the Metro rail can be regarded as captive users because its travel time is highest and it has the poorest accessibility.

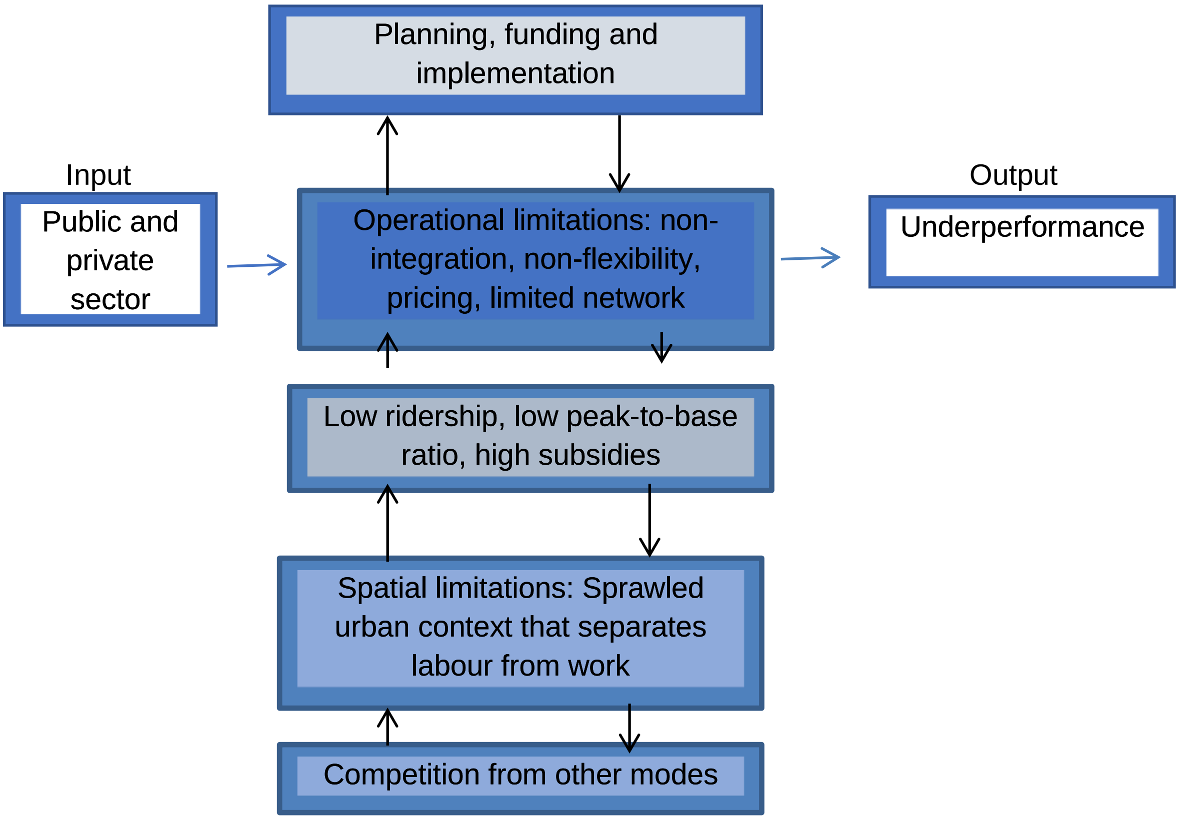


Figure 8.5: Complex relationships in Johannesburg's formal public transport landscape

Source: Own construction (2018)

8.2.2. Issue 2: BRT exists parallel to other modes in Soweto

Though the Rea Vaya was implemented to move workers from Soweto to the city's core economic nodes, it exists parallel to other public transport modes (metro rail, minibus taxi and the metro bus). Incidentally, each of the other three has at least one of the factors that determine residents' modal choice, as revealed by the NHHTS 2013. The metro rail, though have the highest travel time, is the cheapest; the minibus taxi is quite flexible; and the metro bus is cheaper than the Rea Vaya. These factors will continue to influence modal choice and may continue to limit the BRT from attracting more users in Soweto. In terms of safety from accidents, it is concluded that the BRT is safer than the minibus taxi and metro bus because of its dedicated lanes, but due to changes in commuters' preferences, this factor has been replaced by the top three illustrated in Figure 8.6. Safety was one of the three determinants identified in the NHHTS 2003. This implies that people's preferences change overtime.

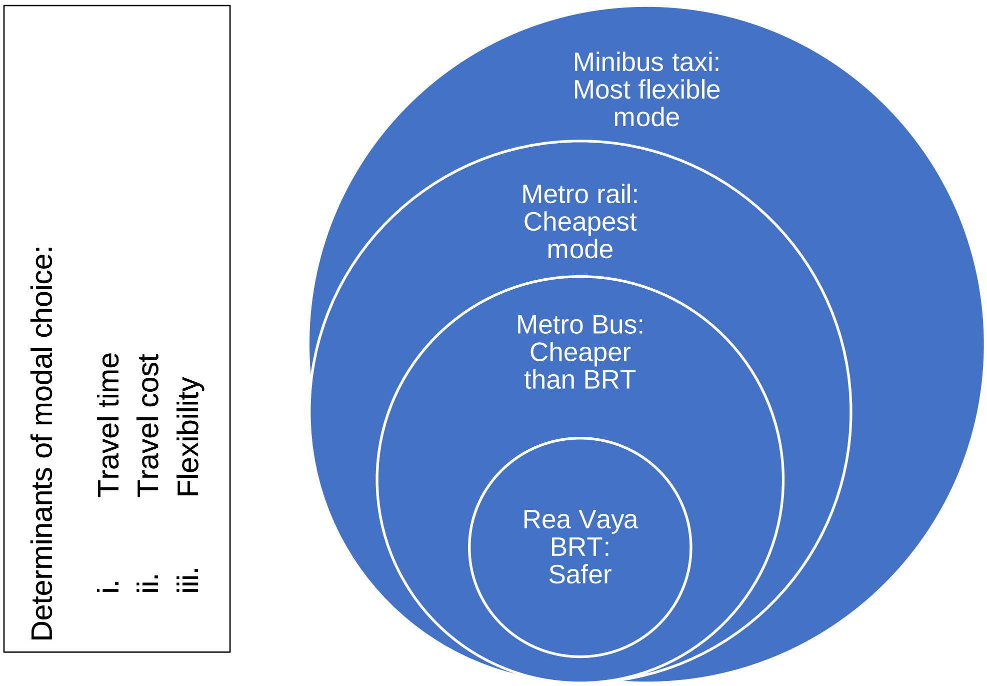


Figure 8.6: Key strengths of parallel public transport modes in Soweto

Source: Own construction (2018)

8.2.3. Issue 3: Public-Private Partnership (PPP) gives better output

This ownership arrangement ensures all role players give their best inputs to protect their interests. The study shows that all the respondents (public institutions) have institutional (formal) interface with the Bombela Consortium (operators of the Gautrain). The Gautrain's optimal peak period ridership figures and the satisfactory feedbacks recorded from users' survey are reflections of likely outcomes from public-private ownership projects. In as much as the Rea Vaya equally incorporates former players of the taxi industry to make ownership and operations formal, the city is solely responsible for the funding; and such arrangement will not produce the same results as seen in the Gautrain.

8.2.4. Issue 4: Extension of the Gautrain is more beneficial

Planned extensions to the Gautrain are still in the conception stage but there have been media speculations of future expansions to the west of Johannesburg, the east of Tshwane and south of Ekurhuleni. The potentials of future expansions will reduce travel time between the two metros, with a likely reduction in travel cost influenced by market forces (increased ridership). These two factors are part of the three determinants of citizens modal choice in the last national travel survey. Although such growth in ridership can only be an equally opposite reaction to actions that enhance service provision and capacity building. Measures like the recent increase in fuel price and the e-tolling of provincial freeways can also compel car users to leave their cars for a regional public transport mode with an expansive network. Figure 8.7 is an illustration of a set of interdependent inputs and outputs that will occur from an expansion of the Gautrain.

