

Enhancing Transit-Oriented Development Networks in South African Cities: Pathways for Sustainable Mobility and Access in the City of Johannesburg

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1 ABSTRACT

Transportation and spatial planning are inextricably linked. Transport networks and facilities have an immense influence on the spatial development of any city. Moreover, they determine the nature of the neighbourhood and the quality of life by directly influencing property market values. Transit-oriented development seeks to integrate urban spaces and bring people, amenities, and activities together with easy cycling and walking proximities to the excellent transit services. Consequently, successful transportation and spatial planning integration result in efficient transit-oriented development. This paper presents pathways for enhancing sustainable mobility and access through transit-oriented development networks in South African Cities. The paper adopts a case study research design wherein the impact of transit-oriented developments in the City of Johannesburg is presented and discussed. Quantitative and qualitative research approaches were deployed to gather relevant data, as well as specific questionnaires and interview guides. Preliminary findings reveal that transit-oriented developments have tremendous benefits and effectively transform neighbourhoods. There are still challenges associated with and hindering the integration of transit-oriented development and spatial planning in the City of Johannesburg. The paper concludes by recommending cities in South Africa and other developing countries adopt and implement transit-oriented development to achieve sustainable cities concerning efficient physical connectivity, mobility, and accessibility and to ensure climate-friendly and liveable cities. Lastly, transit-oriented development must be crystallised in city-wide developments in order to overcome contemporary mobility and access challenges in cities of the Global South.

Keywords: Transit-Oriented Development, Sustainable development, Spatial planning, Sustainable Mobility and access; City of Johannesburg.

2 INTRODUCTION

Since South Africa's democratic dispensation in 1994, various first and second-tier urban spaces have experienced rapid urbanisation. Thus, developing and enhancing the urban built environment to efficiently support sustainable transport is one of the overarching challenges for urban planning in most African cities (Gumbo et al., 2022). It is evident from previous scholars that the concept of land-use influences the traveling perception of citizens. According to prior researches, African cities have enhanced public transportation, boosted cycling and pedestrian activities, and reduced driving by integrating land-use planning with transportation planning. These implementations result from applying Transit Oriented Development (TOD) as an intervention and development principle for intensifying the urban built environment around public transit corridors and transportation nodes (Risimati & Gumbo, 2019). The TOD is an intervention that most developing countries in Africa should shift to its planning paradigm. This is because TOD is the vehicle that delivers sustainable mobility and access within the city. With that at hand this paper seeks to unpack how TOD concept is being codified within the inner city of Johannesburg, particularly this paper will utilise 400m radius from Park Station to further illustrate the concept of TOD as a point of case to support the study. The nature of TOD is to promote less driving and more cycling and walking, however, this paper outlines how TOD can be utilised as strategy to mitigate climate change. This paper highlights the ways in which the city of Johannesburg enhances the TOD networks in South African cities spaces, and how to further influences accessibility and sustainable mobility. Lastly the the paper provides feasible recommendations.

3 BACKGROUND

The concept of Transit-Oriented Development was codified by Peter Calthorpe in the late 1980's, other scholars had similar concept which contributed to the design of TOD existing today. The concept of TOD

became a headline for contemporary planning after the publications of “The New American Metropolis” by Peter Calthorpe in the early 1993. That was a steppingstone for the concept to be applicable for today’s planning paradigm. TOD is sustainably driven, hence, Calthorpe perceived it as a neo-traditional chaperone to sustainable cities design. Beyond TOD’s definition of built form, TOD was codified to meet communities needs and standards also it was an intervention to address innumerable societal challenges. As delineated by Nasri & Zhang (2014) the concept of TOD invigorates the development of vibrant and full cities designed to be concentrated on a transit facility. Since the codifying of the TOD, the concept invigorated growth of cities to be more compact and transit-supportive, the ideal of the concept was to integrate variety of residential real estate, commercial and amenities within a cycling and walking proximity of a transit station or stop and endorsing green and opening space and promote sense of community within urban spaces. TOD has been one of successful concept in urban planning which is a realistic concept to sustainable development. In the late 1989 the Board of Directors of the Bay Area Rapid Transit District (BART) conducted an intensive study on the possible high-rise housing on a TOD station. Housing units concentrated on a TOD was referred to as ‘Transit-Based Housing’ which were effectively influenced by the ‘particular’ transit. With that being surfaced the following session of the study is the ‘literature review’, the study reviews how TOD has been crystallised within the city of Johannesburg.

4 CONCEPTUAL SYNOPSIS

The TOD literature on European cities like Istanbul and Athens, amongst others, is widely cited as an inspiration for the development of TOD in most African cities, including Johannesburg (Cervero, 1996). These developed cities are most likely to be highly regarded among TOD researchers. They are highly regarded because they can integrate public transport and land use. However, to some degree, there might be a tendency to overestimate TOD's proliferation. Considering the wideness of the nation, the concept of TOD can be reluctant to the planning practice in these developed cities. For instance, according to Pettersson & Frisk (2016), there was intensive research conducted in Sweden regarding the implementation of TOD within the region of Skane; the research was conducted because the TOD concept was reluctant towards development. However, the study found that factors that make the concept difficult to achieve were the public transport accessibility development location, quality of public transport, and density.

