

# **Innovative Initiatives Usage to Improve Efficiency in the City of Johannesburg Public Transportation**

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## **1 ABSTRACT**

Past spatial planning practices have left developing cities such as the City of Johannesburg with sprawling low-density areas of settlement, lacking viable public transport systems. The majority of marginalized citizens in South Africa are still living on the fringes of the cities, commuting daily, often at considerable cost, long distances to access work and economic opportunities. As such, it is very critical in developing cities to trace the existing spatial patterns, economic distribution, and the envisaged mobility innovations. Thus, the aim of the paper is to explore innovative initiatives to meet the envisioned mobility network through the Spatial Development Framework, 2040 and proposed corridors of Freedoms as mobility spines from a high-level perspective within the City of Johannesburg. A mixed-method approach was used which consisted of an exploratory research design that involves an empirical enquiry using spatial and qualitative methods of data. The results reveal that the City of Johannesburg has identified key public transport corridors, consolidating growth and development opportunities around existing and future public transport nodes. The location and concentration of jobs opportunities does not match that of where people live. This job-housing mismatch significantly contributes to inequality in the city as for many residents' access to economic opportunities is stifled by costly and distant commuting. There are also two major spatial discontinuities in the city structure that are barriers to opportunity. In interpreting the current city structure morphology, the city displays a unique structure of inverted polycentricity, inherited largely from its complex history. In conclusion, the envisioned mobility networks of the city have the potential to link citizens to mixed-use development nodes with high density accommodation supported by office buildings, retail development and opportunities for education and recreation. This will give rise to a people-centred city, where communities' needs, their safety, comfort, and economic well-being are placed at the core of planning and delivery processes.

Keywords: Mobility, corridors, public transport; spatial patterns; economy.

## **2 INTRODUCTION**

Urban public transport as a catalyst for urban development in the era of smart mobility is well recognised (Reardon, 2020; Peprah et al., 2019). Typically, smart mobility describes movement patterns or city transport networks which are utilising active travel modes; information and technology; energy efficient renewable forms of energy; or shared vehicles wherever possible, resulting in low carbon output per passenger journey (Dia, 2016; Namiot and Pokusaev, 2019; Liu et al., 2020). Integrated multimodal-networked public systems have emerged as a smart mobility paradigm (Risimati and Gumbo, 2018). They use transfer potential to provide a maximal service for a reasonable and efficient operating budget and a genuinely feasible alternative to automobile travel within urban areas (Jones et al., 2012). As mobility is the essence of modern life in urban areas, it creates serious social, economic, and environmental problems. In a situation of growing car ownership, public transport services are facing tough competition from private automobiles (Alpkokin and Murat, 2012). The continuous increase in the number of vehicles on the road network poses further threats to traffic movements. This is evidenced by traffic congestion, slower flow, more accidents, and waste of time, money and efforts (Agyapong and Thomas, 2018). A shift from mobility-centred to accessibility-centred transport and land use planning has been advocated over decades (Hrelja, 2015; Cervero, 2013; Banister, 2012). This shift starts from the idea that the demand for transportation is largely derived from people's demand to reach their destination, rather than for the sake of movement. It suggests that enhancing accessibility to desired destinations is what really counts for the users of that transport system (Wang and Chen, 2015).

One of the most popular accessibility-centred planning approaches is Transit Oriented Development (TOD) (Ndebele and Ogra, 2014; Makhubu, 2016; Nasri and Zhang, 2014). TOD can enhance accessibility through

strengthening the integration between transport and land use systems by means of relatively high density, mixed-use, cycling and pedestrian-friendly development around transit stations and networks (Renne, 2016). TOD characteristics are positively related to accessibility at the catchment level. Likewise, at the catchment level, the transport feature of the TOD system is highly related to accessibility, while for transit-oriented land-use patterns the associations are much smaller. This suggests that in order to improve accessibility of an area, transport-enhancing policy should be considered as the first option. If the transport system is kept unchanged, land-use policy relating improving urban density, diversity and pedestrian-friendly development is recognised as an effective tool to enhance accessibility of the area. Consequently, in developing countries past spatial planning practices have left cities such as the City of Johannesburg with sprawling low-density areas of settlement, lacking viable public transport systems (Luke and Heyns, 2017; Chakwizira, 2011). The majority of working class and poor citizens are still living on the fringes of the city, commuting daily, often at considerable cost, long distances to access work and economic opportunities (Risimati and Gumbo, 2018; Seftel and Peterson, 2014). As such, it was very critical to trace the existing spatial patterns, economic distribution and the envisaged mobility innovations for City of Johannesburg, South Africa.

### 3 METHODOLOGY

This section presents the research approach for data and analysis. An exploratory research design was adopted to assess spatial distribution patterns. The key informant interviews were used to collect information for this study. The interviews were semi-structured, using open-ended questions to guide the conversations on transport infrastructural developments in the city. The interviews were held with officials from the City of Johannesburg Metropolitan Municipality, Johannesburg Roads Agency (JRA), Johannesburg Development Agency (JDA), Gauteng Department of Roads and Transport (Gautrans) and Gautrain Management Agency (GMA).

Content analysis informed by Systematic Review methodology was used to analysis qualitative data in the form of literature on the spatial distribution of urban transportation systems. Using key themes as shown in Figure such as the ‘Compact city’ and ‘Transport Oriented development’ case studies on the state of the art in urban mobility planning were identified and evaluated. Using content analysis infrastructure projects by the city of Johannesburg were evaluated such as the Empire Perth Development; Turffontein Development Corridor and Louis Botha Avenue Development Corridor. Likewise inferences to future motorised and non-motorised development were evaluated.