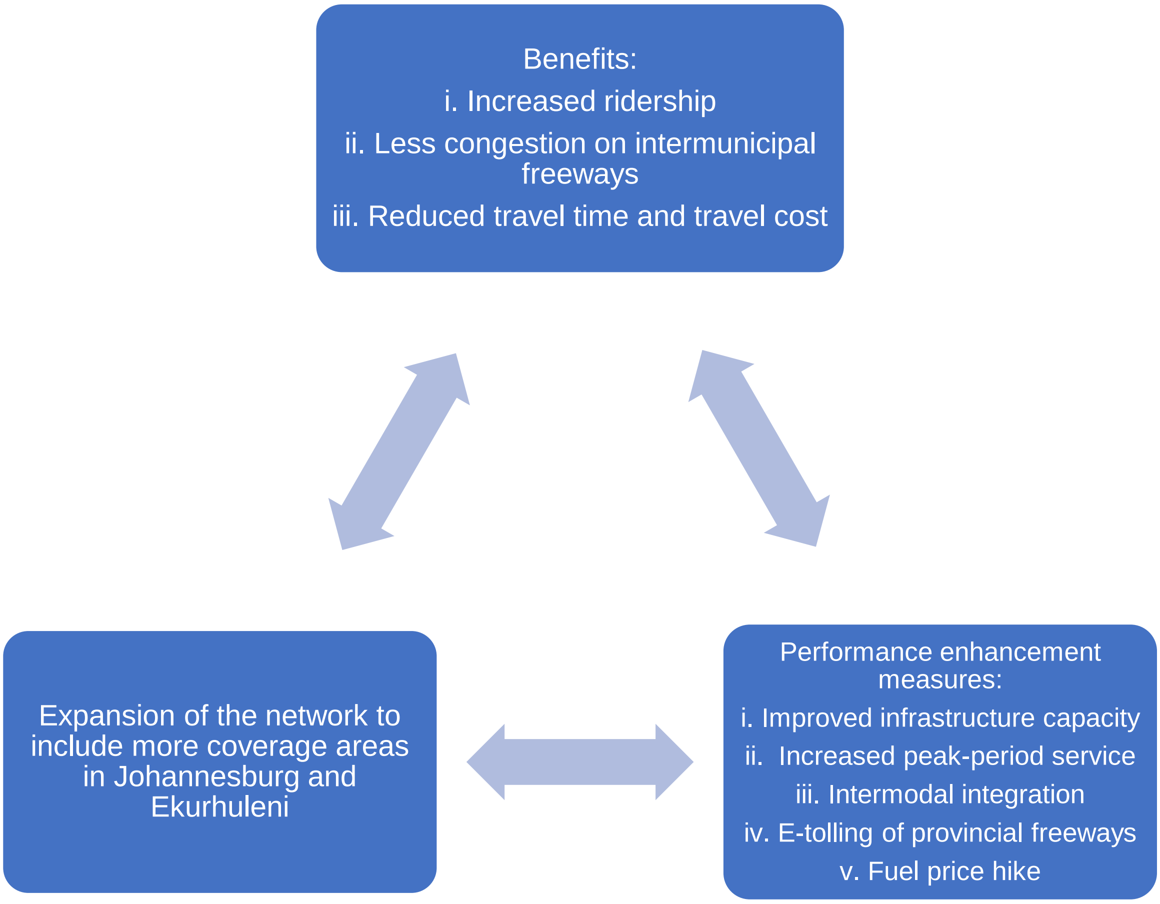


Figure 8.7: Likely outcomes of Gautrain expansion

Source: Own construction (2018)

8.2.5. Issue 5: Spatial impact from public transport is a process

The Sandton and Rosebank stations have had promising spatial impacts, though such developments have mostly been office buildings whose prices are exclusively for the elites. The remaining three stations in Johannesburg have not catalyzed the expected surge in private investments associated with a project like Gautrain. Nevertheless, the study believes that it is still early days, and that such changes take more than 10 years, considering factors like land use management barriers, funding and provision of adequate infrastructure by government. In addition the UDFs for most of the stations have not been implemented and they are guides to both the public and private sectors on the TOD futures of these precincts.

The Rea Vaya has not spatially impacted on its routes but the city's Corridors of Freedom initiative is premised on existing and future Rea Vaya corridors. The Gautrain and PRASA metro rail corridors are also included in this plan, and this reflects in the Urban Design Frameworks and Precinct Plans of areas like Sandton and Midrand.

8.2.6. Issue 6: Need for Transport Planners

The study revealed that there is a great disconnect between the travel patterns of Johannesburg's different urban contexts and the public transport initiatives of the city. Trip generation is dependent on the level of income, meaning the more affluent areas generate more trips. Though these areas are private car oriented because of their high purchasing power and lack of viable alternative to their cars. Similarly, the historically marginalized township of Soweto, which serves as the origin of Rea Vaya's first two phases, generates more educational trips than work trips. The learners are actually the highest users of the buses in Soweto and Orange Farm. This revelation is in contrast with the Rea Vaya's objective of replacing the minibus taxi as the choice mode for work trips. Walking and minibus taxis remain the predominant modes for work trips in the townships. In addition, by drawing from the study's stance on the need for professional municipal transport planners, it appears there were gaps in this regard, at the BRT's planning stage. Transport planning is dynamic, and must provide solutions based on clear understanding of users' present and projected travel patterns.

8.3. Testing the Hypothesis

The hypothesis outlined in section 1.4 has been proven correct. The empirical findings revealed that:

- The Rea Vaya BRT and Gautrain have not influenced residents' modal choices due to reasons such as non-flexibility, ease of access and affordability;
- Outcomes have been largely informed by the city's reactive approach to land-use and transport integration, which, as established from the theoretical founding generates successful outcomes if proactively integrated at the planning stage.

8.4. Conclusion

The transport planning trajectory of Johannesburg changed with the preparation for hosting the 2010 Soccer World Cup. While the Rea Vaya has been developed up to Phase 1C, though still underperforming; the Gautrain is setting precedents in the context of creating a viable alternative to the private car. Though the two systems have not had profound spatial impacts, there are potentials for anticipated outcomes if all role players become more result oriented and the

Strategic Area Frameworks and the Urban Design Frameworks are implemented with a sense of accountability. The next chapter will provide recommendations and areas for further research.