TOD is one concept that is designed to mainly influence the use of public transit and develop a pedestrian-friendly urban environment. Over the years the concept of ‘TOD’ was referred to other various items including “transit-supportive development”, “transit village”, and “transit-friendly design”. However, TOD is the most used popular term among these terms. In juncture, TOD generally provides an environment where citizens live within a walking proximity of a major transit station and essential amenities (Risimati et al., 2021). TOD is mainly premeditated to stimulate transit ridership and use of several different features. First and foremost, citizens who are living nearby transit, are most likely to be provided with the culmination opportunity to be well connected to the entire transit network. With that at hand, TOD aims to increase usage and transit ridership whilst providing vast access to economic opportunities, cultural facilities, and educational opportunities. Hence this study seeks to unpack ways to enhance TOD development at large in the city of Johannesburg. Interestingly, the study oversees the concept of TOD within the precinct of Park Station. The way the TOD concept is crystallised within Park Station influenced the study.

Moreover, TOD features, including design and mixed-use, aim to influence transit usage and thus reduce automobile trips for different purposes. This is primarily applicable to the city of Johannesburg. Recent studies indicate that a business-use zone consisting mainly of retail businesses strategically located between the station and residences is one of the essential factors in reducing automobile usage in transit-served neighbourhoods within Johannesburg. This planning concept is based on the principles of new urbanism. However, this planning concept adequately promotes rail-pedestrian trip-chaining. In addition, recent studies have adequately surfaced that a retail business land-use near amenities such as rail stations can invigorate the transit commute mode share by approximately 4% (Cervero, 1996). This paper also stresses that a well-designed, mixed-use, and concentrated development around transit nodes can foster transit use around six times higher than comparable development away from transit. Also, this paper seeks to answer the question of how the city of Johannesburg can attain sustainable mobility by enhancing TOD.

4.1 Transit-Oriented Development

The present-day public transportation systems are well customised towards enhancing mobility within Johannesburg. In all epochs of life, the development of mobility infrastructure is essential. In light of this, the fourth industrial revolution era is convincing cities in South Africa to invest more in new innovative transportation systems to improve spatial development and connectivity. With that at hand, the city of Johannesburg metropolitan municipality is one of the leading Metropolitan cities in South Africa, with various innovative public transportation systems which adequately complement the transit-oriented development (TOD) (Risimati & Gumbo, 2019). Currently, the city is showing the ability to integrate public transport and the residential zones. The city has various informal and formal forms of public transportation, including high-speed trains (Gautrain) and rapid bus systems (Rea Vaya). The city also includes the traditional public transport systems that have been carrying the mass of the city (metro rail, Mega Bus, minibus taxis, Putco & metro bus). These are urban public transport essential to supporting the TOD in any given residential zones in Johannesburg city (Cervero & Dai, 2014). TOD has surfaced as one of the possible intrusions for sustainable urban mobility.

The implication of TOD with the city of Johannesburg has assisted in reshaping the quality of urban growth towards improved city accessibility and mobility, inflated sustainability, friendliness to pedestrians, and a high degree of human reciprocity. By definition, a TOD vicinity is a community that is a pedestrian-friendly built environment. The community will adequately have a central location of bus or rail stations that are relatively surrounded by high-density residential and mix-used commercial developments. The basic concept entails that TOD communities will, by default, have shorter proximity to amenities. In addition, Nasri & Zhang (2014) delineated that TOD communities are commonly located within 600m of a radius from a transit station or stop; this is a distance that is appropriately considered to be the scale of the pedestrian. Nasri & Zhang (2014) continues with an analogy that TOD urban spaces are built in urban forms unruffled by numerous TOD communities on transit lines. TOD is the model of dignifying transit by integrating urban land use with traffic. Nonetheless, TOD does not equate to a region where private automobiles are replacing public transit. Case in point, Doornfontein's vicinity in Johannesburg has an immense figure of TOD as much as the city of Johannesburg is a transit-oriented metropolis.

The Bus Rapid Transit (Ra Vaya) station and the companionship of midi-buses travelling along Bertrams Road between the Johannesburg stadium and the Caltex filling station make Doornfontein a viable alternative to driving. Many travellers opt for public transit commuting despite continued automobile ascendancy. This paper emphasizes that TOD is adequately designed for non-motorized and motorized modes. This paper also recommends fostering pedestrian trips without tendencies to reject automobile traffic. This is feasible by designing street networks that allow safe and efficient interaction with all the transport modes. In addition to what is being delineated, the theoretical framework built for TOD definition consists of design, characteristics, expected benefits, and guidelines. With that being said, there are empirical elements for analysing TODs to observe how effective TOD is in improving transit ridership, encouraging more non-motorized travel, and reducing emissions. The scholar Robert Cervero conducted one study on TOD. The outcome was that TOD residents are around five times more likely to use transit to work. In addition, those who reside and work in TOD areas are about three times more likely to use transit to get to home or work compared to all residents within the vicinity of the city (Mu & de Jong, 2012). However, according to the study by this paper, the city of Johannesburg has neighbourhoods designed with TOD elements. For example, all the residents residing within Park Vicinity and the nearest neighbourhood, including Braamfontein, are well integrated with transit stations with fewer proximities to amenities and services. However, the TOD concept has been crystallised strategically within the area of Park Station. This is a catalyst for sustainable mobility within the city of Johannesburg.