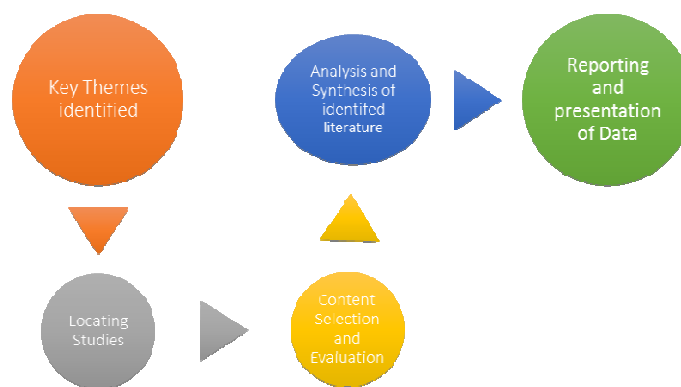


Figure 1: Roadmap of Content Analysis

Spatial data of urban public transport infrastructures (Gautrain, Rea Vaya, Metrorail and Metrobus) were collected in shapefile format from their service providers (Gautrain Management Agency; JRA; JDA; PRASA; and City of Johannesburg). Although, the data is currently not open source, it is available on request from the public transportation providers. The spatial data gathered were used to visualise the spatial trends maps using Geographic Information Application (ArcGIS 10.3 software) to inform analysis and discussion on the envisioned spatial patterns and infrastructure of urban public transport systems in City of Johannesburg.

## 4 RESULTS

The City of Johannesburg is embarking on new spatial plans in line with the Johannesburg Spatial Development Framework 2040 and the 2040 Growth Development Strategy based on transport-oriented development. The shape of the future city will consist of well-planned transport arteries, the Corridor of Freedom linked to interchanges, where the focus will be on mixed-use development. Joburgers will then not have to use private motorised transport but can opt for the alternative means, which including cycling, bus lanes and pedestrian walkways. The Corridors of Freedom aim to transform entrenched settlement patterns, which have shunted most residents to the city's outskirts, away from economic opportunities and access to jobs and growth. Gone will be the days of being forced to rise at dawn to catch a train, bus, or taxi to a place of work. PRASA has completed a New National Plan which will guide infrastructure investment into specific identified corridors. The City of Johannesburg Strategic Integrated Transport Plan Framework identifies a high-level public transport network for 2040, based on population growth, areas of employment growth and projected densities. It has identified several key public transport corridors, consolidating growth and development opportunities around existing and future public transport nodes, starting from the Corridors of Freedom linking Soweto, through the Inner City, to Sandton (along Empire-Perth and Louis Botha Avenues) and linking Turffontein into the Inner City (see figure 2). This will also include a focus on transit-oriented development nodes, including Gautrain, Rea Vaya (BRT) and Metrorail stations. Some of the public transport corridors will function as transit corridors, transporting large numbers of people from one part of the city to another. Other public transport corridors have the potential to grow into development corridors, with the opportunity to not only link mixed-use development nodes but to articulate public transit with housing, new employment activities and social amenities, while optimising investment capacities (Mbatha and Gumbo, 2019).

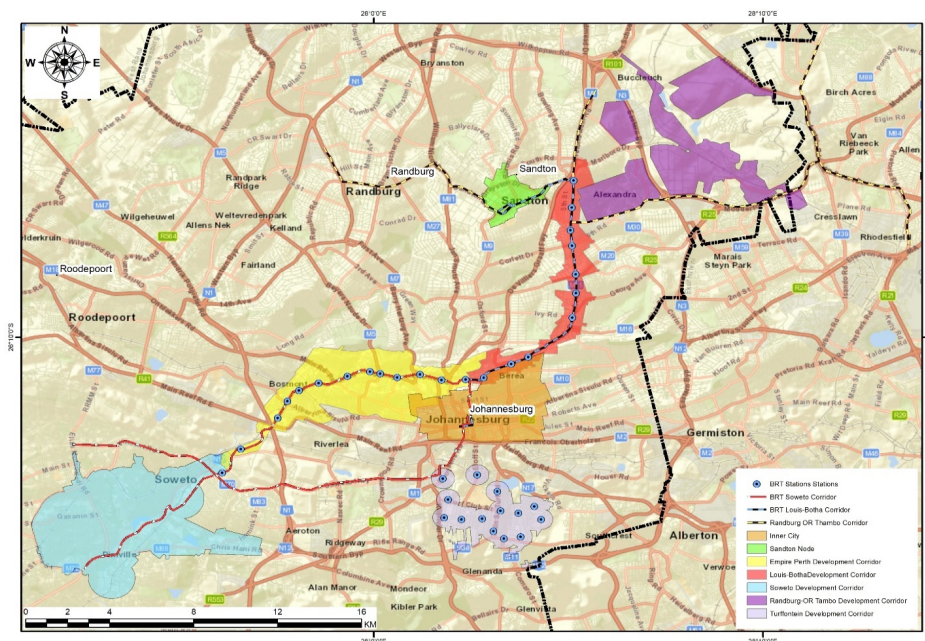


Figure 2: City of Johannesburg Corridors of Freedoms and Development Corridors Map