CHAPTER 9: STRATEGIC PLANNING RECOMMENDATIONS

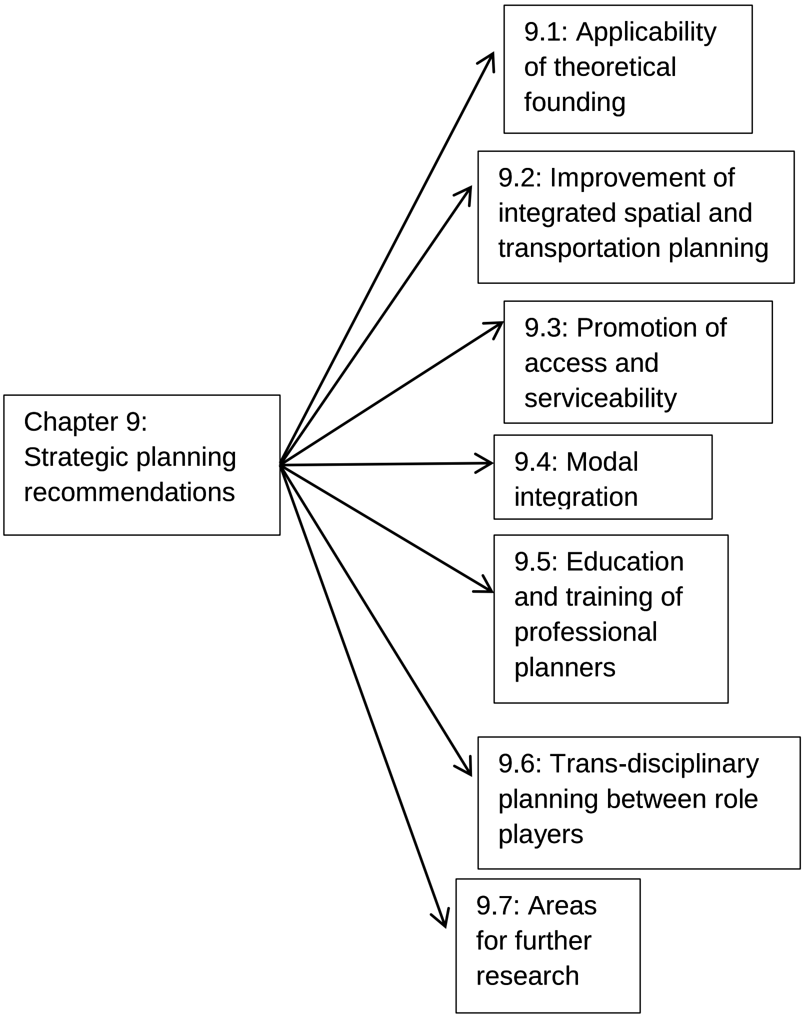
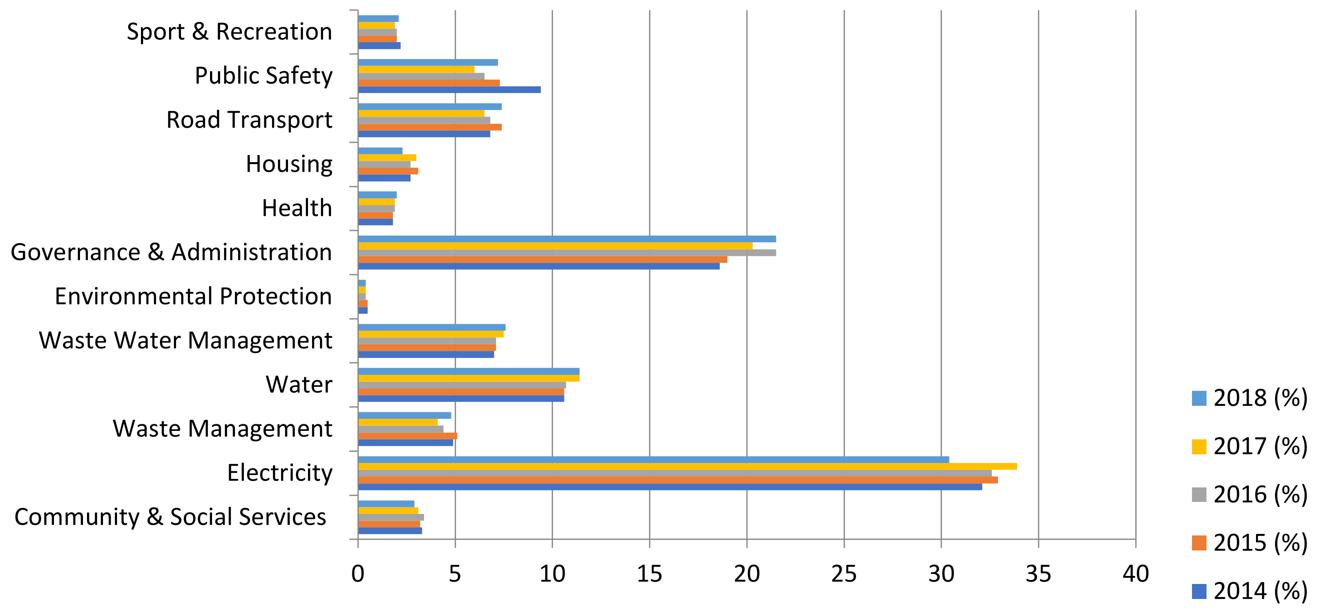


Figure 9.0: Layout and framework for chapter 9

9.1. Applicability of theoretical founding

The sprawled and fragmented nature of the study area, which is informed by pre-democracy planning and policies, has influenced public investments in the provision of infrastructure, public services and transportation. According to Figure 9.1, electricity, water, waste-water management, waste management, public safety and road transport are the sectors that have attracted the largest investments over the last 5 (2014-2018) years. It appears that public investment in the provision of electricity continues to dominate the city's expenditure, a justification for the need to promote urban strategies that facilitate connectivity and compact growth.

The study argues that a compact city limits energy use on transportation, as well as the production and distribution of electricity, because shorter distances between places may lead to reduced cost of infrastructure.



	Community & Social Services	Electricity	Waste Management	Water	Waste Water Management	Environmental Protection	Governance & Administration	Health	Housing	Road Transport	Public Safety	Sport & Recreation
2018 (%)	2.9	30.4	4.8	11.4	7.6	0.4	21.5	2	2.3	7.4	7.2	2.1
2017 (%)	3.1	33.9	4.1	11.4	7.5	0.4	20.3	1.9	3	6.5	6	1.9
2016 (%)	3.4	32.6	4.4	10.7	7.1	0.4	21.5	1.9	2.7	6.8	6.5	2
2015 (%)	3.2	32.9	5.1	10.6	7.1	0.5	19	1.8	3.1	7.4	7.3	2
2014 (%)	3.3	32.1	4.9	10.6	7	0.5	18.6	1.8	2.7	6.8	9.4	2.2

Figure 9.1: Historical capital expenditure on service provision by the city of Johannesburg

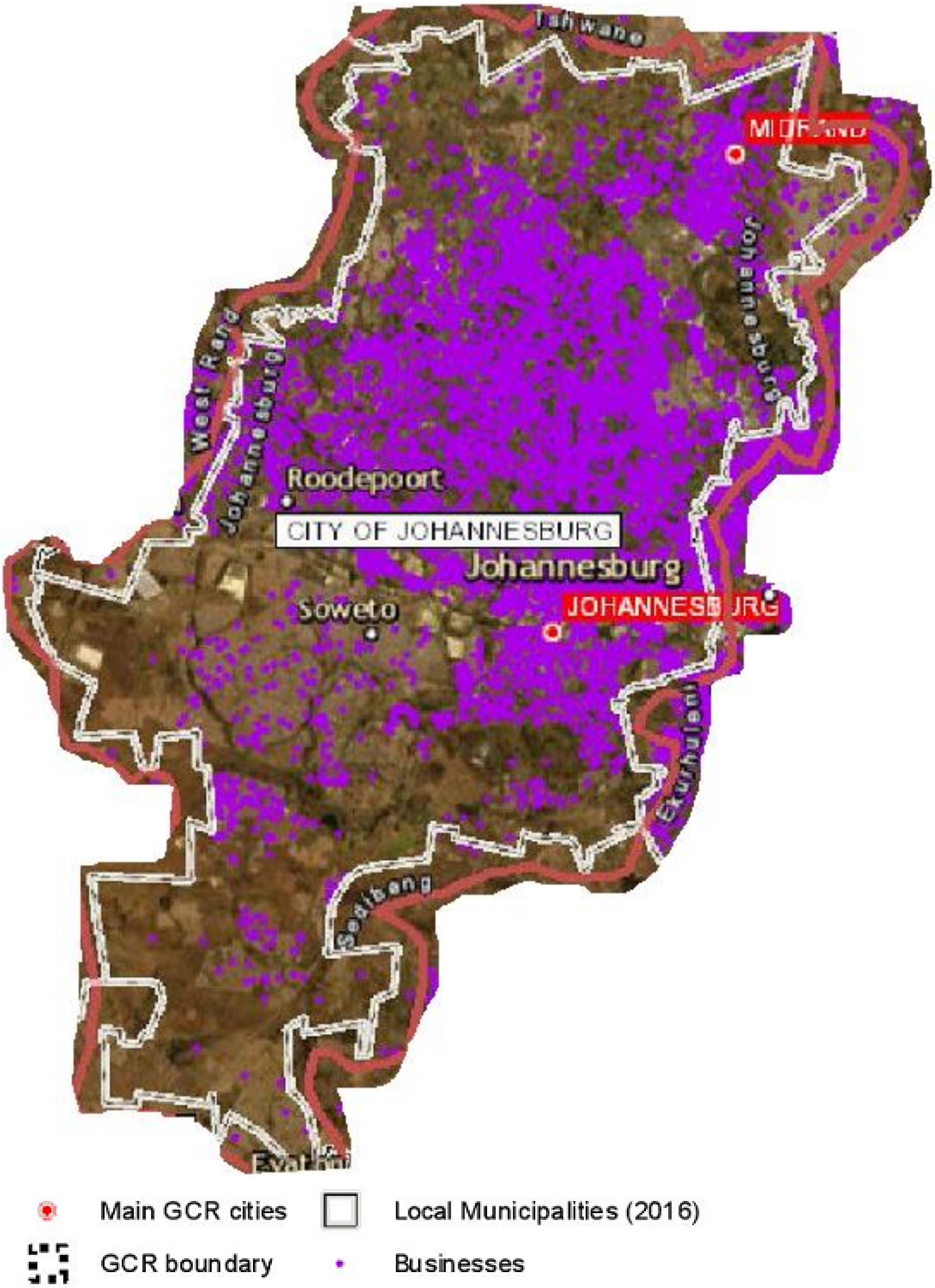
Source: https://municipalmoney.gov.za/profiles/municipality-JHB-city-of-johannesburg/#spending