4.1.1 Existing integrated public transportation infrastructure TOD

Strong (2017) sees that TOD can develop when existing and maintained public transport infrastructure such as rail or bus stations take action as a catalyst and leading market densification, and positively influencing land-use development. A fresh perspective from the study supports Risimati & Gumbo (2019) findings, due to the observations of South African cities. According to this paper South African cities development is purely based on the perspective of lucratively, thus the concept of TOD is on robust fundamentals of success. On the other hand, this will effectively find its path to sustainable mobility. Thus, Park Station is a

quintessential to this very study. In addition to Mu & de Jong (2012) vantage point, the design, planning and implementation is required to leverage and reposition the efficacy of the existing public transport infrastructural assets and channel them in attaining the new measures of prosperity and development. Moreover, Tabane et al. (2021) further underpins the study of Risimati & Gumbo (2021) that with the development of TOD projects funding information and cost and policy considerations, they provide leverage to decision makers to contemplate the sincere significant implementations and risks options. This is an integrated perspective that adequately surfaces a conventional focus and perception on the significant element that derives a successful business concept from the TOD concept of existing integrated public transportation. According to Strong et al. (2017) the development of TOD on existing integrated public transportation infrastructure rejuvenates the state of urban spaces, moreover, by virtue of the study area of the study, Park Station has revived the central business district (CBD) of Johannesburg. The transformative development from existing public transportation infrastructure also presents challenges aligned with regulation, planning and policy and the limitation of construction in an operational environment. This particularly means that the business case needs early and careful considerations to figure out if the ultimate value of the development is greater than the cost of implementation. To mitigate the risks and improve the feasibility toward the success of the TOD. This is because the concept of TOD can sometimes be reluctant towards implementation due to accessibility.

4.1.2 New integrated public transportation infrastructure TOD

TOD can call for radical development centred on existing integrated transport infrastructure that seeks to transform existing development, community, and environment. Strong et al. (2017) elucidated that an effective way of initiating TOD is through introducing a new integrated transport infrastructure at a primitive stage; this is a strategic way of stimulating the renaissance of previously inaccessible locations and contaminated field sites (brownfield sites). A new integrated public transport station it's a fresh perspective that can engender a ripple effect for the development throughout the vicinity of a city. Thus, in some cases, involved schemes incorporate land parcels altogether, forming a more significant new precinct through the influence of TOD. The development of TOD on a new integrated public transportation infrastructure requires an accurately calculated decision to make the development successful and to ensure sustainable mobility within a city. In addition, the requirements for the progressive development of TOD (building a station) incorporates well informed integrated approach, concrete significant upfront political structure, major investment from both private and public sectors, considerable leadership, and a large-scale planning process. The fundamental principle of TOD is to encourage transport infrastructural investment, this also impacts the market structure of the surrounding properties value, also this influences the sprawl of development and provides more accessibility and value to the precinct. Moreover, Thomas et al. (2018) also sees the initiative of TOD as a portal that opens up for new development opportunities and practices sustainable development at large. Commonly it is known that the TOD concept focuses on the strata of public transport infrastructure investments as first, effective discussion in regard to parallel land-use movement that permits an increased density that will equally develop a supplementary viable process. According to this paper, incorporating land-use policies decisions and public transport investment in regard to the projected mobility metrics in coordinated strategy in the process of developing TOD into new integrated public transportation infrastructure can lead to a success path (Thomas et al., 2018).

5 STUDY AREA

Geographically, the City of Johannesburg is within the heart of Gauteng province, South Africa. However, the core focus of the study is interest in the Park Station precinct. The Study area is strategically located in region F of the city of Johannesburg Metropolitan Municipality. The study utilized a 400m radius of walking proximity from the Gautrain Rapid Rail Link station for this study. The geometry dynamics of the study area include Smit Street, De Villiers Street, Hospital Street, De Korte Street, Rissik Street, Koch Street, Simmonds Street, King George Street, and Wanderers Street. In terms of spatial location, the Johannesburg Park Station precinct is well positioned to be in the centre heart of Johannesburg, with which it is well functionally integrated. The area surrounding Johannesburg Park Station Precinct is tremendously predominated by commercial land use in nature.

With the arrival of the Gautrain, there was a better projection of Park Station in terms of spatial transformation. The transit node involved the redevelopment in accomplishing residential and commercial land use at a higher density. The predominance of commercial land use established the area to have a high degree of business services and real estate, insurance, the high profile of finances and communication sectors, storage, and transport. With that at hand, one can perceive high-density luxury residential growth within the cycling and walking proximity to Gautrain station. This could be for high-income earners at Randburg, Midrand, and Sandton. This concept is convenient for their affordability. The TOD concept at Park station has effectively increased the opportunities for hotels, retail stores, restaurants, and conference facilities within Park Station Node. The fact that Park Station is within the inner city of Johannesburg, the transportation system is decentralising from the inner city to the peripheral, and it is planned with the concept of a co-centric model of planning. This ensures that Park Station caters for all income classes with its market forces and inclusionary housing. The following figure 1 represent the map of Johannesburg park station with the radius of 400m.