As depicted in figure 2 above, the proposed Corridors of Freedoms and development corridors are significant as mobility spines from a high-level perspective within the Gauteng City Region. They are also public transport and pedestrian spines, supported by existing active street edges and land-uses. They have the potential to transform entrenched settlement patterns that have kept many communities at the outskirts of the city, away from access to jobs and growth. They can also guide future city growth towards areas best serviced by transit infrastructure and the full range of vibrant urban amenities and services. The intention of the current initiative is to optimise development in and around high intensity movement corridors to create more accessible opportunities for the residents of Johannesburg and economies of scale that are attractive to investors. As such, future growth around these corridors is envisaged as medium to high-rise residential developments growing around the transit nodes, gradually decreasing in height and density as development moves further away from the core. Social infrastructure, schools, clinics, police stations and government offices will be strategically located to support the growing population. The future vision is premised largely

on theories and best practises around the notion of TOD. This seeks to create urban spaces with a vibrant mix of high-density residential developments, office, retail and recreational spaces within walkable precincts anchored by high quality social amenities.

#### 4.1 The Louis Botha Avenue Development Corridor

The Louis Botha Avenue Development Corridor represents one of three strategic frameworks that deal with the medium-term scope of the Corridors of Freedom, the other two being the Empire Perth Corridor, and the Turffontein Corridor. The Louis Botha Avenue Development Corridor is located to the north-east of the Inner City, between the CBD and northern parts of the City around Alexandra. The southern parts of the corridor study area are predominately residential in nature, encompassing some of the oldest residential suburbs in the City. Further northwards, the corridor passes through several key commercial and industrial areas, such as Bramley, Kew and Wynberg. The corridor is well connected to existing key nodes and elements in the City, including Midrand to the north, a key growth and employment node; the Modderfontein/ Greenstone area, a significant future growth opportunity for the City, and Sandton, one of the key economic nodes to the north of the City. The corridor further links to adjoining metropolitan Municipalities and is one of the main connectors bringing together people and jobs from neighbouring municipalities. Planned inter-modal facilities, such as the envisaged terminal at Watt Street will strengthen this function. Figure 3 below depicts the Rea Vaya Louis-Botha corridor and Louis-Botha development corridor.

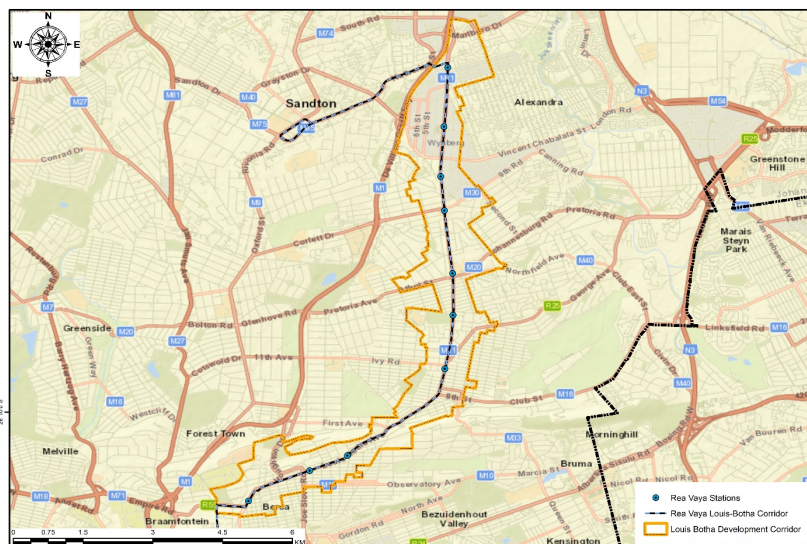


Figure 3: Louis-Botha corridor of freedom

The Louis Botha corridor forms part of Phase 1C of the Rea Vaya BRT. Louis Botha Avenue will function as the trunk route along which services will operate between the CBD and the Alexandra and the Alexandra and Sandton Nodes, connecting with existing Phase 1A and 1B service. Along this trunk route, buses will operate within the medium of the roadway with a segregated right of way. Trunk route stations (in the median) facilitate the physical integration between trunk routes, complementary/feeder services and other public transport systems, and provide strategic locations for future development. Minibus taxis and rail transport constitute the largest proportion of the existing public transport mode share. The Phase 1C of the Rea Vaya system also aims to strengthen public transport services between the CBD and Alexandra/Sandton. Most parts of the Louis Botha Avenue Development Corridor are serviced by the Gautrain Feeder and Distribution service. It is therefore imperative to promote integration between the Rea Vaya and Gautrain services, as Gautrain commuters from Marlboro Station could access the numerous economic, institutional and education opportunities in the corridor by means of public transport. The stations forming part of the Rea Vaya system are critical interventions for realising the benefits of Transit Oriented Development. Sidewalk facilities have been provided on most Class 2 and Class 3 roads but are inadequate, as the network is discontinuous and poorly maintained. In many cases, street furniture has reduced the effective width of sidewalks. No dedicated cycle facilities currently exist, although the City of Johannesburg is currently busy implementing cycle lanes in selected areas.

