Chapter 16
Impact of Urban Policy on Public Transportation in Gauteng, South Africa: Smart or Dumb City Systems Is the Question

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Abstract Policy on public transport often directs where infrastructure and investment is directed. Currently, the discourse is towards transport infrastructure investments that facilitate the attainment of the so-called smart city and smart mobility status. This status is often seen as the panacea towards all the public transport problems that among others include traffic congestion and unreliability. This chapter grapples with the question; to what extent have the urban planning policies in South Africa and Gauteng province been instrumental in the pursuit of efficient, effective and responsive public transport systems? Have the transport systems led to either smart or dumb city systems. The Gauteng province has put in place policies such as the Gauteng 25 year integrated master plan (ITMP 25) that has a vision to better the lives of Gauteng residents through the establishment of a smart and efficient public transport system. The ITMP 25 also seeks to attract foreign investments and boost tourism through land use densification that supports the use and efficiency of public transport systems. The policy also aims to reinforce the passenger rail-network as the backbone of the public transport system in Gauteng, and to extend the integrated rapid and road-based public transport networks that assist to strengthen freight hubs; thus ensuring effective travel demand management and mainstreaming non-motorized transport. As a result, Gauteng has invested in bus rapid infrastructure (Reya-Vaya within the City of Johannesburg, the Gautrain which is a high-speed rail network that caters for all three metro municipalities) and investments in non-motorized transport lanes in Johannesburg. The study applies smart city and smart mobility indicators to determine the level of smartness of the Reya Vaya, Gautarin and cycling infrastructure. The results indicate a steady uptake in public transport and use of cycling as a means of transport as well as a paradigm shift towards smart mobility by Johannesburg and

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Gauteng residents. Nevertheless, this has yielded unintended consequences such as the reinforcement of spatial segregation and inadequate use of new transport infrastructure. Parts of the challenges are a direct result of weak policy formulation and implementation strategies at both national and provincial levels as well as a deep culture that prefers private automobiles to public transport. There is therefore need to improve transportation policy and promote evidence based transportation policy.

1 Introduction

Smart cities and smart mobility have recently dominated the urban planning discourse. It appears like the majority of cities the world over are in a race to become smart yet there is little or no consensus on what constitutes a smart city (Angelidou 2015; Caragliu et al. 2009). There are four key components or concepts that are commonly used to define and identify a smart city and these include (1) "smart machines" and informated organizations, (2) engaging communities, technology providers and research institutions (3) (re)-learning and adaptation, and (4) investing for the future (Ching and Ferreira 2015). Ostensibly, for a city to be smart, there is need for the adoption and implementation of information communication technologies (ICTs), hence smart cities are often equated with highly technological cities. According to Caragliu and Del Bo (2015) ICTs enable cities to foster urban development, economize time, improve individual mobility, improve access to information and services, save energy and resources as well as improving citizenry participation in urban decision making processes. Although smart and informated machines are the most well known aspects of smart cities, it is important to note that for a city to be smart, ICTs are not the only essential cogs since ingredients such as collaboration between community, technology providers and research institutes are also key to the realisation of smart cities. Similarly, continuous (re)-learning and adaptation are crucial to sustain smart cities. (Re)-Learning can be from other cities for example; the European smart cities network (Giffinger et al. 2007; Neirotti et al. 2014). The (re)-learning and adapting is the ability to assess performance using measurable metrics or performance indicators (Giffinger and Gudrun 2010). In developing counties cities are often hesitant to assess performance as a result of political pressure and fear of public outcry. Lastly smart cities invest in the future if they are to continually survive.

An important component and topical issue in the smart cities debate is transportation, that is often referred to as smart mobility (Calabrese 2013). Chun and Lee (2015) note that smart mobility is a concept of comprehensive and smarter future traffic service in combination with smart technology. Similarly, transferring demand from private cars to public transport is an integral part of smart mobility (Siemens 2015). However, the level of smartness depends on the transport mode that is in use, for example, combustion buses or taxis and or electric trains differ in their levels of smartness. The lack of or absence of smart transport modes that lead to a

deplorable commuting experience has resulted in the general public shunning public transport and this is particularly so in developing countries such as South Africa (Allen 2013). Papa and Lauwers (2015) argue that smart mobility has evolved to being more than the technology used to optimize transport planning to more about improving the consumer and or customer experiences. Such innovations and the realisation of improved commuter conveniences emanating from smart transport systems have resulted in the shift in mind-sets within local, provincial and national governments in South Africa's approaches to infrastructure provision for public transit purposes.

This chapter focuses on the concept of smart cities, applying the urban planning discourse and perspective to the current debates, consequently extending the frontiers of knowledge in this domain. The paper determines the level of smartness of the relatively new public transport infrastructure in Johannesburg against the backdrop of a myriad of policies and legislation that have been formulated and enacted to support the innovative developments. The chapter starts by reviewing and discussing the policy and legislative frameworks around smart transport planning and provision. It then focuses on the methodology that was adopted in collecting, analysing and reporting the research results. The chapter discusses the level of smartness of public transport systems within the study area and then it ends by proffering conclusions and recommendations on the best way to achieve smart mobility within South Africa and other developing countries in general.