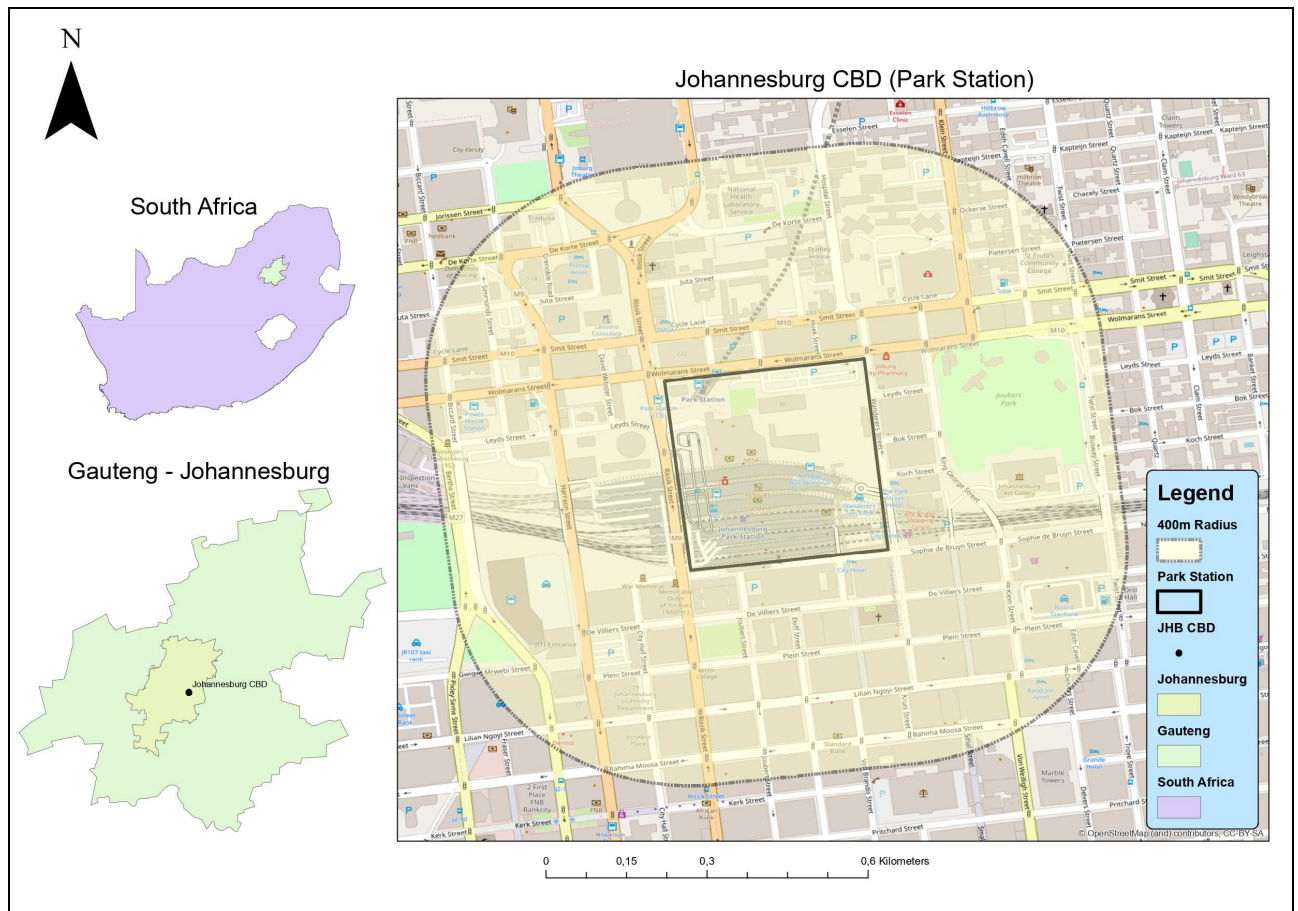


Fig. 1: Johannesburg Park Station Map

The above is the map (see figure 1) showing Park station, this map is following the logic of the study. Therefore, the radius of 400m is the appropriate proximity which the study also supports. The study also discovered commuters due to different groups of income, low-income groups are likely to walk more than 500m to Park station. Commuters also surfaced that the reason in line with that issue it's because the precinct is populated. With that being elucidated, the urban functionality and the status quo will be discussed further on research findings. The following section will elucidates how the data was collected.

6 RESEARCH METHODOLOGY

An exploratory research design was adopted to assess Park Station's spatial distribution pattern from the 400m radius of walking proximity from the Gautrain Rapid Rail. The study also utilized the mixed method research design, as it was adopted where quantitative data and qualitative data analysis were utilised. For the accuracy of the study, various research instruments were deployed in the study. The key informant interviews were effectively utilized to further accumulate information for this particular study. For this study,

interviews were semi-structured and blended using open-ended questions to discuss other transit-oriented development Pathways for sustainable mobility and access in the City of Johannesburg. Ten interviews were carried out with different daily commuters of Gautrain residing within the 400m radius of walking from the Gautrain Rapid Rail with a positive response. Five interviews were conducted with the officials from different departments in the city of Johannesburg.

