COMPARATIVE ASSESSMENT OF EFFECTIVENESS OF BUS RAPID TRANSIT (BRT) SYSTEMS OF JOHANNESBURG AND TSHWANE

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DECLARATION

I, THANDEKILE KHUMALO, do hereby declare that this dissertation is a result of my own investigation and research, except the extent indicated in the references and by comments included in the body of the report and that it has not been presented to any academic institution. The study was carried under the supervision of Mr. A. Ogra and Mr. E. Makoni. It is submitted to the University of Johannesburg (Department of Town and Regional Planning), as a requirement to obtain a **Master degree in Sustainable Urban Planning and Development.**

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Signature January 2019

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ABSTRACT

Transport remains connected to our indigenous habitat, wellbeing and monetary thriving which rely upon good transport frameworks that provides effectiveness, comfort, fairness as well as affordability. Public transport is often framed as key component of building sustainable cities. Nonetheless, present estimations recommend that transport development is unjustifiable. Transport intimidates the social, economic, and our environmental future. Modifying as well as overseeing patterns of transport shows a critical issue which necessitates collaboration from participants at all governmental spheres. The study presents the critical review of literature of the relationship between public transport and sustainability with the purpose to comparatively assess the effectiveness of BRT systems of Johannesburg and Tshwane metropolitan cities. The study identifies the impacts, status quo, and benefits of this bus system, as well as its integration to other modes of transport. The study contributes to transport domain by identifying the key problems associated with sustainability of transport based on the perceptions and discussions of significant literature on transport. The attention is on connection amongst sustainable transport division and the sustainable development within South African setting. The research on the subject topic was done through desktop research, surveys, geographic information systems as well as interviews with the public transport users and transportation management to gain different perspectives regarding the users of the Bus Rapid Transit systems in the city of Johannesburg and City of Tshwane. BRT commuters and BRT stakeholders were the main participants in the research survey in order to cover important aspects of public transportation which includes increasing mobility and access; providing safety; financial benefits for commuter; and reducing traffic congestion, travel times and air pollution. Outcomes demonstrate that the concept of sustainable transportation has received recognition from the globe and improvement of sustainable transport is evident around the city. The study concludes that sustainable transportation is still a long process for developing countries, as it provides a progression of proposals that are intended to upgrade the

execution of the Johannesburg and Tshwane transport development and design method, with suggested changes for moving transportation improvement to a sustainable motivation.

Keywords:

Public Transport, Sustainable Transport, Bus Rapid Transit System (BRTS), Sustainability Analysis, Sustainable development.

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LIST OF ABBREVIATIONS

ANC	African National Congress
BEE	Black Economic Empowerment
BHSL	Buses with High Level of Service
BRT	Bus Rapid Transit
BRTOD	Bus Rapid Transit-Oriented Development.
C1	Complementary routes
CBD	Central Business District
CO_2	Carbon dioxide
COJ	City of Johannesburg
COT	City of Tshwane
CTMM	City of Tshwane Metropolitan Municipality
DBSA	Development Bank of Southern Africa
DEA	Data Envelopment Analysis
EMM	Ekurhuleni Metropolitan Municipality
F1	Feeder route
GIS	Geographic Information System
IPPUC	Instituto de Pesquisa e Planejamento Urbano de Curitiba
IRPTN	Integrated Rapid Public Transport Network
ITDP	Institute of Transportation and Development Policy
ITS	Intelligent Transport System
KPI	Key Performance Indicators
LA	Latin American
LBS	Location Based Service
LDV	Light Delivery Vehicles
LRT	Light Rail Transit
MEC	Member of the Executive Council
MMC	Member of the Mayoral Committee
MSA	Moving South Africa (1998)
NDP	National Development Plan