The Louis Botha Avenue Development Corridor is broadly serviced by the city's existing Metro Bus service, with most suburbs having some degree of walkable access to this service. With the introduction of the Rea Vaya network, however, a process of alignment is soon likely, which should see the optimisation of the Metro Bus system with reference to integrating public transport with systems such as the Rea Vaya. The north-east of the Inner City, which comprises parts of Hillbrow and Parktown is characterised by intense levels of development. Hillbrow remains one of the key inner-city residential areas, and there are isolated opportunities for densification through infill development and redevelopment of certain structures that remain. However, much of the opportunity associated with the current initiative relates to ensuring good connectivity to the planned Rea Vaya stations and consolidating and enhancing the supporting social and community infrastructure that exists in the area. Clarendon Station is the first of the Rea Vaya Stations proposed between Hillbrow and Parktown. The location of the station enjoys good accessibility to the Hillbrow side of Louis Botha Avenue, but relatively poor connectivity to the western side of the road, into the Parktown areas, due to the lack of local connections into this area. It is proposed that a pedestrian/NMT link be pushed through the block west of the Clarendon Station, to tie into Park Street.

Wynberg and Alexandra is anchored by the proposed Watt Street BRT Station and interchange. In terms of prevailing land use and character, the Wynberg area is predominantly industrial with some commercial activity around the Watt Street area. The areas east of Louis Botha Avenue, towards Alexandra, have undergone extensive growth over recent years, with the development of the Pan Africa Mall. These reinforce the strong east-west movement flow, much of which is pedestrian in nature, moving across Louis Botha Avenue towards Sandton. Peak hour pedestrian flows along this route often exceed 1000 people per hour. Movement and connectivity in the Alexandra and Wynberg areas is strongly influenced by the current treatment of Louis Botha Avenue, with the road being more divisive than integrative where it runs through the area. This is due in part to a median barrier which runs along the middle of the route, as well as service lanes which tend to limit integration between the road and the adjoining properties. The Marlboro portion is comprised of portions of the suburbs of Wynberg, Alexandra, Marlboro, Marlboro Gardens and Marlboro South. The area has the potential TOD opportunity for the current stage of the Rea Vaya system, with the route shifting westwards along Lees Avenue and across the M1 Motorway towards the Sandton CBD area. The final station offers good levels of accessibility into the adjoining areas.



Figure 4: Empire Perth Corridor of Freedoms

#### 4.2 Empire Perth Development Corridor

The Empire-Perth Development Corridor is in Region B of the City of Johannesburg, immediately to the west of the central Business District of Johannesburg. It serves as a regional, national, and continental node and is a thriving centre of trade and increasingly, a living environment to many diverse user groups. It forms part of a large movement corridor and has traditionally been the link between the densely populated residential settlements of Alexandra in the North and Soweto on the southwestern periphery of

Johannesburg. In the current context, the corridor thus connects two of the most significant settlements affected by apartheid in Johannesburg, linking vast population groups with employment, education and recreational facilities situated along the corridor and in the CBD. Due to its strategic location, the corridor is also an important metropolitan link between the western regions of Johannesburg and the CBD. Several important metropolitan links exist between the wider western regions of Johannesburg and the CBD. Further important metropolitan routes and rail links cross the corridor and the Rea Vaya Trunk route along Empire Road. Figure 4 below depicts the Rea Vaya Empire Perth corridor and Empire Perth development corridor.

The Empire-Perth corridor forms part of Phase 1B of the Rea Vaya and will function as the trunk route along which services will operate between Soweto and the CBD connecting with the existing Phase 1A service. Along this trunk route, buses will operate within the median of the roadway within segregated rights of way at a peak hour frequency of 1 bus per minute. The Phase 1B of the Rea Vaya System aims to strengthen public transport services between the CBD and Soweto. This Public Transport Spine should be supported by complimentary modes of public transport, including conventional Bus networks as well as the Commuter rail network that traverses the corridor area. The trunk route will be supported by complementary routes (extended, circular routes that connect to the main route), as well as feeder routes (routes from outer suburbs that join the trunk route at key stations) that will extend to places like Yeoville, Cresta, Florida, Parktown and the Charlotte Maxeke Hospital. Trunk route stations (in the median) facilitate the physical integration between trunk routes, complementary/ feeder services and other public transport systems and provide strategic locations for future development. The corridor is a connecting point for various districts and areas in Johannesburg and functionally can be viewed as a destination corridor. The corridor is regionally very accessible via private and public transport, with Rea Vaya, Gautrain Feeder services and future high-speed Metrorail services all servicing the corridor area. On a metropolitan scale, the corridor is a gateway between the traditional marginalised areas and the economic, education and recreational opportunities situated not only along the corridor, but in Central Johannesburg. Its current and future function in terms of connecting a vast number of Johannesburg residents with a wide range of opportunities makes the Empire-Perth Corridor a 'Corridor of Freedom'. The area earmarked for the Empire-Perth development corridor comprises of a buffer-zone situated around the existing Trunk Route 1B of the Rea Vaya Network and extends from Empire Road in Parktown in the East westwards to the intersection of Commando and Main Reef Road in Riverlea. Trunk Route 1B provides a link between the northern and southern parts of the city through the centrally located institutional corridor along Empire and Perth Roads. The location of the area within the city context elevates the potential to restructure the city and bridge the development gap between the south and the north while creating opportunities for accommodation related to tertiary education and other economic and social institutions in the area.