These informants provided insightful information for the study about the various transport modes that park stations in Johannesburg have, from informal and formal public transport to support further the TOD to provide complete access to the city of Johannesburg. Most significantly, the core focus of the study was acknowledged by the daily commuters residing within a radius of walking from the Gautrain Rapid Rail. These commuters answered positively to the question: of how the city of Johannesburg enhances the TOD to further provide sustainable pathways for sustainable mobility and broader access to the city of Johannesburg. This study adopted subjective/purposive sampling due to the informed commuters and officials' respondents through the interviews, documented studies, and observations. Moreover, these tools were utilised to gather data from various sources. In addition, the study utilised secondary information that was acquired from ginormous databases including Francis and Taylor, Google scholar, Science direct and Sage.

7 RESEARCH ANALYSIS AND FINDINGS/RESULTS

The City of Johannesburg is venturing into its new contemporary spatial plannings aligned with the 2040 Growth Development Strategy, including the Johannesburg Spatial Development Framework 2040. These are strategic policies that are well based on transport-oriented developments. The city of Johannesburg has a high-profile city plan, including its corridor of freedom roped to interchanges. The city has spatial plans focused on mixed-use development, which adequately support the TOD city-wide (Mbatha & Gumbo, 2019). These equally provide configurations of the future city incorporating well-planned transport arteries. The main objective of the spatial policies is to commit to and reduce private motorised transport and provide vast alternative means such as pedestrians' walkways, bus lanes, and cycling. In addition, the study has also surfaced that 90% of the officials of the City of Johannesburg, Gautrain, and Metrorail provided positive feedback about integrating the transport modes provided in Park station precinct. The officials provided that the northernmost Gautrain station is adjacent to Metrorail's Johannesburg Park station, which has overridden the transport system within the inner city of Johannesburg. Since the Gautrain station assimilates Gaubus stations which include pickup points expanding the modes of public transportation within the inner city.

There was a strategy of the city of Johannesburg to enhance the transport systems to be more reliable and cost-efficient. Interestingly, the commuters residing around Park Station also had vital positive feedback from Questionnaires and interviews towards integrating public transport as they have specified that they travel easily to workplaces and amenities. The Park Station is approximately 100m to Gaubus station and Gautrain station, accommodating commuters to walk between the stations easily. Likewise, the city of Johannesburg is diverse, incorporating all the different levels of income. About 70% of commuters are facing the challenge of Metrorail (PRASA) hiccups since it's not operating in recent days due to looting and financial constraints from PRASA. There has been a disadvantage to the low-income commuters living near Park station. Metrorail has the following station in Johannesburg: Centurion station and Johannesburg Park station. However, it also has stations at Pretoria and Kempton Park. In addition, Metrorail has subordinating stations within the city's urban nodes.

The study has found that Metrorail has been a pillar transport to many commuters as a fund by the study. 80% of Metrorail commuters agree on integrating the following system to the park station: Metro bus and BRT. This will dispense benefits to the commuters of both transport systems. Through clear observations, the BRT only utilises well-serviced and intensely busy routes. In addition, BRT also uses routes potentially connecting other locations, including the City of Tshwane and the City of Ekurhuleni. The commuters have also highlighted that the BRT transport reaches significant sites around the CBD and these locations incorporate their workspaces. However, these commuters utilise the BRT through the connectedness of the transport systems. Thus, they suggest that BRT and Metro buses be closer to Park Station as part of enhancing transit-oriented development networks in Johannesburg. This was a significant finding for the study since it answers the people's statement of the study. However, 20% of the commuters are not pleased with the routes BRT, GauBus, and Gautrain use because they do not reach their desired places, such as their workstation. These commuters are reluctant to accept the idea that the transport system in the city of

Johannesburg is not well integrated. 80% of the commuters who reside closer to Park Station value the integration of the transport system concept due to how the system is convenient to them. Through how the data was collected the findings answered the research question on how can TOD be enhanced in South African cities and provided sustainable mobility and access in the City of Johannesburg. How transit-oriented networks can be enhanced? With that at hand, the following section seeks to answer the research question on how can the City of Johannesburg enhance the TOD networks in South African cities spaces, and how to further influence accessibility and sustainable mobility.

7.1 How to enhance TOD networks in South African cities?

This section seeks to discuss pathways which the South African cities including the city of Johannesburg are indulging on. The City of Johannesburg is committed to deliver sustainable mobility and continue to enhance accessibility through its spatial transformation.

7.1.1 Spatial integrated systems

The integration of spatial system is an exclusive planning framework which seeks to incorporate all the possible zonings. For accurate results, the aid of GIS is always applicable to further recognise zonings that should be relevant. The integration of spatial system is a framework that seeks to correct the exclusionary land-use patterns that were implemented by apartheid. However, integration of the spatial systems in South African city network is needed since it will improve the efficacy of the spatial planning since spatial integration systems seeks to locate residential development closer to economic opportunities, employment opportunities and exploit surplus bulk infrastructural capacity to reduce the cost of development. The spatial integration systems also promote social cohesion on social dimensions it can also increase the accessibility within the city for low-income residents to services, facility and opportunities. The spatial integration conveys the cultural and economic opportunities for diversity within the city. Most significantly it designates the levels of connectivity between the different geographical scale of transport systems. Moreover, Spatial integration is encouraged positively by the present of efficient physical, administrative bodies and function status quo between areas and the absents of political controversies.