This sprawl-induced high costs of infrastructure is further exacerbated by infrastructure decay and service delivery breakdowns, identified as a major challenge in the city's Annual Report (2017/2018). These breakdowns result from lack of infrastructure maintenance and the absence of long term planning.

By drawing from the various views on the significance of promoting compact urban forms, as against dispersed and open patterns of urban development, the study advocates for planning strategies that would catalyze a sustainable urban form in the study area, with emphasis on high density, compact, mixed-use developments reinforced by affordable multi-modal public transportation system. This recommendation underlines the significance of spatial planning, highlighted by its strategic and integrated approach, cross-sectoral coordination and entrenchment of long-range planning on a metropolitan scale. It is argued that the implementation of spatial planning imperatives in the City of Johannesburg, as promoted in theory, would limit service breakdowns induced by inadequate infrastructure maintenance. This is because, in contrast to conventional planning, strategic plans are subject to regular reviews, with attention paid to institutional aspects, financing and sequencing of development.

With regards to the promotion of compact urban form, the city's SDF envisions a future metropolitan region with a hierarchy of dense mixed-use areas, reinforced by corridors and nodes connected by an efficient public transit system. It is recommended that investment in road transport should receive more attention, especially given the metropolitan scale of the study area, because adequate connectivity and a vibrant regional transport may reinforce the economic and other inter-dependencies between the core and the periphery. In theory, a region is described as an agglomeration of specialized industries, service industry locations, a pattern of transport nodes and links that promote optimal accessibility to these activity areas.

However, it is argued that the dispersed nature of the study area, which has increasingly reinforced longer trip distances between origin (home) and destinations (work), has undermined the significance of existing transport links, with regards to the optimization accessibility. For example, the distance from Soweto to Sandton, which this study established as the highest trip attractor in the study area is over 40 kilometers. Similarly, sprawled areas like Diepsloot and Zandspruit are between 15 to 20 kilometers far from the closest secondary metropolitan sub-centers of Randburg and Midrand. This view is further reinforced in Map 9.1 which shows that: (i) townships such as Soweto do not have clusters of businesses relative to the CBD and northwards towards Sandton, Randburg and Midrand, and (ii) they do lack proximity to these centers of economic activities.



Map 9.1: Businesses (intense economic activities) in the City of Johannesburg

Source: GCRO GIS Viewer (2019)

It is recommended that commute distances could be reduced through the entrenchment of the city's polycentric urban form. The three principal metropolitan sub-centers, Sandton (existing), Soweto (emerging) and Modderfontein (future), which have been identified in the municipal SDF could facilitate the city's polycentric growth objectives. While the city appears to have adopted compact growth through its SDF, it is however recommended that investments in rapid transit at outer suburbs like Cosmo City and Ivory Park that represent sites for future nodes should be promoted. This is because private car trips from these suburbs may decline; thereby limiting private car influence on pedestrians and public transport oriented inner nodes.

9.2. Improvement of integrated spatial and transportation planning

The Rea Vaya currently exists parallel to the dominant public transport mode (minibus taxi) in these townships. Future expansions and implementation of similar projects must incorporate elements of travel demand and population forecasts to determine the best mode for route and consolidate resources to strengthen it. The three metro municipalities, through an umbrella Transport Authority, can implement a provincial BRT that will be integrated with the Gautrain on the Randburg-OR Tambo corridor and the Randburg-Centurion corridor. It should be an elitist BRT that will provide a viable alternative to the dominant private car on these corridors.

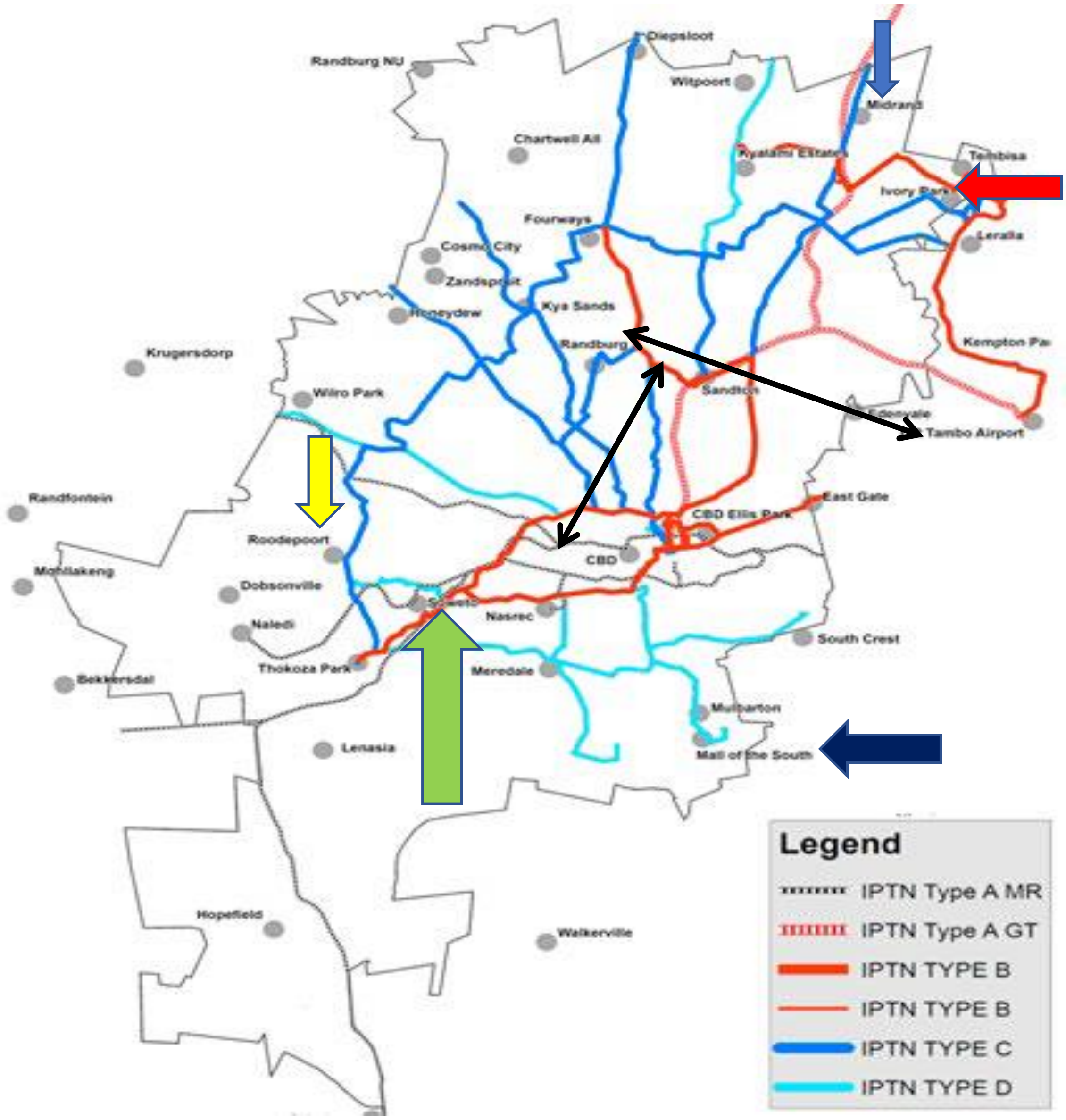
The CoJ metro municipality must demonstrate an understanding of the city's different contexts by reinforcing the dominant modes (walking and minibus taxi) for work trips in the townships, to accommodate more users and increase productivity. Work trips in Johannesburg Central are also pedestrian and taxi oriented. An improvement in pedestrian movement in Johannesburg Central will have a spin-off effect on adjacent nodes and modes, a situation that will consolidate previous measures.