PPM	Partial Productivity Measures
SA	South Africa
SFA	Stochastic Frontier Analysis
SITPF	Strategic Integrated Transport Plan Framework
SPSS	Statistical Package for the Social Sciences
T1	Trunk routes
TEOR	Transport Est-Ouest Rouennais
TFP	Total Factor Productivity
TOD	Transport Orientated Development
TRT	Tshwane Rapid Transit
UDA-RT	Usafiri salama Dar es Salaam Rapid Transit
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change's
US	United States
VKT	Vehicle Kilometers Travelled

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CONFERENCE PAPER

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CHAPTER 1: INTRODUCTION

Public transport thought is being advertised as an important catalyst for an economic future, particularly in extensive metropolitan regions with developing populaces. Whether such venture will dismiss the tide from auto mobility is an unavoidable issue; nevertheless, paying little mind to the possible result, any responsibility regarding enhanced public transport has a developing number of opinions to seek after (Crambeck & Qu, 2015). In spite of the fact that rail varietals ordinarily appear to be leading in numerous strategic proclamations on urban change, going from heavy rail through to metro rail and light rail, interest is developing worldwide in methods for improving utilization of the bus as an essential mode of public transport, and not restricted as a mode that feeds a rail network (McHugh, 2013)

There is recharged enthusiasm for some developing and developed nations in discovering methods for providing proficient and powerful public transport that does not accompany a high price. An expanding number of countries are inquiring what kind of public transport framework can convey value for money. Even though light rail has frequently been encouraged as a good mode of transport, bus rapid transit has been developing as a powerful mode of transport. Bus Rapid Transit is a high-quality bus system that is designed to improve capacity and reliability, operating on dedicated lanes to deliver fast, comfortable and cost-effective service (Waldeck & Van Heerden, 2017). The thought that buses basically operate in an obliged advantage condition under mixed traffic and that trains have favored devoted right-of-way is never once more the most economic and considerable suggestion (Diaz, 2009).

BRT frameworks have picked up prevalence worldwide as a cost-effective option too much more costly city rail funding. Transport based systems with great values moreover incredibly provide to the low-density ranges of various rustic markets and small-to-medium size urban regions because of the characteristic flexibility likings of rubber tire systems – a comparative car which gives fast service advantages on a dedicated lane can change into a feeder car, collecting and dispersing commuters on adjacent paths.

This minor research dissertation comparatively assesses the effectiveness of BRT systems in the City of Johannesburg area and the City of Tshwane. It assesses the effectiveness of BRT with regards to accessibility of the system; providing improved service; being a reliable mode of transport; providing affordability to the customers; decreasing time spent commuting compared to other modes of transport; increasing capacity; providing speedier boarding; and its integration with other modes of transport. Transportation with the capacity to transport a huge quantity of travelers, utilizing substructure whose fares are to an extraordinary degree appealing, stay the foremost best transport mode. Whereas advancing lifecycle costs are considered, the costs of giving high limit incorporated BRT systems are an alluring alternative in various unique situations.

1.1 Background (BRT in Johannesburg and Tshwane)

There are many ways in which public transport can be improved as an integrated framework, characterized by the excellent BRT systems in South America such as, Colombia, Curitiba in Brazil, and TransMilenio in Bogota (Hidalgo & Yepes, 2005). BRT is a superb standard transport-based travel framework that conveys quick, comfortable and savvy urban transport through the delivery of isolated right-of-way foundation, fast and incessant operations, and magnificence in advertising and customer service (Hetherington, 2011). BRT basically imitates the performance and enhancement qualities of an advanced rail-based travel framework however at a small amount of the cost. A BRT framework will normally cost 4 to 20 times not as much as light rail travel (LRT) framework and 10 to100 times not as much as a metro framework (Hidalgo, 2005).

With an emphasis on conveying a cost proficient as well as benefit compelling transportation framework, there's availability of chances this century to assess blends of rail and bus frameworks that can benefit the full range of capacity prerequisites and support requests.