2 Policies and Legislation Governing Public Transportation

The provision and management of affordable, well-connected and reliable modern public transportation systems, particularly in cities of the developing world are critical in ensuring both smart cities and mobility within them. Several scholars have for a long time observed that efficient and effective urban public transport is not only important for city dwellers but also assist in facilitating the functioning of cities (Cardinale et al. 2014; Potter and Skinner 2000; Perl and Goetz 2015; Schwaberger 2014). It goes without saying that an accessible, reliable, convenient and affordable urban public transport system enables the swift movement of commuters from one location to another, thus promoting the physical and socio-economic development of cities and their residents (Tan et al. 2008; Tanahashi et al. 2012; Scoppetta 2014a, b; Szczech 2014; Tillner 2014; Zhukova and Smirnova 2014; Zhou 2014; Zhukova 2014).

Notwithstanding the evident benefits of modern urban public transport systems, governments of the developing world at all levels, have been struggling to plan for, develop and manage public transport systems of acceptable standards (Musakwa 2014).

African governments in particular, have been struggling to provide well-coordinated, efficient, effective, reliable and affordable public transport systems in their ever-growing cities spatially and demographically (Cervero 2013). Consequently, there have been spirited efforts in most African countries to not only enact relevant urban transport legislative frameworks and formulate policies but also their implementation to facilitate the development and management of efficient and effective modern public transport systems.

Notably, South Africa is one of the few African countries that have made concerted efforts to improve their public transport systems. The economies and populations in South African cities are ever growing hence efficient and effective urban public transport systems have become integral for the daily lives of South Africans, hence the Bus Rapid Transit (BRT) system and the Rapid Railway Systems (Gautrain) have been implemented since the beginning of the new millennium. Several Metropolitan cities in South Africa that have been adopting and introducing modern urban public transport systems include the City of Tshwane, City of Johannesburg, City of Ekurhuleni, City of Cape Town and the City of Ethekwini metropolitan municipality. The innovations have been implemented to reduce travel time, lessen traffic congestion, create employment opportunities for citizens and minimize greenhouse emissions. Consequently, South Africa has been adopting several enabling policies and legislative instruments to promote innovative urban public transport systems since the realization of the democratic dispensation in 1994 and these commenced with the National Constitution of 1996; The Green Paper on National Transport Policy that was launched in early 1996 that culminated in the adoption of the National Transport Policy White Paper later in the same year.

Recently there has the National Rail Policy Green paper was launched in 2015 to solicit views and ways of facilitating the planning and development of improved railway transport systems within the country. In particular, the province of Gauteng, which is the economic hub of the country, is experiencing an ever-increasing demand for public transport hence the adoption of the innovations in public transport systems. Consequently, the province adopted the Gauteng's 25-year Integrated Transport Master Plan that seeks to improve urban public transport systems within the province. Other policies that sought to promote and support public transport in Johannesburg include, the National Rail Policy Green Paper of 2015, National Transport Policy Green and White Papers of 1996 and the Gauteng's 25-year Integrated Transport Master Plan of 2013 (ITMP 25) (Gauteng Government 2013). The ITMP 25 plan seeks to achieve several objectives through the adoption and implementation of several strategies and among others they include the provision of responsive and efficient urban public transport systems that is well linked and connected to promote its use and reduce reliance on private modes of transport. Consequently this has given rise to BRT systems such as the Are yeng in Pretoria, Reya Vaya in Johannesburg and the high-speed railway (Gautrain).

2.1 Rea Vaya, Johannesburg Bus Rapid System

Rea Vaya is Africa's first full Bus Rapid Transit (BRT) and is located in the Gauteng province of South Africa where it operates only in the Johannesburg metropolitan city. It was between 2006 and 2007 when the City of Johannesburg decided on the approval of the Rea Vaya BRT project, a project that was mainly aimed at improving the quality of life of the city's residence through a public transport system. In 2006, a BRT system feasibility study was conducted with most importance focusing on integrating the Rea Vaya with Gautrain and Metrorail. The City of Johannesburg send representatives to Bogota in Latin America in 2007 for further study and tour and in the same year a memorandum of understanding was signed by Top 6, Greater Johannesburg Regional Taxy Council, Putco and Metro bus which all form part of the Rea Vaya BRT system stakeholders. Through thorough research and consultation with many stakeholders in the private and public sector, the City of Johannesburg finally implemented the first phase of the project in the year 2009. In 2010 during the FIFA world cup, Rea Vaya BRT was operating to transport people from the inner city to the Soweto area were Soccer city is located.