The Parktown and Braampark areas, situated on the eastern boundary of the corridor are served by the Parktown J1 Gautrain Feeder Bus service. This service links the important office and business node of Parktown, as the Charlotte Maxeke Hospital with Park Station. The service runs adjacent to the proposed Rea Vaya Trunk route on Empire Road (between Victoria and Queens Road) and could potentially form an integral part of the local network in terms of providing a regional entry point to the corridor on the eastern boundary. It is imperative to promote integration between the Rea Vaya and Gautrain Services as many Gautrain commuters from Park Station could potentially access numerous economic opportunities and institutional and educational facilities in the corridor by means of public transport. The stations forming part of the BRT system are critical interventions in terms of realising the benefits of Transit Oriented Development. The corridor is also served by strategic rail services including the main line linking Johannesburg CBD with Soweto (Naledi-Park). Rail stations within the corridor are Croesus, Industria, Langlaagte, Newclare and Westbury. Langlaagte Station handles the largest number of commuters, especially during the morning and afternoon peaks. Langlaagte Station is also considered as both an origin and destination station given the large number of commuters boarding and alighting during the morning and afternoon peaks. Croesus Station is second in terms of the number of commuters going through the station. However, given the largest number of commuters alighting during the morning peak and the large number of commuters boarding during the afternoon peak, Croesus Station is considered a destination station. Longdale Station is close third in terms of commuter number and is also considered a destination station based on its commuters' number. New Canada Station in the southern part of the Corridor area, has short term potential to develop as a significant TOD precinct, with PRASA currently planning substantial housing and mixed-use

development within walking distance of this station. Integrating public transport services and improving linkages between rail and Rea Vaya stations is thus crucial to promote a modal shift away from private transport to public transport.

Different areas within the corridor are currently characterised by different types of streetscape and layouts which inevitably influences the movement of people between areas, including to and from transport facilities. Sidewalk facilities have been provided on most Class 2 and Class 3 roads but are inadequate as the network is discontinuous and poorly maintained. In many cases, street furniture has reduced the effective width of sidewalks. No dedicated cycle facilities currently exist through City of Johannesburg is currently implementing cycle lanes in selected areas. Walking distance from several Rea Vaya Stations indicate the impact of large barrier such as the University campuses and the natural ridge within the corridor. Though situated no more than 400m from the station, certain locations in Brixton are more than 2km in terms of walking distance from the nearest station.

### 4.3 Turffontein Development Corridor

Turffontein is situated in Region F of the City of Johannesburg, immediately to the south of the CBD. The northern portion of the site consists of a swathe of industrial land, warehousing and storage spaces, the remnants of the city's historic manufacturing hub. While industrial activity may have changed substantially in the city, the built form of these industrial areas continues to attract light industrial and warehousing functions. This industrial space is contiguous with a band of partially active mining land, some of which may be reclaimed in the near future. This east-west mining and industrial belt separates the inner city from the lower density residential areas such as Turffontein, Kenilworth and Rosettenville in the south (See Figure 5).

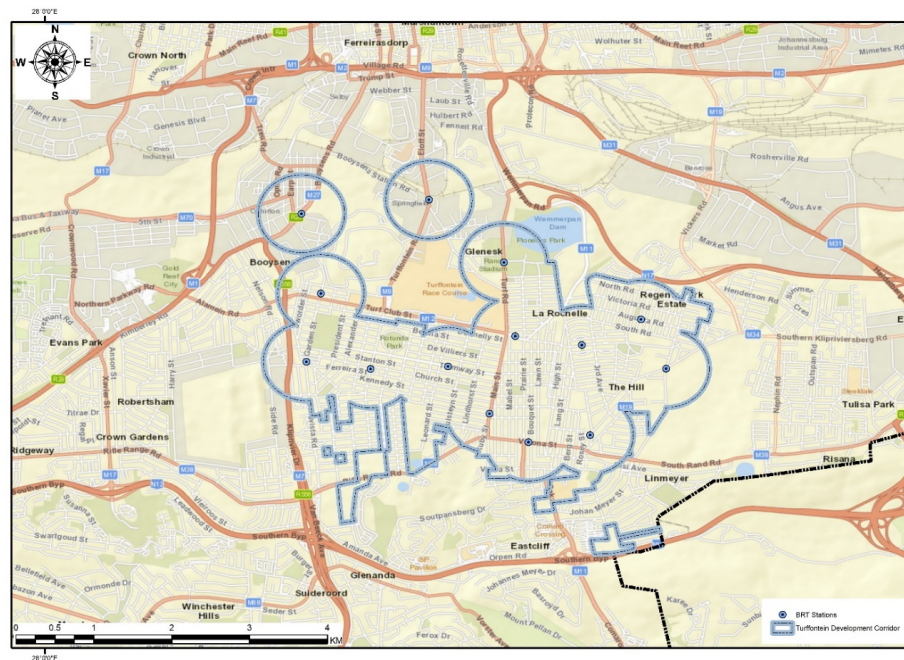


Figure 5: Turffontein Development Corridor

As depicted in figure 5 above, situated to the south of the Corridor area are the very low-density residential areas of Glenvista, and further south Alberton. These areas are interspersed with agriculture activity and some significant natural resources such as the Klipriviersberg Nature Reserve and the scenic East West Ridges/Koppies. Due to its strategic location, the area is well integrated with the surrounding urban areas. All major arterial roads originate from the CBD and radiate out into parts of the city. This includes the national routes N1, N3, N12 and N17 and makes the Turffontein area highly accessible from a local and regional point view. The CBD also houses several key transportation nodes (such as railway station, bus terminuses and large taxi ranks) that are important to national and sub-Saharan movements of goods and people. The existing public transport infrastructure and services in Turffontein are inadequate, given the city's intent to radically transform and re-stitch the city. The identification of a high-quality public transport route linking Turffontein with the wider Rea Vaya Network is central to the Corridor of Freedom initiative for Turffontein. The new public transport route is pivotal in terms of determining future densification and

land use strategies in Turffontein and is thus one of the catalytic projects aimed at unlocking the full development potential of the wider area. The proposed route links several destinations including the Johannesburg CBD, industrial and mining belt, Faraday, Village Main and Booyens Rail Station and recreation facilities in and around Pioneer Park, Turffontein Racecourse, and the residential suburbs in the Corridor area. More importantly, the feeder links Turffontein with the Johannesburg CBD, thereby connecting the area with the wider Rea Vaya network, consequently increasing the viability of public transport as a feasible mode from and to the area.