Bus Rapid Transit (BRT) frameworks are being advanced all over the world as a possibly viable method for conveying significantly enhanced public transport

administrations to marginalized urban communities and in this manner diminishing exclusion-related poverty (Hidalgo & Yepes, 2005). The Johannesburg and Tshwane municipalities implemented its new long-haul transportation framework, propelled amid October 2013 in the Johannesburg municipality, and April 2014 in the Tshwane municipality (Adewumi & Dhiren, 2013). According to Hetherington, (2011) the "Strategic Integrated Transport Plan Framework " (SITPF) sets out the Cities transport vision and strategic thrusts that will empower a formative acknowledgment of the Cities long term vision set out in the 2040 Growth and Development Strategy.

According to Kane (2010), transport sector is an important component of the City of Johannesburg's economy and a common tool used for development, and as well plays a critical part in connecting the divided spatial form of the city. When transport systems are efficient, they provide economic and social opportunities and benefits that result in positive multipliers effects such as better accessibility to markets, employment and additional investments. The City of Tshwane, on the other hand, was faced with challenges to improve public transport within the city. Although the image of public transport in the City was poor, a number of events provided a window of opportunity to address the situation such as Soccer World Cup 2010, the decision to go ahead with the construction of Gautrain, with three stations within the Tshwane area, the taxi recapitalization programme, which was expected to go ahead soon after years of delays, increased congestion, the city densification and corridor development land use strategy that has been approved by Council (Hidalgo & Yepes, 2005). The City of Tshwane identified BRT as one of the possible methodologies to improve the image, quality, and utilization of public transport within the city.

The municipality of Johannesburg has progressed with the idea of linking spatial planning to infrastructure by the BRT since 2006 (Litman, 2011). The idea has been convenient for the community of Johannesburg as it has limited traffic congestion and being the reliable mode of transport. Planning for the BRT has included intensive negotiations with various parts of the taxi industry (Mabena, 2010). This has been a long, often conflictual, process. The municipality has attempted to incorporate taxi operators as partners in running the BRT and as shareholders in the company.

Feasibility studies showed that involvement in the BRT in these ways would replace jobs and incomes lost through the displacement of taxis on key routes (Todes, 2012). While some taxi associations came on board early on, others were resistant, claiming that the BRT would undermine their livelihoods. Resistance to the BRT led to delays in construction but propelled by the need to have in place an operational system to support the 2009 Soccer Confederation Cup games, and especially the FIFA World Cup in June 2010, the municipality moved ahead with its plans (Rea Vaya, 2014). Some BRT buses experienced violent attacks, and intervention was required by South Africa's president Zuma to move negotiations forward (Venter, 2011). Agreement on the first phase (beyond the limited development for the World Cup) was finally reached in late 2010, but other phases have still to be negotiated. The BRT system was introduced in the City of Johannesburg and it took less than three years for the city to get *Rea Vaya* up and running, from the early planning and design phase to the daily operation with 64 buses on the road.

In the field of public transport, the City of Tshwane Metropolitan Municipality (CTMM) was faced with challenges, however, there are exciting new developments impacting on public transport within the city, and which needs to be accommodated.

The City of Tshwane (CoT) wanted to build and activate a Tshwane Rapid Transit (TRT) framework to enhance public transport in the city. The Inception Phase of the task connected the city centre area to Hatfield and was planned to be working by April 2014, and the next phase of the framework connected Akasia to the CBD and Hatfield to Menlyn (Waldeck & Van Heerden, 2017).

The TRT System has lined up with the CoTs Integrated Rapid Public Transport Network (IRPTN) Strategy description of the course and means to give an effective and accessible transport framework similar to private transport. The TRT foundation targets are to maximize the facilities for non-mechanized activity (like cycling and walking) along the whole route and is intended to fit in with the current streetscape (Crambeck & Qu, 2015). The TRT framework incorporates various diverse lines, including Line 1A which interfaces the CBD with Rainbow Junction. Line 1A runs along Rachel De Beer Street, R101, Mansfield Avenue and Paul Kruger Street (Crambeck & Qu, 2015).