Rea Vaya operates in Region A to F in the Johannesburg Metropolitan City. It operates in different phases and has systematic hierarchical routes that connect micro city centres in the Johannesburg Metropolitan City. It has completed the construction of Phase 1A and 1B and currently developing Phase 1C. Rea Vaya's Phase 1A has a trunk route operating between Ellis Park in Doornfontein and Thokoza Park in Soweto, linking with several feeder routes in Soweto (Reya Vaya 2016) (Fig. 1).

Feeder buses run from Protea Glen to Thokoza Park and from Eldorado Park to Lakeview (Reya Vaya 2016). The route covers 325 km of special lanes and intersections while feeder and complementary buses carry passengers to the trunk route stations.

The inner city circular route (Fig. 2) travels around the CBD from Hillbrow and Braamfontein, to Ellis Park in the east and Chancellor House on the western edge of the city (Reya Vaya 2015). The Phase 1B has routes that operate through Cresta, Windsor West, Parktown, Yeoville; in addition, routes that operate to and from the University of Johannesburg Soweto are being added. The route starts in Noordgesig in Soweto and travels through Pennyville, New Canada, Highgate, Auckland Park and Braamfontein to Parktown, Metro Centre and Rissik Street in the CBD.

The route has made it possible for commuters to easily reach key public healthcare centres such as the Rahima Moosa, Helen Joseph and Charlotte Maxeke hospitals as well as educational institutions such as the University of Johannesburg, Wits University, Milpark College, Parktown Boys' High School and Barnato Park High School. Feeders run to and from Leaglen, Stormhill, Florida, Cresta, Yeoville and Parktown. There are also additional feeders in Soweto from Pimville and Mapetla. These routes are now linked to the Metro Centre Rea Vaya loop, which travels to the inner city through Braamfontein.

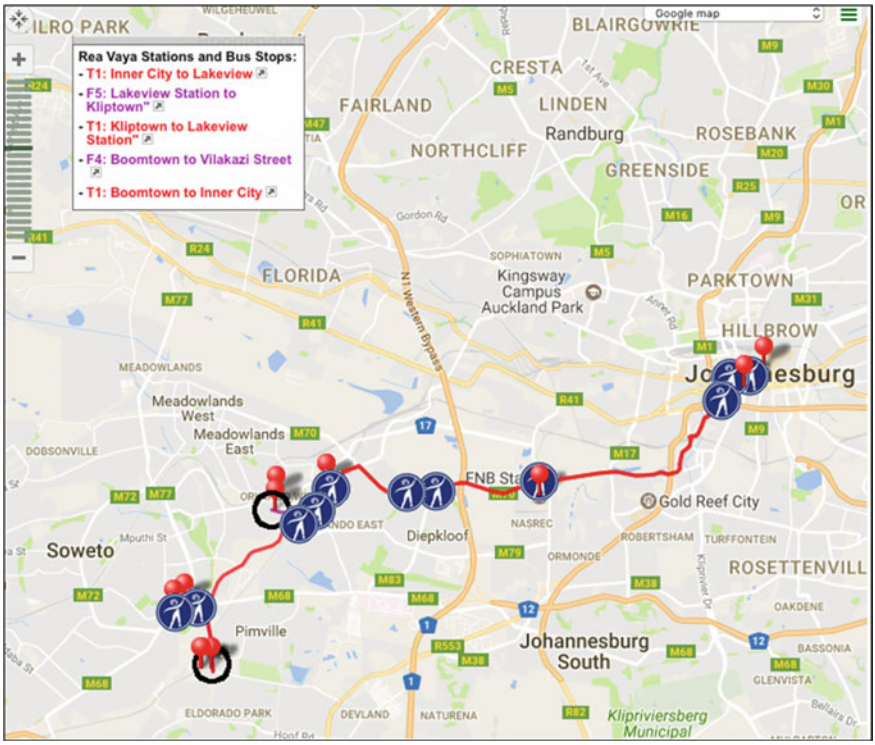

Fig. 1 Reya Vaya Soweto route. *Source* https://www.reavaya.org.za/consumer-information/the-routes

Rea Vaya's current focus is the development of Phase 1C following the completion of Phase 1B. Phase 1C will run from: Parktown to Alexandra; then Alexandra to Sandton, with complementary services between the CBD and Ivory Park; and from the CBD to Sunninghill on Oxford/Rivonia roads. Future plans also include extending the Phase 1C route from Sandton to Randburg by 2018, and possibly extending the trunk route from Soweto Highway to Dobsonville, enabling feeders to service areas such as Braamfisherville. The Rea Vaya trunk routes from the CBD to Sunninghill through Oxford Road and Ivory Park to Sunninghill will be prioritized after 2018. The three interchanges will be at Sandton, Alexandra and Westgate, where a number of station modules will be clustered and there will be integration with other modes of transport, including walking and cycling.