Furthermore, the study revealed that the Gautrain was implemented to alleviate traffic congestion on the N1 freeway between Johannesburg and Pretoria by providing a fast and reliable alternative. Likewise, the network will imminently be extended to western nodes like Soweto and Roodepoort. However, in as much as the study recommends the expansion of the Gautrain, all role players should ensure that it is premised on residents' travel behavior. The objective of reducing congestion between Johannesburg and Pretoria does not align with the province's current travel pattern, as highlighted under research findings.

Trips are more intense between Johannesburg and Ekurhuleni, and this implies that the provincial government must ensure that future projects similar to the Gautrain is/are implemented based on an understanding of inter-municipal travel pattern. Because of its capital intensive and highly subsidized nature (every Gautrain trip is subsidized with about R60.00), every new kilometer added to the network must be justified to offer returns for the money invested. Resources must be consolidated (e.g. through the recommended Regional Transport Authority) to ease the congestion caused by intense private car use on the Randburg-OR Tambo corridor.

To reinforce this recommendation, this study proposes a strategic implementation of nodal and corridor development in the City of Johannesburg. As illustrated in Map 9.2, TOD-based corridor development may be facilitated on the Randburg-Sandton-OR Tambo and the Louis Botha corridors; while nodal development may be promoted at Midrand, Ivory Park, Roodepoort, Soweto and Mall of the South.

In addition, all facets of the public must be consulted at both the planning and implementation stages of projects like the Rea Vaya and Gautrain. The study reveals that the public institutions have a strong interface with the public while undertaking their mandates, but theory does not support this assertion. Nothing short of a 'very strong' interface is the acceptable standard at every stage of planning and implementation. The municipality must avoid cases as seen in Soweto where only the minibus taxi industry and residents with some connection with the government were the only ones with prior knowledge. Planning must be all inclusive and all residents (and even learners) must be consulted at the planning stage. Consultations done at both the planning and implementation stages must provide for interactions with everyone that will be affected by the project. Academics, research publications and inputs from think tank organizations like the GCRO and CSIR must be incorporated as an essential part of the planning process.



Map 9.2: Highlight of nodes and corridors that may be developed by using TOD and nodal growth approach

Source: CoJ (2016)

Similarly, perception is a part of the implementation process that the provincial and municipal role players must take seriously. They must do more to project the brands of these transport systems and frequently sensitize the public (through jingles and physical interactions at the ward or nodal levels) on the benefits of shifting to modes that are more sustainable. The research revealed that the density bonus initiative of the municipality to attract private investors to the Urban Development Zone (UDZ) has not produced the anticipated outcomes. This is because most private players are not adequately informed about it. The municipality can contract private advert companies to assist with sensitizing the public in this regard.

9.3. Integration of role player agendas to promote access and serviceability

In spite of the progress made with the promulgation of SPLUMA, the institutional arrangement of public transport providers in South Africa is still highly fragmented. The Rea Vaya and Gautrain are owned by two different spheres of government, and most of the challenges they have are associated with the diverse interests and conflicting or duplicated objectives of the various role players. Outcomes have been severely hampered due to the fragmented and overlapping nature of the institutional arrangement for transport provision. One of the reasons the Gautrain has performed better in terms of ridership projections is because of its institutional setup. All the respondents for this study have a level of formal interaction with the Bombela Consortium (Gautrain operators), which means that the Gautrain enjoys a form of institutional appeal.

The provincial government should perform its supervisory role by overseeing the integration of the various role players in public transport provision in Gauteng. This should culminate in the creation of a unitary Transport Authority (TA) that will consolidate and protect the various interests and ensure lessons are learnt from successes and mistakes. A lack of action in this regard will continue to undermine efforts to use public transport as a tool to bridge the gaps left by apartheid. The Regional Transport Authority will consolidate functions, physical and human resources drafted from various institutions responsible for spatial and transport planning in Gauteng.

The Transport Authority will equally be responsible for physical and operational integration of the different modes in the GCR. In addition, the provincial government must ensure that the new Transport Authority operates independently, and is free from influences that may compromise its objective. As established in the study, professionals in Transport Planning and other associated professions with first-hand knowledge of the GCR's different transport and spatial contexts must form the core of the personnel of the new Transport Authority. In addition, to further highlight the significance of the three metropolitan municipalities (Tshwane, Ekurhuleni and Johannesburg), a sub-Regional Transport Authority should be formed as a subordinate of the Regional Transport Authority. It will be responsible for decisions regarding inter-municipal travel between the three metros, and will be answerable to the Provincial Authority.

The study revealed that travel is more intense between Ekurhuleni and the City of Johannesburg, and the researcher submits that forecasts on future transport solutions should seek to consolidate on the progress made with the Gautrain. The personnel in the sub-Regional Transport Authority will be drawn from the Regional Transport Authority and will be mainly professionals recruited by the provincial government and the three metros. Though they will align their roles between the two institutions, the essence is to prioritize resources in a manner that will reduce congestion caused by automobile dominance on routes between the metros. Representatives of the minibus taxi industry and PRASA will also be included as part of both institutions. Figure 9.2 gives an illustration of the components of the umbrella Transport Authority. Future expansions of the Provincial Authority can incorporate the other local and district municipalities that make up the wider Gauteng City-Region.

Furthermore, though the NLTA (2009) reinforced this focus, the country is yet to maximize the potentials entrenched in a vibrant public-private partnership. As revealed in the study, the Gautrain has provided a glimpse on what is achievable, but is still far from the best results that can be produced from stronger collaborations. The private sector must be optimally engaged in this regard, because the government lacks the capacity to single-handedly provide for the need of a growing city and city-region.

The City of Johannesburg Metropolitan Municipality must leverage on the provisions in the NLTA (2009) and forge stronger relationships with private investors with similar objectives. Similarly, the Johannesburg Development Agency (JDA), Johannesburg Property Agency and City of Johannesburg Department of Economic Development should immediately strategize and implement a new approach that is private sector oriented. Lessons must be learnt from existing arrangements and future partnerships should correct structures like the 80% public and 20% private sector funding that exists for the Gautrain. In future, such arrangement can also eliminate current sentiments on the Gautrain.