The buses for the BRT system's inception services started coming off the production line on April 14, explained MMC for Transport George Matjila at the unveiling of the new bus at the *A Re Yeng* bus station, in Hatfield (McHugh, 2013). Volvo Southern Africa, in partnership with Marcopolo South Africa, was contracted to produce 131 buses to the City of Tshwane by 2016. Bus organization Tshwane Rapid Transit (TRT) an acting body representing influenced bus and taxi administrators, purchased the buses while the City of Tshwane provided the bus details to coordinate the *A Re Yeng* service and stations (Waldeck & Van Heerden, 2017). The Tshwane Bus Services warehouse was being repaired for use as an interval stop, where the buses would be housed and all repairs, refueling, and administration would occur. According to (McHugh, 2013) the *A Re Yeng* control centre, which controls all interchanges connected to the *A Re Yeng* trunk line, was set up at the Tshwane Metropolitan Police Department central command. The buses, which work under a high-tech framework depends heavily on a knowledge transport framework and accommodates 33 seated travelers and 35 standing travelers.

Negotiations to ensure the inclusion of the taxi industry and the prevention of displacement were still underway, with the recruitment and training of taxi drivers who operated the Menlyn, Elarduspark and Pretoria stations' taxis, kicking off in May (McHugh, 2013). The taxi drivers, who were sourced from a database of operators expected to be impacted by the introduction of *A Re Yeng* in the inception phase, completed their training by the end of June 2014, explained A *Re Yeng* executive project manager Lungile Madlala (Waldeck & Van Heerden, 2017). The training of the drivers included an induction regarding the TRT system, working conditions of bus drivers, procedures and policies of the TRT, customer care, BRT operations and compliance with contractual obligations," she said. More drivers were recruited and trained as the next phases of the BRT project progressed.

Speaking to the media at the launch, executive mayor Kgosientso Ramokgopa said the delivery of the first *A Re Yeng* bus was the start of Tshwane's long-term ambition of placing 85% of its population within 500 m of the BRT trunk or feeder corridor (McHugh, 2013).

Buses keep operating on specific streets to guarantee standards of service delivery in a speedy way, while the bounded stations are intended to be extensive and inviting (Adewumi & Dhiren, 2013). Wright and Hook (2011) highlight on the safety and standard of these stations, he says that the administration room screens the transports and stations, guaranteeing that BRT is at the same level as world-class qualities. The administration area has a very good communication system which allows the staff to interact with the drivers to guarantee that transports keep running on time, it also has real-time tracking of bus movements (Todes, 2012). A vital component of the *A Re Yeng & Rea Vaya* venture is the lessening cities open transport carbon impression; the Armada is the most current accessible, with advanced designing to guarantee carbon outflows are as low as could be expected under the circumstances (Venter, 2011).

According to Seftel and Peterson (2014), the standard of these stations, the administration room screens the transports and stations, ensuring that BRT is at the same level as world-class qualities. The administration area has great correspondence framework which enables the staff to interact with the drivers to guarantee that transports keep running on time, it likewise has a continuous following of transport developments (Todes, 2012). An essential part of the *A Re Yeng* and *Rea Vaya* venture is the lessening of urban areas open transport carbon impression; the Armada is the most current accessible, with advanced designing to guarantee carbon outflows are as low as could be expected under the circumstances (Venter, 2011).

Nonetheless, BRT (*Rea Vaya & A Re Yeng*) does not work in a vacuum; it is a critical part of a vast arrangement to give the general population of these metropolitan cities a consistent public transport framework coordinating consistent rail, buses, private mobiles and taxis (Walters, 2012).

1.2 Problem Statement

Research Problem (World 1): Incorporation of accessibility in transport planning.