7.1.2 Integration of the electronic payment systems

Covid-19 pandemic have escalated the concept of cashless societies at a global scale. The practice of electronic payments in retails and other services was enhanced even on transport sectors. The system of “pay as you go” is a traditional way that was introduced through cash transactions. This is the same system that South African cities can indulge on using for electronic payments. Moreover, the city of Johannesburg can enhance their payments methods on their transit nodes including Ra Vaya, Metrobus, Metrorail, Gaubus and Gautrain to accept immediate payment through cell phone or tag devices through tapping their devices through terminal payments to avoid long queues of cash and cards transactions. Also, the city of Johannesburg can influence and rope other private entities of transport nodes into the system such as Starbus, Putco and Megabus to venture in and integrate their system of electronic payment systems. The “Payment Systems in Public Transport” concept is grounded on what is known to be “four-party model payment” this model comprises responsibilities of allotting bank also acquiring bank are clearly divided in the card payment transaction process. The public transport operator is also observed as a service provider that accept rapid payments that equally channelled to an acquiring bank for transport provided. Therefore, the integration of the electronic payment systems on the transit nodes on city of Johannesburg will enhance transport availability and rapid transportation since the payments systems will be centralised. This means all the transport nodes will use one integrated payment model. The commuter will be eligible to use their device to make payments in all various transport mode. Moreover, integrating block-chain technology in the “fund’s system” will further ensure all the information happening on the system from registration to transactions is made anonymous and secure.

7.1.3 Development of station hubs

The development of a new station hub is ideal. This a fresh perspective that can further stimulates the economy Gauteng at large. Certainly transportation sector always present immense economic opportunities in urban spaces. This paper encourages transit station at Soweto township. Developing an immense public transport station at Soweto can influence the surrounding real estate values particularly in housing sector.

However, this can also rope in some risk such as pushing away some other groups due to property values in Soweto. Although this has also great benefits to all groups since there will be an increment of employment opportunity. Nonetheless, the great capacity of transport will have positive influence to the low-income group in this current cripple economy. Development of a new hub station comes vast feasible benefit including mitigate of climate crisis, accessibility, sustainable smart mobility, development of retail development and implementation of place making concept. Despite the traffic congestion that might be possible in Soweto, this development can further decentralises resources from the inner city to the peripheral of the city, it will also provide excessive frequency of transport services in respect to locations in Gauteng and South Africa as a region. A rail station can accommodate immense group of travellers at a comfortable and safe curtesy. This station can utilises smart transfer solutions for calculated decisions and the future of the station. Smart transfer solutions are exclusively independent on an effective design of the station, integrated, and multidisciplinary approach is proficient way. It is commonly known that railways links cities, regions and districts, railway also thrives in dynamics of departures and arrivals. Thus, in a global scale studies have shown that the railway is an embraced alternative for sustainable transport which thrives to improve the quality of life in urban spaces.

7.2 Pathways sustainable mobility and access

7.2.1 Policy and legislative frameworks on TOD

Sustainable mobility is still one of the overarching challenges that global cities are facing. The city of Johannesburg has also implemented positive reinforcement in terms of its policies to thrive in sustainable mobility. However, the concept of new urbanism and transit-oriented development are vastly evident within the urban spaces of the city of Johannesburg. With that being said, the city of Johannesburg is still reinstating its Spatial Development Framework 2040 (SDF) to further transform its spatial spaces to be sustainable and integrate transport systems. The discourse of this policy seeks to also invest on transport infrastructure to influence smart mobility. In addition, by virtue nature the concept of TOD seeks to merge development and investment in a close proximity to transit infrastructure. Accessibility in the city of Johannesburg can be assessed to various opportunities and activities by utilizing several transport modes in both qualitatively and quantitatively measures. In this case of point, the BRT (Ra Vaya) has enhance the accessibility of the city of Johannesburg.

7.2.2 Implications for Sustainable mobility and access

Transport sector is one the factors that influences the human activity within the city of Johannesburg hence the transport well-being robustly depends on characteristics and performance. Since the city mobility systems connect places and people while it presents significant social and economic added value and enhancing the quality of life, the city of Johannesburg seeks to integrate the transport systems which there is a potential success on this concept due to transport and spatial elements that are already in place. The city of Johannesburg has a vast high profile transport infrastructure that is significantly providing immense accessibility. With various transport modes that are currently available within the city spaces (see figure 2) there has been improvement of accessibility and sustainability within the city of Johannesburg.

The above map denotes the transport modes that are available within the city of Johannesburg as they impact the accessibility and sustainable mobility positively. However, the city of Johannesburg has vast transport infrastructure that also caters for other transport notes of the joint transport private entities such as Megabus, Putco, Starbus etc. With that being delineated, the inner city of Johannesburg comprises of diverse land-use, thus the following section seeks to unpack the function ability found in the inner city (Park Station).

7.3 Park Station urban function status quo

The inner city of Johannesburg is found within the region F, this region also consists of industrial and residential zones that can be found on the south of the city. Region F has dual characteristics, it is commonly known to be the host of both high-income and low-income communities including Berea and Bertrams catering for low income and wealthier suburbs of Parktown in the north of the city. Moreover, region F also consist of wealthy vicinities in the south of the city in Bassonia, Glenvista, and Mulbarton. The region F is one of the focused regions in the city of Johannesburg with well serviced road infrastructure, this region has access to M1 that joins the inner city with the Southern suburbs whilst the M2 joins the inner city with the

industrial zone of the city. Moreover, due to the chosen study area, Park station node has a significant function as an intermodal public transport hub. Park Station is within the city centre; thus, it represents a gateway to the city's peripherals for various commuters, also Park station is known to be the gateway for commuters from other countries from Africa including other cities locally (Mbatha & Gumbo, 2019).