2.2 *The Gautrain System*

The Gautrain project Gautrain is Africa's first world-class, modern rapid rail and bus service for Gauteng, a province regarded as the economic heartland of

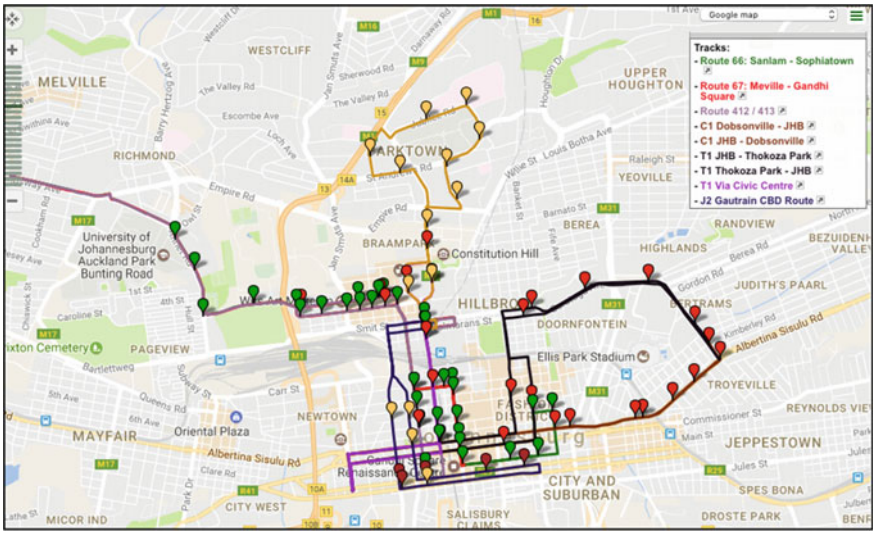

Fig. 2 Inner city route map. *Source* https://www.reavaya.org.za/consumer-information/the-routes

South Africa (Fig. 3). Gautrain is more than just a train. It is one of several strategically integrated Gauteng Provincial Government projects to meet future transport demands anticipated as a result of economic and population growth (Gautrain Management Agency (GMA) 2010a; Musakwa 2014).

It is also referred to as a mega-engineering project. It is a state-of-the-art rapid rail connection between Johannesburg (Africa's business capital) and Pretoria (Donaldson and Van De Westhuizen 2011). Gauteng, the country's economic hub currently experiences traffic congestion on its major routes, especially between Pretoria and Johannesburg. The current transport facilities and services between these two cities are mainly road based. Accordingly the Gautrain was supposed to ease this traffic congestion, in an attempt to create a smart city based on mixed land uses and development corridors (Musakwa 2014). The Gautrain project is also meant to promote rejuvenation of central Johannesburg and Pretoria (GMA 2010b). Construction of the Gautrain is informed by spatial planning is embedded in two parallel strategies that were initiated by the Gauteng Provincial Government namely the Gauteng Spatial Development Framework (GSDF) 2000 and the Gauteng Spatial Development Initiatives (SDIs). Consequently it is envisaged that the Gautrain will promote, smart mobility and accessibility, redirection of urban growth, contained urban growth, resource based economic development and rural development beyond the urban edge.

The Gautrain has two routes the South-North and West-East routes (Fig. 4). The North South route begins at Johannesburg park station in central Johannesburg to, Sandton and Pretoria and Hatfield in the north cutting across Johannesburg and Pretoria metropolitan municipalities. The West-East route takes passengers from Sandton Station, via Marlboro, to Rhodesfield Station in Kempton Park. From there

Fig. 3 The Gautrain. *Source* http://gma.gautrain.co.za (Gautrain Management Agency (GMA) 2013)

it connects to a station built within the airport terminal complex at OR Tambo International Airport (GMA 2010b).

Gautrain has proposed to expand routes as from August 2013 and this project forms part of the Gauteng Province's 25 year Integrated Transport Master Plan. There are 7 new proposed routes that will link with the existing routes from Park to Pretoria, Sandton, Marlboro and Midrand covering the South, North, East and West of Gauteng. The new proposed routes are prioritized according to phases.

3 Methodology

The chapter focuses on the new bus rapid system, the Reya Vaya in Johannesburg, the Gautrian high-speed train in Gauteng province and cycling in Johannesburg. Accordingly, smart mobility indicators where selected and divided into three categories namely (1) cycling (2) smart mobility systems which determine how smart ICT has been infused in the public transit system and (3) indicators pertaining the public transit system (bus rapid system known as Reya Vaya and the Gautrain high speed train system) (Table 1).