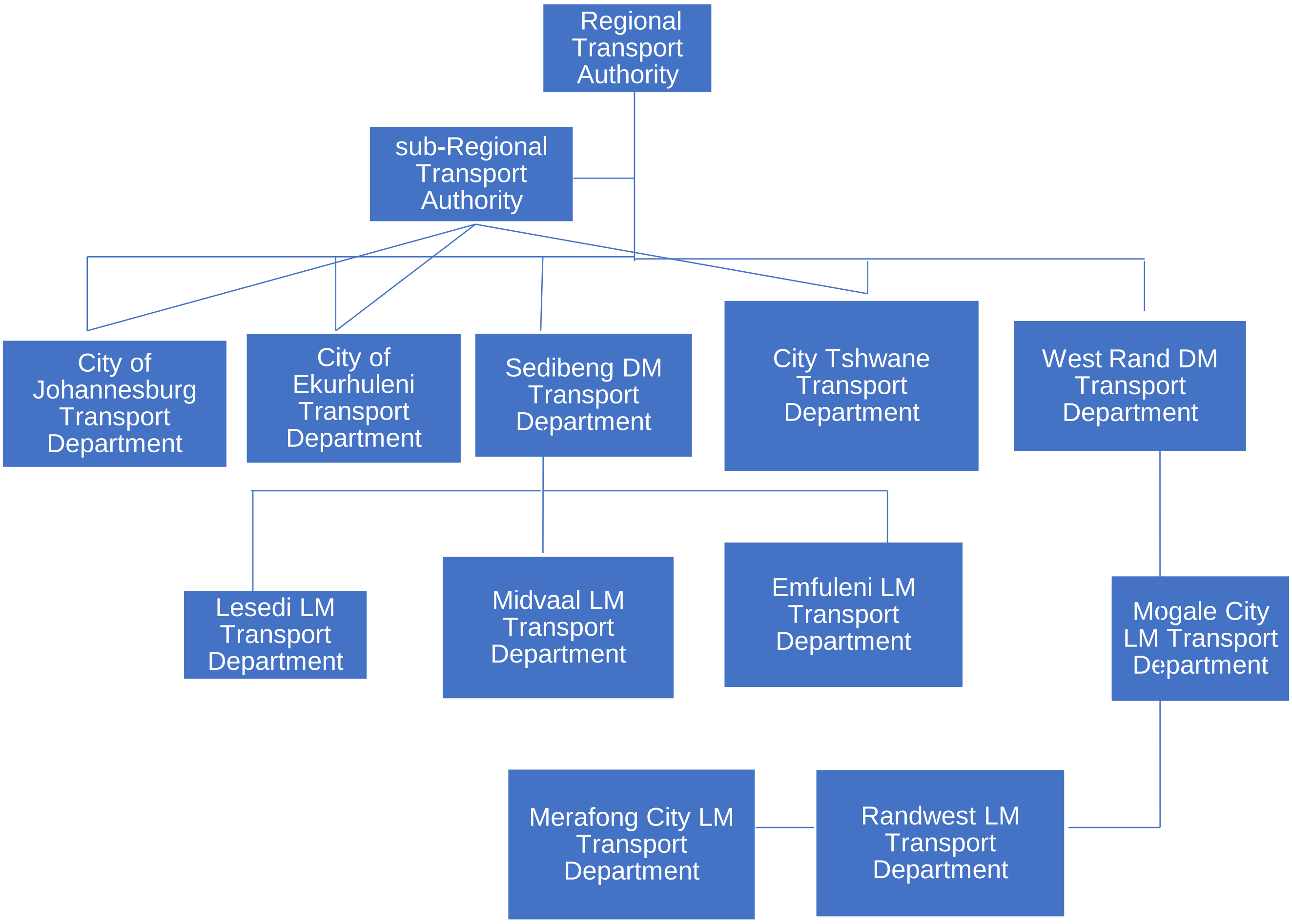


Figure 9.2: Outlook of the recommended umbrella Transport Authority in Gauteng

Source: Own construction (2018)

In addition, the new approach must incorporate all categories of private sector players, irrespective of their financial strength. The big private investors are often pushed outwards to the peripheries due to the absence of large greenfield sites and land use management bottlenecks that impede large scale spatial change. The JDA should review the current approach that limits SMMEs from investing in smaller parcels of land that are found in the city's built areas.

In another context, the public funding structure must be harmonized to drive better outcomes. The research showed that learners are the highest users of the bus in the townships and educational trips are even more than work trips. Provincially, most bus trips are for educational purpose, and this implies that the learners are the highest users of the bus mode in the province.

Currently, the Gauteng Provincial Department of Education is responsible for the provision and funding of subsidized bus services for learners in the municipalities. Such counterproductive arrangement must be reviewed to reflect an institutional understanding of users' needs and differing context. In the short term, the provincial government must prioritize funding for the scholar bus service, and increase their capacity to better serve the City of Johannesburg's learner population.

The research recommends that as a medium to long term measure, the function of providing scholar bus service should be completely devolved to the CoJ metropolitan municipality. This way, the municipality can synchronize both its funding and operations with the Rea Vaya BRT. The recommended Transport Authority is in a good position to oversee such initiative, and at the same time, it will serve as a pool of resources for changing Gauteng's transport landscape.

Finally, the travel time of the Rea Vaya must be competitive with the private car if it must attract private car users. The private car has the least average travel time (other than walking and motorcycle). The BRT must also be made flexible to attract minibus taxi users. The CoJ metro municipality must implement measures that will reduce congestion on the BRT corridors, in order to reduce its travel time. Similarly, the current pricing mechanism that seeks to recover the operational and development costs from fares must be reviewed to bring fares within the reach of extremely low income earners. Although this will mean an increase in subsidies on the BRT, complementary measures like introduction of parking tariffs in the CBD and Sandton can be used to serve the dual purpose of reducing congestion and generating revenue to offset the subsidies. Such initiatives are not new in South Africa, with the city of Cape Town currently charging about R130.00 for up to 8 hours parking in its CBD.