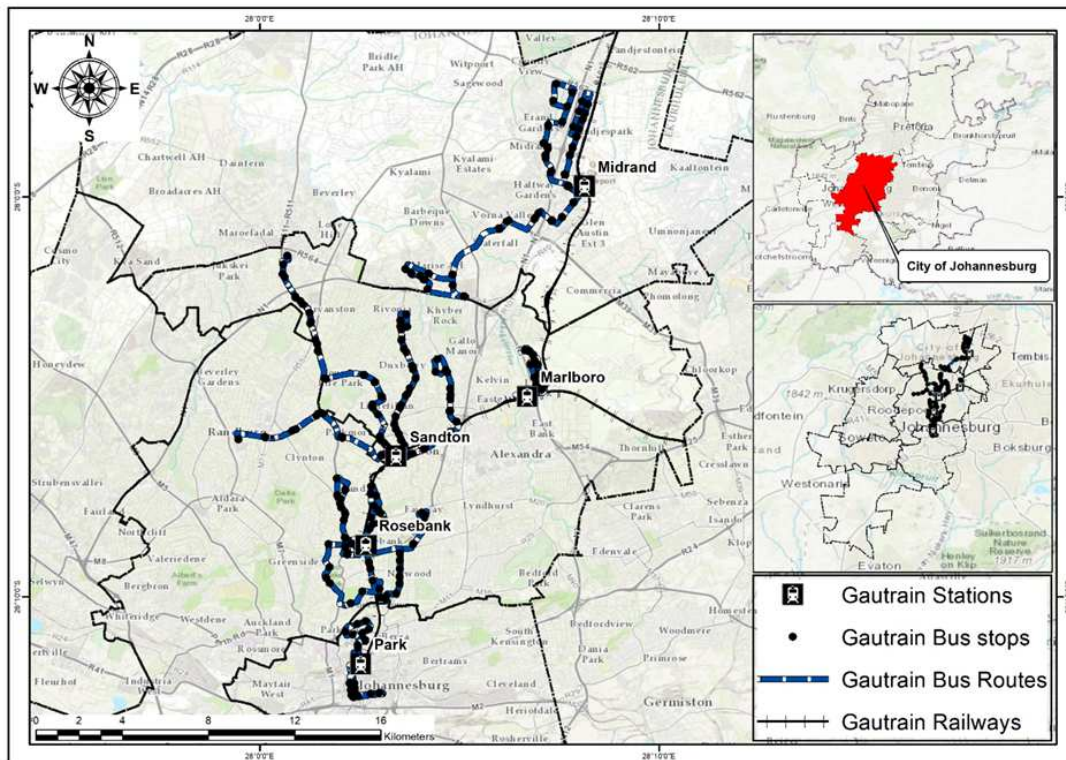


Fig. 2: Johannesburg transit Map

The Buses and Metro Rail services at Park Station are for regional transport services, intra-city transport as well as the inter-city. The Park station is accessible in all directions, this can be the mobility spines of De Korte street, Smit Street and De Villiers Street. These streets are all within short proximity to M1 highway. Park Station is the anchor of accessibility to the inner city; however, it also stipulates access to Braamfontein, a well-recognised high-density precinct that has undergone the incubation process of city regeneration. Braamfontein vicinity spatially supports the transit-oriented development since it also hosts a multiplicity of government departments including higher educational facilities (Wits university), local retail businesses, vast student accommodations, municipal and financial institutions. Due to Braamfontein's urban functionality, there are lots of people within the vicinity including various commuters through the area which results in more pressure on the capacity of service delivery and its quality (Risimati et al., 2021).

7.3.1 Land uses

The research site is in Johannesburg's suburban area to accommodate a broad range of land uses. Park Station is a sub-place due to its characteristics of a mixture of high-density land uses. According to the suitability of the study, this study utilised the 400m radius for its accuracy and rigour. Moreover, the intensity of land uses varies as they range from a nucleated by primarily commercial land uses in the south of sub-place. This has derived spatial planning from concentrating amenities and services, including educational facilities, parking spaces, governmental offices, and other diversified land used towards the north. The study supports TOD due to spatial planning and transformation; for reliability and validity, the Johannesburg Park Station sub-place falls within the eastern quadrant of Johannesburg and incorporates mixed land uses, commercial buildings, health care amenities, and educational facilities. With the high intensity of land uses in the vicinity of Park Station, it also has high volumes of people crossing the area for various motives. In addition, the study also discovered that within the 400m radius, there is no park or green space radius of chosen research. It is commonly known that Park Station is a protuberant transport main terminal in the city of Johannesburg, South Africa, and the Southern African Development Community (SADC). Park Station is a terminal known to dispense metro rail platforms, taxi ranks, and bus stations strategically located in walking proximity to the park station precinct. The study also noted that the BRT and

Gautrain Park station bus routes are significant distributors and feeder routes within the area of Johannesburg at large (Tabane et al., 2021).