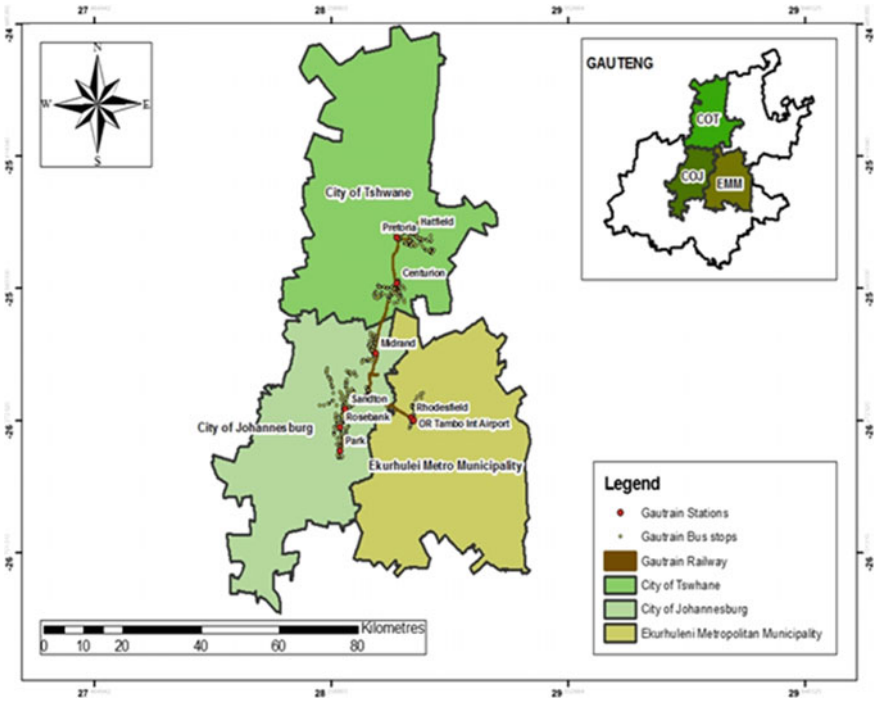

Fig. 4 Gautrain routes

Smart mobility indicators where selected because they determine how far people have shifted from using private cars to public transport (Calabrase 2013), how efficient and reliable the public transport is and how smart the public transit system is in the use of ICT to enhance the overall commuting experience. This would determine if the investments in public transport infrastructure has been smart. The indicators on smart mobility were mostly derived from observation, service provider websites, secondary data, and studies by Allen (2013), Garau et al. (2016) as well as Musakwa and Selala (2016).

The cycling indicators (total cycling trips, commuting and recreation trips) were derived for the year 2014 using a methodology described in Musakwa and Selala (2016). Data from Strava Metro was obtained from Strava for Johannesburg for the year 2014. Strava Metro utilizes data from the Strava mobile application, which is a global positioning system (GPS) enabled smartphone application that tracks bicycle rides and uploads the data to an online community of other users. Data purchased from Strava was in database (dbf), Microsoft Excel and shape file (shp) format. Cycling patterns where analysed on the basis of the type (recreational or commuting), temporal and spatial coverage. The analysis was also at city and neighbourhood level. Geospatial modelling software (GME) as well as the spatial analyst and map algebra functions of ArcGIS software were utilized to calculate the descriptive statistics (median) of cycling patterns (Musakwa and Selala 2016).

Table 1 Indicator selection

Variable	Indicators	Source
Cycling	– Total cycling activities recorded from Strava data – Total cycling trips – Total commuting and recreational cycling trips	– Musakwa and Selala (2016) – Strava data
	– Cycle lane density	– Garau et al. (2016)
Smart mobility support system	– Automated and electronic ticket system – Information on public information displays on routes schedules and waiting times – Information on mobile application on routes schedules and waiting times – Availability of tickets online – Electronic ticketing systems – Electronic bus stop signs – SMS services – Presence on social media – One ticket system	– Fieldwork observation – Garau et al. (2016) – Websites and reports from Gautrain and Reya Vaya
Public transport uptake; high speed train (The Gautrain) and bus rapid system (Reya Vaya)	– Bus network density – Demand for public transit – Passenger numbers – Fares – Level of integration	– Website and reports from service providers – Observation – Garau et al. (2016)

Sources Allen (2013), Garau et al. (2016), Musakwa and Selala (2016)

The smart mobility support system indicators and the public transport uptake where mostly analysed using semantic analysis of emoticons (Gal-Tzur et al. 2014) and quantitative analysis. Indicators that where not quantitative such as, automated and electronic automatic systems, information displays and mobile application where classified as yes if they where available and no if not. Emoticons where then used to describe the level of service (Table 2).

4 Results and Discussion

This section is structured as follows; the cycling in Johannesburg is discussed first followed by a discussion on the smart mobility support system and lastly the findings on the level of uptake of the public transport system in Johannesburg is discussed.

Table 2 Indicators on smart mobility and uptake of public transport in Johannesburg

Theme	Indicator	Reya Vaya	Gautrain
Smart mobility support system	Automated ticketing	☺	☺☺☺☺
	Electronic ticketing	☺	☺☺☺
	Information on public information displays (PID) on routes and waiting times	☹	☹
	Mobile application that shows routes and waiting times	☹	☺☺
	Tickets online	☹	☹
	Electronic bus stops	☹	☹
	SMS services	☹	☺☺
Public transport uptake; high speed train (The Gautrain) and bus rapid system (Reya Vaya)	Bus network density	0.30	N/A
	Demand	0.53	☺☺☺
	Passenger numbers	25,000/day	580,000 per month
	Fares	☺☺☺	☹
	Level of integration	☹	☹
	One ticket system	☹	☹

4.1 Cycling in Johannesburg

From the Strava analysis it is indicated that the number of cycling trips for Johannesburg in 2014 was 84,297. Only 20% of the cycling trips are for commuting whereas recreational trips accounts for 80% of the cycling trips (Fig. 5). Although millions of Rands where invested in providing cycling infrastructure in Johannesburg, it appears that the money has been wasted as people in Johannesburg are not using cycling as means to commute to places of work. Perhaps there is need to invest in cycling infrastructure for recreation as the cycling for recreational purposes is very high.