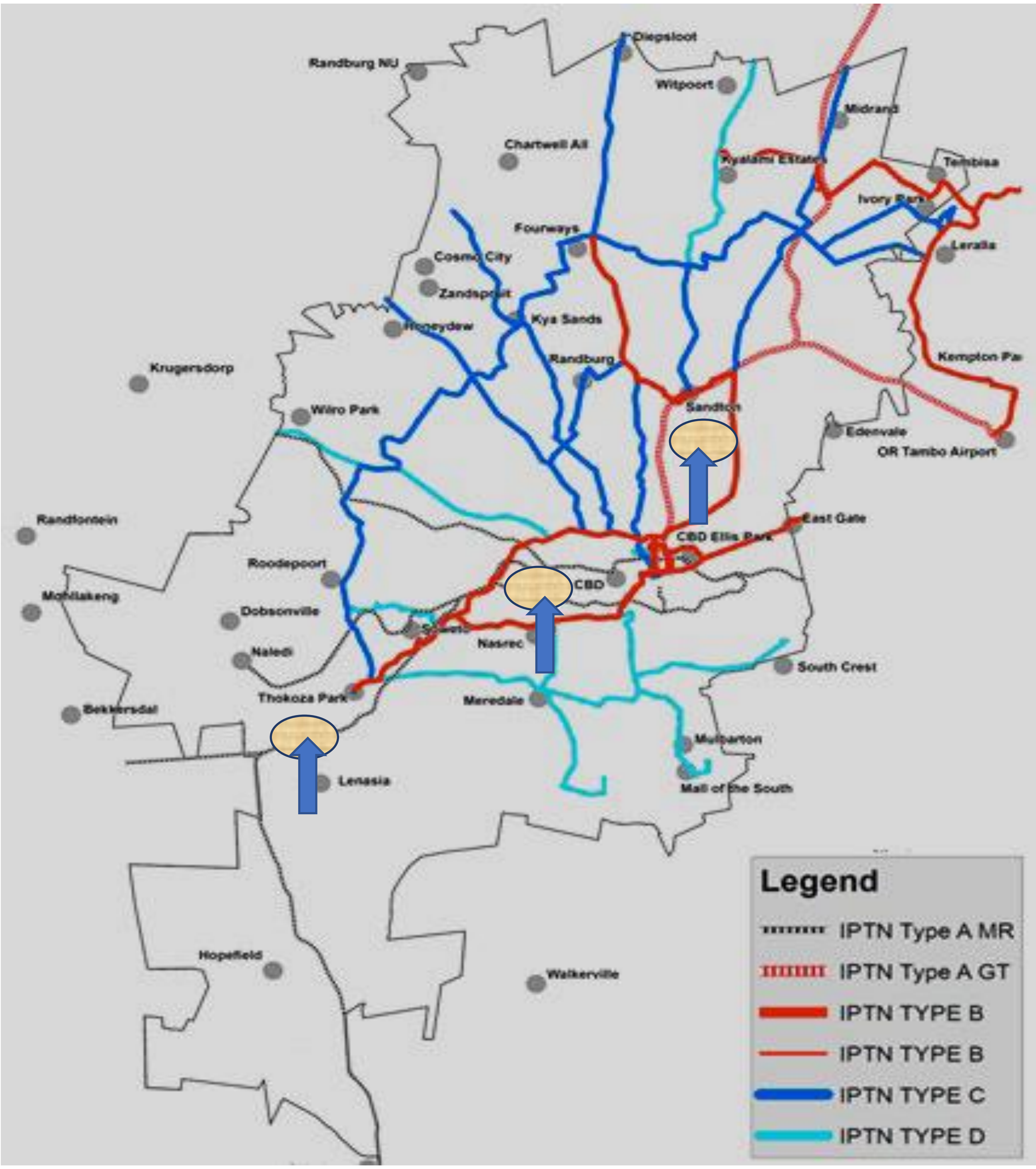
Since travel time and travel cost were two of the three determinants of modal choice in the NHHTS (2013), the BRT will become more attractive if the CoJ municipality enhances its capacity in this regard. Its capacity for spatial impact will also be strengthened with increased ridership.

Incidentally, the target users of the Gautrain are insensitive to travel cost but will equally be attracted to an equally comfortable system that is flexible, and with shorter travel time than their private cars. Therefore, Gautrain's capacity in this regard can be intensified by integrating it with NMT modes and the private car. The OR Tambo and Sandton stations have been the two busiest stations, yet peak-period congestion on this corridor (inter-municipal) is still high because it remains largely private car oriented. The provincial government should use the corridor as a flagship for incorporating walking and cycling with the Gautrain stations. Likewise, subject to historical and projected ridership figures, the peak-period train service on this corridor can be increased.

9.4. Modal integration

The research reveals that in addition to the parallel relationship of the Rea Vaya BRT with other modes in Soweto, its non-flexible nature, as well as its limited coverage area is equally responsible for the limited ridership figures. However, this study identifies lack of modal integration as a major limitation to formal public transport ridership outcomes in the study area. This is reflected in the very low inter-modal transfers during work trips, with only 27.9% of commuters in the CoJ and 25.5% in Gauteng connecting other modes during their daily work trips. Essentially, it was argued that metro rail users are largely responsible for these transfers, with close to half of them making at least one transfer per trip. However, the non-accessibility and uncompetitive average trip time of the metro rail continue to undermine its user appeal.

Based on these deductions, it is argued that strategic integration of the Rea Vaya BRT with the minibus taxi at Soweto, Park Station, Alexandra and Sandton may significantly enhance the perception and appeal of the BRT. This could be implemented by providing exchange terminals at Thokoza Park, Johannesburg CBD and Sandton, as illustrated in Map 9.3. The basis for this recommendation is the significance of Thokoza Park (Soweto) in the Rea Vaya BRT network, with the first two phases originating from Soweto, while the CBD is a major activity center, and Sandton has proven to be the highest trip attractor in the city. In addition, the map reveals that the three activity nodes serve as origins or destinations for at least three different public transport modes. This will facilitate their status as transfer points between the separate modes.



Map 9.3: Three major activity nodes identified for intermodal transfer terminal

Source: CoJ (2016)

In order to promote swift transfers at these transfer points, these nodes should be highly pedestrianized, to enhance access to transfer terminals. It is argued that such strategic interventions would generate improved outcomes at Soweto and Johannesburg Central, because work trips in the two activity nodes are pedestrian oriented.

9.5. Education and training of professional planners

The study reveals the scarcity of transportation planning professionals at the municipal level, a situation exacerbated by the lack of an accredited professional body for regulating the profession. In terms of education and training, while there appears to be a lack of mentorship opportunities in public institutions, very few South African universities offer transport planning degree at postgraduate level. In addition to the shortage of municipal transport planners, the country's fragmented funding landscape for public transportation is another factor hampering modal integration outcomes, especially at the municipal level.

It is recommended that all role players in the study area should promote policy implementation by aligning with the provisions of the NLTA 2009 that mandates the creation of intermodal planning committees in municipalities with commuter rail. Furthermore, it is argued that improved private sector involvement in transportation planning decisions would spur the demand for transport planners in the private sector, and this may encourage more universities to offer transport planning degrees.

However, in order to facilitate integrated outcomes, cooperation among professionals should be promoted. It is argued that efficient cooperation among professionals such as transport planners, engineers, spatial planners, town planners and economic planners would impact overall outcomes. This can be reflected in institutional integration between the state and municipalities, within municipalities and between municipalities, scholars and private sector professionals.

9.6. Trans disciplinary planning between professions and stakeholders

It is imperative to align the goals of planning and governance in order to achieve the best results. Planners are long term oriented while political, provincial and municipal officers are short term oriented because the government must keep up with its obligation of providing infrastructure and services. Against this background, planning must be done by professionals with an understanding of both worlds and the competence to establish a meeting point that will not jeopardize the objective of both players. Such planners must be employees of the municipality or provincial government, who are frequently capacitated through trainings and interface with private professionals and academics. Both the provincial government and the CoJ municipality must stop contracting planning functions like the preparation of UDFs for station precincts. Exceptions are only permitted where the respective sphere of government is unable to recruit such professionals or to find private sector professionals for collaborations.

Furthermore, the municipality should match ambitions with equal action(s) in discharging its spatial planning and land use management responsibilities. Situations where the UDFs, SAFs and Precinct Plans are not implemented almost a decade after they were developed will continue to slow down progress made in promoting the overall imperative of a regenerated urban form. There is also the need for political will and continuity regardless of changes in political dispensations. Situations where new governments will discontinue progressive projects under implementation by the previous ones should be resisted by municipal officers who are enjoined to avoid conflict of interest by mixing politics with professionalism.

9.7. Areas for further research

The recommendations provided by the study are practically applicable for increasing the capacities of the Gautrain and Rea Vaya for better outputs. The two major players in the transport and spatial planning – the public and private sector – have been incorporated in these arguments, and the study has provided an opportunity for future research into likely outcomes of stronger participation, even at the planning and design stage, by the private sector.

The study also offers solutions like increasing the capacity of the two modes for competition through reduced cost and increased flexibility, thereby opening avenues for future research into the chances of achieving the suggested results. The recommended unitary transport authority can equally be further explored to determine the likelihood of strengthening modal integration and its ability to promote or limit transport-land use integration.