7.3.2 Property trends

Within the radius of 400m of Park Station, various property trend strata show mixed results. Subsequently, the development of Gautrain integration with Park Station was predicted to enhance the real estate and property markets. This was more biased towards the residential and retail properties. Considering that the study is within Braamfontein's boundaries, this has been advantageous to Braamfontein in the aspect of property development through the city regeneration projects by the private sector. According to Risimati et al. (2021), in mid-2006, Braamfontein was successfully transformed into a fully fleshed arts and cultural and commercial precinct. In addition, the precinct became an entertainment vicinity supported by a vibrant student population from the University of Johannesburg and Witwatersrand University. The city of Johannesburg prioritized the setting of Braamfontein with students' accommodations, art galleries, restaurants, and street-scale strips of malls offering fashion. The other border of the study area is Joubert Park. The properties of Joubert park also show a distinct trend. As elucidated, Joubert Park is within the sub-place, just outside the study area. The Residential properties in Joubert are decaying, forming a degrading Joubert precinct, with numerous residents occupying these decaying buildings. These decaying buildings are influential to the TOD at Park Station; however, the city of Johannesburg has city regeneration programmes that object to reviving these decaying buildings and rejuvenating them with adequate urban infrastructure.

8 POLICY IMPLICATIONS AND LESSONS LEARNT

The municipal system Act 32 of 2000 delegates all the South Africa local municipalities to effectively develop and produce a well-functioning Integrated Development Plan (IDP) that regulates the initiatives of the development. IDP delineates all the future terms period, thus it also addresses the challenges such as the city performance measurement systems, spatial planning, risks mitigations and management, and economic development. With that being elucidated, it is evident that the government of South Africa has prioritised the enhancement of transport systems throughout the strategic policy instruments and mega projects investment. Nonetheless, the city of Johannesburg is venturing on new spatial plans of development that are more aligned with the 2040 Johannesburg Spatial Development Framework and Growth and Development Strategies. These are policies that are found during the study. Also, the policies are strategically aligned with transit-oriented development with prominent public transport networks (Risimati & Gumbo, 2019). The city of Johannesburg successfully acknowledged numerous public transport corridors, including future public transport nodes, development opportunities, and consolidated development initiating from the corridors integrating peripheral urban spaces such as Soweto, linking it with the inner Sandton city. This transition includes the existing public transport modes Metrobus, Metrorail, GauBus, Rea Vaya, and Gautrain. Moreover, the public transport corridors will adequately operate as transit-orientated corridors capable of transporting numerous colossal commuters from one point of the city to the other with ease at an efficient cost.

Other public transport corridors will integrate public transportation with housing development, optimize investment, provide new employment opportunities, and provide social amenities. On the other hand, the city dimensions will consist of high-profile planning practices of transport arteries, and the corridors of freedom will be incorporated into the city's interchanges (Mbatha & Gumbo, 2019). The outcome is that the public is advantaged with vast alternative means that are cost-effective and reliable. This includes extrapolated bus lines, rail lines, cycling ways, and pedestrian walkways. With that all being said, TOD as a policy concept has been metastasizing globally with the aid of international conferences, policymakers, and scholars endeavouring to transfer the idea to various cities and other countries.

9 RECOMMENDATIONS

This paper investigated ways to enhance transit-oriented development networks in South African Cities and Pathways for sustainable mobility and access in the City of Johannesburg. The findings collected suggestions from commuters and other interested parties about the TOD in Johannesburg. One of the recommendations included integrating available transit nodes within the inner city to accommodate low-income commuters further since Metrorail is not currently operating due to unfortunate circumstances and financial constraints.

Moreover, this paper supports the recommendation since integrating these modes will be interchanged in the city, allowing Johannesburg to make convenient policy adjustments. Furthermore, integrated public transit allows TOD to dispense significant intermodal integration and mobility options. This can be crystallised in congested vicinities in the CBD. Integrating the transit modes can allow diversity in transportation; for instance, old age and youth will be able to utilize multiple modes of transport. This paper strongly recommends the place-making concept. Placemaking can enhance public safety and improve the sense of place and transport through active development throughout the day and evening with eyes on the street. This concept can also improve the safety of pedestrians and promote pedestrian-centric areas within Johannesburg since the city of Johannesburg is venturing into new spatial development plans that are more aligned with the 2040 Johannesburg Spatial Development Framework and Growth and Development Strategies. The policies should rope in sustainable urban planning to reinstate a sustainable development approach to urban planning. Since TOD is channelled on denser density than low-density development, Sustainable urban development in TOD can reduce the need to convert open spaces and natural cover land-use into development.

10 CONCLUSION

This paper pursued to uncover the mobility innovations and the spatial transformation visions drafted by the city of Johannesburg to enhance the TOD networks in Johannesburg and find Pathways for sustainable mobility and access in the city. This paper also acknowledges most contributing factors to city conditions such as population dynamics, current economic opportunities, and political systems to enable the study to contribute knowledge about the city. The city of Johannesburg is accumulated by an endless list of challenges, including urban decaying, informal settlement, and traffic congestion. However, the city is leading the development and academic affiliations in the country. With that being said, this paper concludes that TOD is the vehicle to deliver sustainable development to South African cities and provide resilient, intelligent, sustainable mobility. On the other hand, this paper has surfaced that TOD can be a mechanism South African cities can utilise to metastasize the concept of place-making. Also, it has surfaced by the study that public transport corridors can accommodate cogent public transit with housing development.

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