Moreover it appears that although the municipal and provincial government are promoting cycling through a myriad of initiatives such as the eco-mobility festival 2015 which closed of private automobile use in Sandton for a month (October) whilst encouraging use of public transport and non-motorized transport (NMT), the public hardly utilizes cycling as a means of commuting. Therefore there is a strong need to understand the needs, perception, behaviours and characteristics of cycling to inform smart policy and planning. A lesson to be learn is that, it is impossible to promote smart mobility without informative data that can guide decisions, otherwise it will promote planning of ‘dumb’ infrastructure.

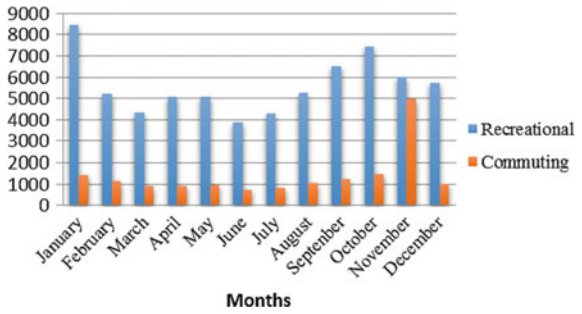

Fig. 5 Monthly commuting and recreational trips in Johannesburg for the year 2014. *Source* Musakwa and Selala (2016)

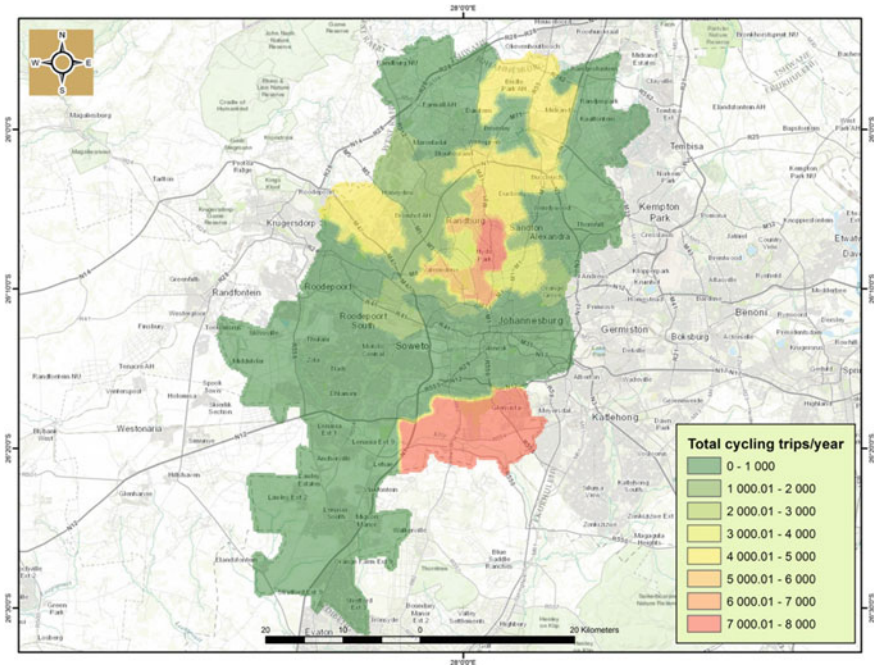

Fig. 6 Cycling trips per suburb in Johannesburg for 2014. *Source* Musakwa and Selala (2016)

Figure 6 shows where cycling is common in Johannesburg and the map can be used to argue for investing in cycling infrastructure north of Johannesburg central business district (CBD) in suburbs such as Sandton and Midrand. With ubiquitous big data such as Strava, smart mobility can be supported by making smart and evidence based decision making in cycling infrastructure will save already strained resources in local government.

4.2 Smart Mobility Support System for the Reya Vaya and Gautrain

Regarding the automated and electronic ticketing system, the Gautrain offers an average of four automated machines per station where commuters can purchase their train tickets or load money onto their smart card (Table 2). However, Reya Vaya does not have a fully automated system as commuters purchase at counters at the bus stations. Nevertheless commuters have an option of purchasing or uploading money onto their smart card at bank ATMs. Therefore, the infrastructure of the Reya Vaya is limited and not as smart as the Gautrain's automated ticketing machines. There is need to invest in automated ticketing infrastructure for the BRT Reya Vaya system and the infrastructure is now being put in place. What is common with the Reya Vaya and Guatrian is that they use a smart card for ticketing and this system is smart because it reduces paperwork and ensures that if lost, the smart card cannot be reused if the commuter registered it. Moreover the smart card is a source of valuable passenger data that can be used in mobility studies.