The City of Johannesburg Integrated Transport Plan Framework includes a public transport mode decision matrix which provides guidelines in assessing the role of each mode of transport in possible future transport systems. Given the need for a high-quality public transport service in the area, especially in terms of frequency and level of service, it is proposed that the route be classified as a Rea Vaya feeder. The demand for commuter transport is the determining factor in terms of the mode of public transport. Increased future demand because of the strategic densification in the Turffontein corridor could potentially necessitate a higher order public transport service. Thus, the implementation of a feeder or complimentary route serving the Turffontein area is the main objective of the first phase of the project. Whilst there will be further work that needs to be done on the configuration and viability of the route and service, it is envisaged that the future population of the area will generate sufficient peak hour trips to warrant the possibility of Phase 2 (possible trunk route/ dedicated busways) of the project.

The Turffontein area is served by variety of public transport services linking the area with the CBD and surrounding areas. Metrorail, Metrobus and Minibus taxis operate in the area, with taxis having the largest modal share. Booyens Station is the only significant Metrorail station in the area, functioning as the main link for workers wanting to access the employment opportunities in the industrial belt. Currently no Rea Vaya plans are in place for the Turffontein region, however, based on the current movement patterns and densification strategies proposed as part of the Corridors of Freedom initiative, the future developments in the area could possibly be better served by a public transport feeder route providing a high-quality link between the area and the wider Johannesburg. The three metrorail stations within the corridor area generally appear to be in a state of degradation and are poorly integrated with the surrounding urban environment. Booyens Station is particularly cut off from the industrial area due to the lack of a northern entrance to the station. Booyens could potentially play a more significant role in providing access to the industrial belt and Turffontein area. It is imperative for this station to be connected with the industrial belt, as the current layout is preventing it from functioning optimally. Only 25% (2172) of commuters' board trains at these three stations during the morning peak indicating the limited extent to which these stations are used by residents (Moyo et al., 2021). This movement pattern is reversed during the afternoon peak, as these workers return homewards to areas outside the corridor area.

The area is served by several Metrobus routes, and given the radial pattern of the Metropolitan network, generally provides north south linkages between Southern Johannesburg and the CBD (mainly Ghandi Square and Braamfontein). Although the municipal bus network adequately serves the area in terms of coverage, the irregular operating times of these services limits the ability of residents to solely depend on public transport as a means of accessing adjacent areas. In terms of the Metrobus service, however, the municipal bus fleet contains only six (1% of total fleet) special needs buses, with none of these operating on any of the routes serving this area (Mbatha and Gumbo, 2019). Bus stops and facilities are in a state of disrepair. The majority of these are in a bad condition and currently contribute to the general negative perception towards public transport in the area. Furthermore, buses run at capacity within the morning peak due to the low frequency service. Analysis of Movement and Connectivity. The major north-south movements within the Turffontein area are along Kliprivier and Prairie Roads, which are representative of the proximity and the strength of the job base of the city north of Turffontein. However, most of this north-south movement is external through traffic travelling directly to and from the city. Through movement plays a major contribution in terms of traffic volumes on roads. It is not practicable to disregard or prevent this movement occurring as it is currently perceived to provide support to local economies. Regional east-west movement occurs via the M1 and N12 motorways, with lesser movement along Turf Club and Rifle Range Roads. Moving forward, these roads must be managed effectively such that mobility needs do not compromise the accessibility requirements of internal movement. However, on a larger scale, it must be recognized that continuously providing for private vehicle travel based on current trends is not sustainable



and viable. As such, stronger emphasis should be given on providing infrastructure and directing land uses which support shorter trips via public transport, walking and cycling. Local motorised and non-motorised trips are generally characterised by shorter trips. These are generally local trips such as recreation or shopping jaunts. There are a variety of local employment, educational, social, and retail opportunities within Turffontein.

#### 4.4 Spatial Analysis of existing transport infrastructure and Corridors of Freedom

The existing public transport infrastructure and services in Johannesburg are spatially disintegrated and inadequate, given the city's intent to radically transform and re-stitch the city. Spatial connectivity through multimodal public transport networks is still not effectively pursued. This has led to creation of modes of public transport which are operationally disintegrated. Even different types of innovative urban public transport systems (Gautrain and Rea Vaya) operate independently of other existing forms or modes. Thus, duplication exists of multiple modes of public transport in the same geographical area without making any difference is inevitable. The proposed Corridor of Freedom routes, as illustrated in figure 6 are central to linking industrial areas, business nodes, mixed use nodes and residential areas.