Most importantly, the study surmises that the Rea Vaya and Gautrain were not proactively integrated with land-use at the planning and design stage, a conclusion that is reinforced by the timing of the respective station SDF and UDF. It is argued that future research can explore the development of a land use and transportation modeling that will become a significant part of the planning process, and with a strong premise on data generated from affected nodes and corridors. In addition to this, the development and training of professionals such as municipal transportation planners can provide a strong theme for further research. Finally, future research can identify more potential for faster impacts and the possibility of incorporating the taxi industry by formalizing it, reviewing the taxi recapitalization scheme and subsidizing the industry.

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ETHICAL CLEARANCE

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24 May 2018

AB Adegbaju
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Dear Mr/Me Adegbaju (29693934)

SUSTAINABLE PLANNING, DEVELOPMENT & IMPLEMENTATION SUBPROGRAMME: M.SC PROJECT PROPOSAL APPROVED BY INTERNAL ETHICS COMMITTEE

The Ethics Committee of the Sustainable Planning, Development and Implementation Subprogram of the Unit for Environmental Sciences and Management have carefully considered your research proposal. The Ethics Committee (consisting of six internal members) concur that your project proposal entitled

"*Sustainable transport system: an evaluation of its potentials and impacts on planning the city of Johannesburg*"

under supervision of Prof CB Schoeman and Prof IM Schoeman in accordance with the scientific method and adheres to the required standards as set out in the *Academic Rules for Master's and Doctoral Students at North-West University*.

No further risk is foreseen in the study as motivated by the reviewed proposal submitted to the committee. Your proposal is highly regarded and is recommended for acceptance by Faculty.

Yours sincerely

Prof JE Drewes
Chairperson: Internal Ethics Committee

Ethics Committee:

Prof Juaneé Cilliers

Prof CB Schoeman

Me Karen Puren

Prof Ernst Drewes

Mr Jako Viviers

Me Selna Cornelius

ANNEXURES

QUESTIONNAIRE

GAUTENG DEPARTMENT OF ROADS AND TRANSPORT

Agency/Organization Responding: ____

Address: ____

Designation: _________________________ Phone Number: _____________________

Date: _________________________ e-mail: _________________________________

1. Which of the following areas is/are a major part of your organization's mandate? (Please mark/tick the relevant boxes)

1.1. Transport	
1.2. Land use/Spatial planning	
1.3. Property transactions	
1.4. Economic Development	
1.5. Other	

2. Does your organization have a formal working relationship with other entities – at the federal, provincial and municipal level – to discuss or plan for current issues arising from transportation and land use interaction?

   1. Yes ☐ 2. No ☐

3. Does your organization engage with the private sector in the course of executing your mandate?

   1. Yes ☐ 2. No ☐

4. If 'Yes' to (2), identify those other entities from among the following by ticking 'Yes':

	Agency/Department Name	**(1) Yes**	**(2) No**
4.1	Gauteng Planning Division		
4.2	City of Johannesburg Department of Economic Development		
4.3	Johannesburg Roads Agency		
4.4	City of Johannesburg Transport Department		
4.5	Urban Morphology Institute		

4.6	Piotrans Property Ltd (Rea Vaya Operator)		
4.7	Bombela Consortium (Gautrain Operator)		
4.8	Corridors of Freedom Champions		
4.9	Center for Scientific and Industrial Research (Built Environment Division)		
4.10	South African Cities Network		
4.11	Johannesburg Development Agency		
4.12	Gauteng City Region Observatory		
4.13	Johannesburg City Parks		
4.14	City of Johannesburg Department of Housing		

5. What role does your organization take in collaborating among transportation planning/spatial transformation interests in the following areas?

	Area	**(1) Lead**	**(2) Supporting**	**(3) None**
5.1	Funding			
5.2	Defining relevant policy			
5.3	Transportation, Planning and Design			
5.4	Roads			
5.5	Corridors of Freedom			
5.6	Property transaction			
5.7	Spatial planning			
5.8	Project implementation			
5.9	Operation			

6. Do you agree there has been a significant reduction in road crashes and fatalities since the introduction of the Rea Vaya BRT and the Gautrain?

   1. Yes ☐ 2. No ☐ 3. Negligible ☐

7. How would you rate the impact of the Rea Vaya and Gautrain on the provision of open spaces?

   1. Excellent ☐ 2. Average ☐ 3. Poor ☐

8. What actions would you suggest for enhancing the capacities of these transport systems to meet their policy objectives?

	Action	**(1) Yes**	**(2) No**
8.1	Expansion		
8.2	Integration		
8.3	Fare reduction		
8.4	Off-peak discounts		
8.5	Improved subsidies		
8.6	Improved service		

9. What is the organization's orientation on the provision of storm water management, public transport and non-motorized transport infrastructure (e.g. complete streets campaign)?

1	Very strong	
2	Strong	
3	Very poor	
4	Poor	

10. Are there immediate or long term plans to physically integrate the minibus-taxis with the other transport modes?

1. Yes ☐ 2. No ☐

11. What is the department's level of involvement towards the integration of all public transport modes in Johannesburg and the core Gauteng City-Region?

1	Very strong	
2	Strong	
3	Very weak	
4	Weak	

12. How has the provision of road and right of way for Rea Vaya and Gautrain affected the aesthetics and the unique cultural resources (e.g. historic buildings, sacred land areas, neighborhood parks, traditional building styles etc.) of their catchment area?

☐ ☐ ☐

1. Preserved 2. Destroyed 3. Negligible

13. Do you agree that the Rea Vaya BRT and Gautrain have contributed constructively to the long term spatial and economic transformation goals of the City?

1. Yes ☐ 2. No ☐

14. What do you believe will be the economic and social implications of the future expansions of these two transport modes (Rea Vaya expands northwards and Gautrain expands to the west)?

	Implication	**(1) Yes**	**(2) No**
14.1	Increase accessibility		
14.2	Better productivity		
14.3	Reduce sprawl		
14.4	Increase opportunities		
14.5	Promote equality		
14.6	Increase densification		
14.7	Mixed-use pattern		
14.8	Increase spending power		
14.9	Attract private investments		
14.10	Land value capture		
14.11	Reduce automobile use		
14.12	Improved well-being		
14.13	Promote agglomeration		

15. How would you assess your civil interactions with affected communities at both planning and implementation stages of your operations?

1	Very strong	
2	Strong	
3	Very weak	
4	Weak	

16. Do you believe public transport's share of the total route network in the City of Johannesburg is adequate?

1. Yes ☐ 2. No ☐

17. What are the organization's major funding sources that aid the delivery of its mandate?

	Funding Source	**(1) Yes**	**(2) No**
17.1	Grants		
17.2	Subsidies		
17.3	Loans		
17.4	Partnerships		

18. What are the major policy and planning instruments guiding the delivery of your mandate?

	Implication	**(1) Yes**	**(2) No**
18.1	International policy frameworks (AU Agenda 2063, UN SDGs)		
18.2	National Development Plan		
18.3	National Transport Instruments (NLTA, NLTSF, GTS)		
18.4	National Spatial Instruments (SPLUMA, IUDF, NSDP)		
18.5	Provincial Transport Frameworks (Gauteng ITMP25)		
18.6	Provincial Spatial Instruments (SDF, GDS, IDP)		
18.7	Metropolitan Transport Frameworks (SITPF)		
18.8	Metropolitan Spatial Instruments (GDS, SDF, SAFs)		
18.9	Green Economy Strategy		

19. How would you assess the department's commitment to a timely delivery of its various transformation projects?

1	Very prompt	
2	Prompt	
3	Very slow	
4	Slow	

20. What are the major limitations?

	Implication	**(1) Yes**	**(2) No**
20.1	Financial constraint		
20.2	Institutional fragmentation		
20.3	Human resource constraint		
20.4	Civil resistance		
20.5	Knowledge gap		
20.6	Evaluation		
20.7	Political will		

21. Would you say the Rea Vaya and Gautrain have satisfactorily met their traffic impact assessment (TIA) projections?

1. Yes ☐ 2. No ☐ 3. Nearly ☐