A major drawback and inconvenience with both systems is the inability of commuters to purchase their tickets or smartcards online which many commuters find frustrating in this world of e-commerce.

Another drawback is the use of two smart cards for use in Reya Vaya and Gautrain. This significantly hampers integration that is so passionately promoted in the public transit system in Johannesburg and this may inconvenience commuters particularly tourists and overseas customers who are used to the one ticketing system in their countries of origin. Although the ITMP 2030 policy documents targets having a one-ticketing system, this system is likely to prove a challenge given the various acts and legislation that separately govern the public transport operators. For example the Reya ownership is at municipal level whereas Gautrain is at provincial level. The public transport system can only be fully smart if there is real partnership and collaboration between agencies that goes beyond superficial technical optimization. Currently, it may appear there is a level of mistrust between service providers that hinders establishing smart infrastructure to enable a one smart card system. Furthermore, in a world of ubiquitous smartphones the service providers need to explore mobile ticketing options (Cheng and Huang 2013).

Provision of information is key in determining the smartness of transport infrastructure given the demanding needs of today's commuters to plan their journeys on information provided by service provides. Both the Gautrain and the Reya Vaya have public information displays (PID's) that show waiting times and the direction which the train and bus are headed. Nevertheless these PID's are static as they do not show route maps and commuters cannot use them to plan their routes. Hence there is need to relearn on the part of service providers to provide smart, collaborative and interactive PIDs which makes a public transport system smarter. The Gautrain has heeded to the commuters calls and they are in the process of installing these interactive PID's that show routes on their train stations.

This goes on to show that smart mobility is much more than infrastructure but there is a constant need to relearn and adapt to improve the public transport system.

Similarly, the public transport industry is being rapidly shaped by intelligent mobile applications. Gautrain does have a mobile application that shows timetables and the routes whereas the Reya Vaya did not have a mobile application until the launch of its application in June 2016. Commuters can use the Gautrain's mobile application to plan their journeys and it is very useful in conveying information on unexpected events, delays and service disruptions (Brugleiri et al. 2015; Alves et al. 2012) enabling commuters to re-plan their trips. Nonetheless, the Gautrain application is static and it is not real time and not on demand. Real-time information on mobile application has shaped public transit systems (Brugleiri et al. 2015) and poor information particularly in South Africa is a major deterrent on use of public transport. Reya Vaya did not have a mobile application until June 2016 and prior to that the unavailability of the mobile application inconvenienced commuters in route planning as well as information provision. The Gautrain and the Reya Vaya mobile applications are not intelligent enough because they do not allow commuters to decide on the best routes to make the trip they want, when they want and what are the expected travel times, based on the actual locations of the public transport vehicles and the travel speeds that can be estimated for the various relevant road segments for the next hour (Alves et al. 2012). Hence, there is need to make the application real-time, intelligent and more interactive.

Concerning electronic bus stops signs, both Reya Vaya and Gautrain buses posses no electronic bus stops that can enable commuters to view specific information about their journey. It has been noted that commuters, particularly the Reya Vaya wait indefinitely and frustrated because they are unable to access or locate their exact location of the incoming bus service. Hence, for the public transit system in Johannesburg to reach smart city or mobility status there is an urgent need to invest in these smart and informated electronic bus stop signs.

Regarding the SMS service, the Gautrain has fully-fledged SMS services that notify commuters of any major disruptions or any information such as delays, which assists commuters in planning their journeys. Nevertheless, the BRT Reya Vaya system do not inform its commuters on any delays or disruptions through an SMS service. Moreover, the Gautrain has a huge presence on social media platforms such as Twitter and Facebook whereas the Reya Vaya system is limited or non-existent. The Gautrain uses social media to position and portray itself as a smart transport alternative, efficient, safe, reliable, secure, predictable and comfortable transit system (Musakwa 2014). Gautrain commuters use social media in judging whether the Gautrain is a safer, reliable, dependable, and smart transit system. Likewise the GMA and commuters post useful information such as emergences, and delays that affect commuter's journeys on social media. Henceforth, the social media communication by the GMA is smart and it is a two-way system, which ensures relearning, and feedback mechanisms that can enable the system to be better in future. Overall, the Gautrain's communication strategy through social media and the sms services enables collaboration and engaged citizens who seek to improve the services.

4.3 Public Transport Uptake Levels of the Reya Vaya and Gautrain

Pertaining the bus network density and passenger demand the Reya Vaya scores 0.3 and 0.53 out of 10 (Gauru et al. 2016). This shows that the BRT infrastructure is very limited and that there is little uptake of the BRT services in Johannesburg. Perhaps the reason behind this is a culture where people are not used to BRT and the limited investment in BRT infrastructure. This is in stark comparison to Barcelona that scores 10 and 9 respectively in the bus network density and passenger demand category (Gauru et al. 2016). This shows that Johannesburg's public transit system is not yet smart despite an overload of numerous policy documents, which promote and advocate for the use of public transports. Perhaps the reason is also because there was lack of collaboration in building the BRT infrastructure with commuters and other service providers.