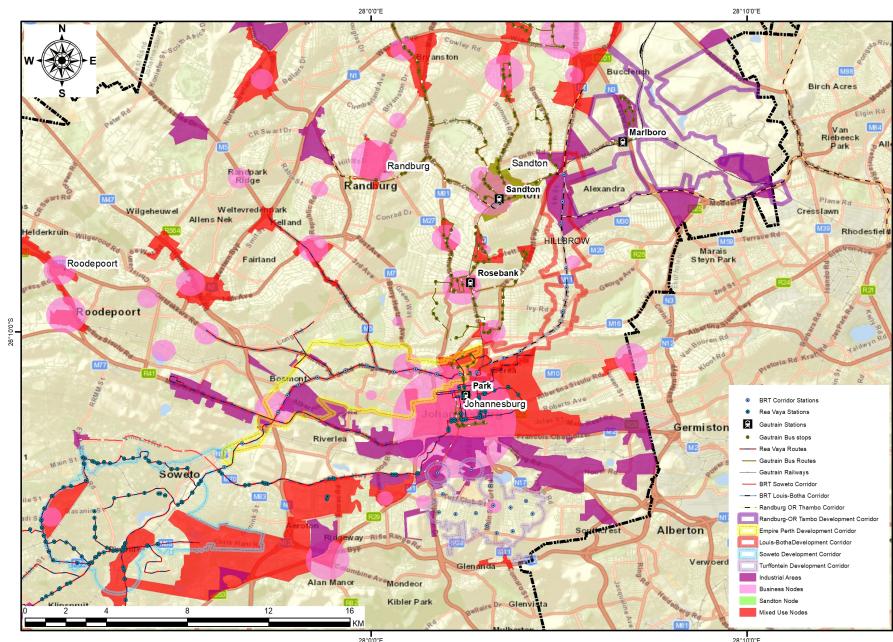


Figure 6: corridors of freedoms, public transport infrastructure, and nodes map

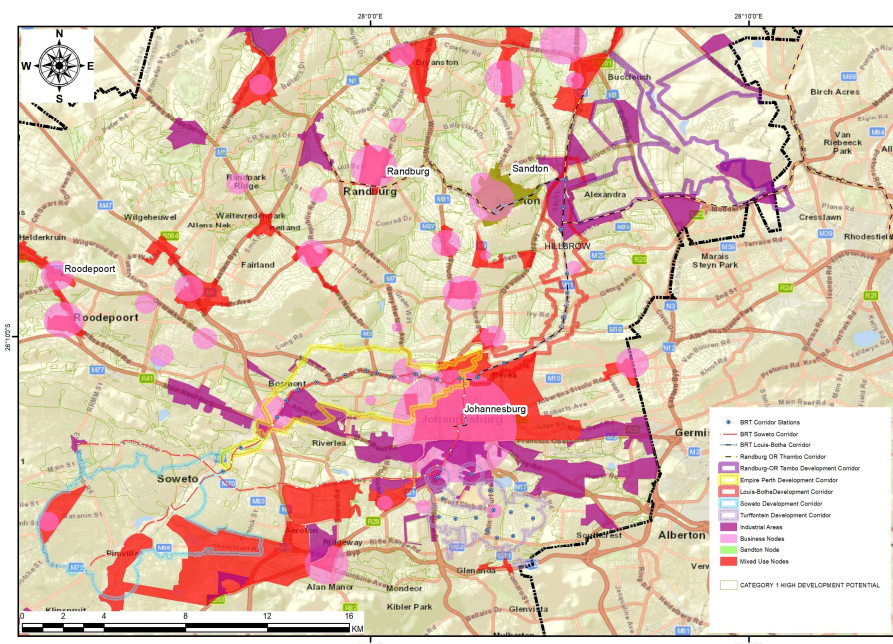


Figure 7: Corridors of freedoms, development potential areas, and nodes map

As depicted in figure 6 above, the shape of the future city consists of well-planned transport arteries linked to interchanges with focus on mixed use development, high density accommodation, supported by retail development, office buildings and opportunities for leisure and recreation. Joburgers in this future will live closer to their workplace and be able to work, stay and play without having to use transport motorised transport. Affordable, safe, and convenient buses, cycling and pedestrian activity will replace the carbon-burning private car. Ndwandwe (2017) stated that the average travel time between home and work for commuters making use of public transport is 59 minutes. More than 1.3 million South Africans spend more than two hours a day travelling to and from their places of residence. This can be added at least 30 minutes per trip spent on walking towards a station and stop and waiting for the bus or train to arrive. The Corridor of Freedom will transform entrenched settlement patterns which have shunted the majority of residents to the outskirts of the city away from economic opportunities and access to jobs and growth. Figure 7 below depicts Corridors of freedoms, development potential areas as well as business nodes, industrial nodes, and mixed-use nodes.

## 5 DISCUSSION

Spatial inequality remains a defining characteristic of the settlement pattern of Johannesburg. The location and concentration of jobs does not match where people live. This job-housing mismatch significantly contributes to inequality in the city, as for many residents' access to economic opportunities is stifled by costly and distant commuting. Some of the highest densities of housing, the 'townships' inherited from apartheid spatial policies, are also some of the most deprived areas in the city, located far from areas of economic opportunities. Post-apartheid housing delivery has exacerbated apartheid spatial development patterns by building housing in areas far from economic activities, with the availability of land being the primary logic behind their location. The private sector, through car-oriented developments (for example malls and gated residential estates and office parks) has further aggravated spatial segregation. Newer townhouse and cluster developments have relatively higher average residential density. These new developments are focused on private use and are frequently located in single use clusters, with limited access to public transit infrastructure. As such, they generally do not foster walkable neighbourhoods and often have not been met with requisite public infrastructure. Some of the highest residential densities in the city are some distance from the core, and from economic activity. Soweto, Orange Farm, Diepsloot and Ivory Park for example reflect relatively high residential densities but are all limited in their land use diversity. These are characterized by controlled street patterns that have moved from the historically open grid to the clustered cul-de-sac, loop and 'lollipop' configuration contributing to fragmentation and low levels of walkability. Johannesburg is characterised, inter-alia, by peripheral or satellite nodes that are disproportionately large compared to and are disconnected from the main urban centre (inner city). It is also characterised by illogical density gradient residential areas. This means that many high-density residential areas are located on the outskirts of the city, and far from job and economic opportunities. This spatial contradiction translates into a significant impact in terms of social exclusion, energy, and carbon intensity (by increasing travel time and travel distances from jobs to housing). It also impacts economic productivity (by jeopardising agglomeration economies), with most commuter's flows being directed to the city centre.