Regarding passenger numbers, the Reya Vaya transports almost 25,000 commuters per day and this number is very low given the population of over three million people in Johannesburg (Reya Vaya 2015). The figures are well below the targeted 150,000 passengers a day Allen (2013). Passenger numbers of the Gautrain on the other hand indicate a steady rise (Fig. 7). The numbers started at around 300,000 per month to almost a million users per month. Perhaps the perceived smartness and the Gautrain massive awareness campaigns are bearing fruit. Nevertheless, the commuting numbers still need to be increase to fully realize return on investment.

Pertaining to fares, the Reya Vaya is generally affordable (Allen 2013) given that an average trip cost 8 Rand. Therefore the Reya Vaya resonates with the majority, as transport is often expensive in a fragmented city like Johannesburg. Conversely, the Gautrain is commonly regarded as expensive given that a 40 km trip from Pretoria to Johannesburg costs 76 Rand (6 Euro). This is very expensive given that a similar trip will cost 2 Euro in countries in the European Union. As a result the Gautrain mostly appeals to the middle and affluent classes. Notwithstanding the high fares, the Gautrain has promoted smart mobility because people who would have used commuted to work on private automobiles now use public transit. This has resulted in less congestion and less greenhouse house gas emissions,

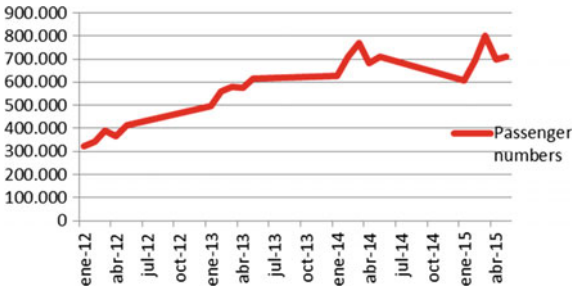

Fig. 7 Gautrain passenger numbers per month from January 2012 to May 2015

which bodes well for well for climate change. Nevertheless the Guatrain needs to be more accessible to the low income and expand its routes as it currently intends for it be smarter and possibly have greater impact in alleviating climate change.

5 Conclusion

This chapter has demonstrated that the Republic of South Africa has been investing in urban public transport systems for several years now. The work has revealed that several enabling policies and legislative instruments to promote innovative urban public transport systems were formulated and adopted at all the three levels of government from national, to provincial and local tiers. At national level, the frameworks and instruments range from National Constitution of 1996; the Green and white Papers on National Transport Policy that were adopted in 1996; the National Development Plan of 2012; the National Rail Policy Green paper of 2015 and many others. At provincial levels, the Gauteng province developed and adopted the Gauteng's 25-year Integrated Transport Master Plan in 2013. The metropolitan cities such as the City of Johannesburg, the city of Tshwane and the city of Ekurhuleni have also devised plans and formulated policies that seek to guide the planning and development of efficient and affordable urban public transport systems within the province. These instruments have been assisting in the provision and management of affordable, connected and reliable modern public transportation systems within South African cities particularly the metropolitan cities. For example the Gauteng has invested in bus rapid infrastructure in the form of Reya-Vaya within the City of Johannesburg, Are-yeng in the City of Tshwane and Harambee in the City of Ekurhuleni as well as high-speed rail network known as the Gautrain that caters for all three metro municipalities. The policies have also been assisting in reinforcing the passenger rail-network as the backbone of the public transport system in Gauteng, and to extend the integrated rapid and road-based public transport networks that assist to strengthen freight hubs; thus ensuring effective travel demand management and mainstreaming non-motorized transport. There are also investments in non-motorized transport patched throughout the province within specific metros. The quest is to improve and realise accessible, reliable, convenient and affordable urban public transport systems that enable the swift movement of commuters from one location to another, thus promoting the physical and socio-economic development of cities and their residents. However there are some unintended consequences such as the reinforcement of spatial segregation and inadequate uses of new transport infrastructure. Parts of the challenges are a direct result of policy formulation and implementation strategies at national, provincial and local levels. Pursuant to that there is need to make improve the implementation of the policies so that outcomes support connectivity and mobility of all residents and also assist in the realization of the development of egalitarian societies by linking previously disadvantaged societies.

Lastly although the city of Johannesburg has tried to improve public transport through smart mobility, it appears that the new public transit systems such as Reya Vaya and Gautrain are not very smart. There is need to realize that smart mobility is not merely a buzzword or the use of smart machines and informated organizations. It is more about collaboration, investing in the future and re-learning. Furthermore investing in smart public transportation requires evidence-based decision-making that can be obtained from ubiquitous smart and big data. Finally a culture that is geared towards public transport has to develop if the smart mobility is to be realized in South Africa.

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