The City of Johannesburg presently displays the inverse of this polycentric urban model with separated land uses and people living far from work opportunities. The metropolitan core does not perform as the strong, structuring centred it should be. High density residential areas (the 'townships') are separated from urban economic centres and movement structures of the city. This pattern of development results in high social, economic and environmental costs. Thus, the Johannesburg SDF 2040 proposes a shift to a more efficient and inclusive urban logic of compact polycentricity with a focus on the Inner City as the core nodes of Johannesburg, surrounded by mixed nodes of various intensities connected by effective public transport and a more logical and efficient density gradient radiating outward from cores. The future polycentric Johannesburg will bring jobs to residential areas and housing opportunities to job centres (rather than merely transporting people between the two). It will bridge spatial and social barriers and build a framework for a spatially just city. With reference to the emerging spatial framework of the city, the following key spatial opportunities exist as a basis for moving towards a more compact urban form. Integrated development of business and residential densification should occur around key public transport facilities (existing and future); as a mixed-use response within the CBD, increasing intensity and capacity in the Inner City; Around current and future mixed use and economic nodes; within transformation areas identified in this SDF,

specifically where nodes exist in these areas (for example the nodes and ToD nodes in Soweto); and around existing social service facilities, including schools, healthcare and public open space. Regionally, Johannesburg is the centre of the Gauteng province, which is home to 12 million residents, 25% of the South African population. Connectivity with the other countries, provinces, municipalities, towns, and cities will foster economic development through specialisation of activities and economies of agglomeration (Risimati and Gumbo, 2019).

### 5.1 Policy Frameworks Deriving Mobility Innovations and Lessons learnt

It is evident that the South African government has made a priority of improving transport systems through mega investment and strategic policy instruments. Moyo et al, 2021 observes that the South African urban public transport system has reached a crucial stage, with major cities (supported by national and provincial governments) already geared up to the implementation of innovative public transport infrastructure. City of Johannesburg seems to be the one at the centre of innovative transport systems initiatives, while other cities and towns have lagged. This is understandable, given the population concentration and major economic activities in metropolitan cities. Johannesburg is embarking on new spatial plans in line with the 2040 Johannesburg Growth Development Strategy and Spatial Development framework, 2040 based on transport-oriented expansion with a high-level public transport network. Built on population growth, areas of employment growth, and projected densities; the city has identified a number of key public transport corridors. These consolidate growth and development opportunities around existing and future public transport nodes, starting from the Corridors of Freedom linking Soweto, through the Inner City, to Sandton and linking Turffontein into the Inner City. This will also include a focus on transit-oriented development nodes, including Gautrain, Rea Vaya (BRT) and Metrorail stations. The public transport corridors will function mainly as transit corridors, transporting large numbers of people from one part of the city to another. Other public transport corridors have the potential to grow into development corridors, with the opportunity to not only link mixed-use development nodes but to articulate public transit with housing, new employment activities and social amenities, while optimising investment capacities. Since the shape of the city will consist of well-planned transport arteries; the Corridors of Freedom will be linked to interchanges, where the focus will be on mixed-use development. The result is that the public will not have to use private transport but can opt for alternative means including cycling, transit lanes and pedestrian walkways.

## 6 CONCLUSIONS

This paper traced the spatial vision and mobility innovations envisioned for the City of Johannesburg. It was crucial to recognise the City of Johannesburg population dynamics, labour market activities and business operations to enable the study to contribute meaningful knowledge of city conditions. The existing spatial structure of the city and its shortcomings in terms of costly and distant commuting to access economic opportunities is also discussed with a closer look at how location and concentration of jobs mismatch where people live. The paper further discussed the City of Johannesburg new spatial plans in line with the Johannesburg Growth Development Strategy and Spatial Development framework, 2040 based on transport-oriented development. Since the shape of the city will consist of well-planned transport arteries; the Corridors of Freedom will be linked to interchanges, where the focus will be on mixed-use development. Corridors of Freedom and development corridors are significant both as mobility spines from a high-level perspective within the Gauteng City Region, as well as a public transport and pedestrian spines, supported by existing active street edges and land-uses. They have the potential to transform entrenched settlement patterns that have kept many marginalised communities at the outskirts of the city, away from economic opportunities and access to jobs and growth; and guide future city growth towards areas best serviced by transit infrastructure and the full range of vibrant urban amenities and services. Therefore, the Johannesburg public will not have to use private transport but can opt for alternative means including cycling, transit lanes and pedestrian walkways. The Corridors of Freedom will transform entrenched settlement patterns which have shunted most residents away from economic opportunities and access to jobs and growth.

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