Based on previous literature on BRT within these metropolitan cities, it is evident that there is a lack of accessibility to the BRT (Deng & Nelson, 2011). This is because, in view of other studies, the routes of this system operate in specific streets within their

cities which basically means that the other streets where they do not operate or have a station, those routes are served by other informal transport modes (Deng & Nelson, 2011). They basically feed passengers to the BRT from these other streets where they do not operate.

Accessibility alludes to the individual's capacity to reach goods, administrations, and activities, which is a definitive objective of most transport activity. According to Bocarejo and Oviedo (2012), numerous elements influence, the quality, accessibility, affordability, the movement of transport choices, transport framework network, mobility substitutes, and land use designs. Accessibility can be assessed from diverse points of view, counting a particular group, area, mode or movement. Since accessibility is a definitive objective of most transportation action, transport planning ought to be founded on accessibility. Nevertheless, traditional panning tends to neglect and underestimate some of these elements and points of view. More extensive examination of accessibility in planning extends the extent of possible resolutions for transport issues.

Problem Statement (World 2): What are the factors affecting accessibility?

Accessibility to stations and bus stops is an essential factor with regards to transport development. Writing has demonstrated that enhanced access to transport gives various chances to poor people (Tiawoun, 2000). Taxis are for the most part accessible within a 5-minute stroll from home. Adewumi and Dhiren (2013) say that additionally, the BRT has comparable accessibility as the ordinary transport (Metrobus and Putco), with the majority of families arranged inside a 15-minute stroll from either a BRT station or a feeder course. Given the officially large amounts of public transport access in the cities, evidently, *Rea Vaya* and *A Re Yeng* do not, all in all, provide any preferable accessibility within the areas of these cities over existing public transport services. Access to transport gives various opportunities to the poor. The absence of access to transport will constrain access to opportunities for poor people (Waldeck & Van Heerden, 2017).

As per Bocarejo and Oviedo (2012), the following are a few general factors that can influence availability:

- Motor vehicle travel conditions, car travel velocities, safety as well as affordability.
- Quality of different modes, cycling, telework, walking, public transit, speed, comfort and service delivery.
- Transport integration- the level of incorporation among transport framework connections and modes.
- The density of ways and roadway associations, and along these lines the explicitness of movement between areas, in addition to the nature of integration between transport, for example, the simplicity of strolling and cycling to open transport stations.
- Land use proximity, improvement of compactness, and along these lines, distances between nodes.

1.3 Research Scope

- **Conceptual scope:** this research scope is mainly based on the development of Rea Vaya BRT in the Metropolitan City of Johannesburg, and *A Re Yeng* BRT in the Metropolitan City of Tshwane in the Gauteng province.
- **Temporal scope:** this research is focusing mainly from 2010 to 2018, which is the period of 8 years where the municipalities decided to go ahead with the idea of linking spatial planning with transportation and adopted on BRT and things have been changing since the development of the BRT.
- **Spatial scope:** this research focuses on specific BRT routes within these Metropolitan cities. The routes are specified on the study area section.

1.4. Preliminary Literature Review

This composition offers a dialog on urban public transport and highlights the utilization of the Bus Rapid Transit framework universally and locally (South Africa). The motivation behind this writing is to encourage a significant investigation relating to

information gathered on the encounters and sentiments of travelers who utilize the *Rea Vaya* and *A Re Yeng* with the goal of understanding the research results.

The numerous economic, social and environmental issues globally are moreover essentially urban issues: urban communities are where the common populace is. This stimulates a logical prescription: urban communities ought to oversee these issues in an integrated logic, with integration crosswise over topography, issues, controls, and organisations. The expressions "quality of life" and "livability" are currently generally utilized in ecological and land-use planning, as well as in planning economic improvement and sub-infrastructure (Deng & Nelson, 2013). As per Mulenga (2013) masterpiece of that foundation is the urban surface transport framework. Regardless of enormous open and private speculations, the urban clog is compounding, and the majority of transportation isn't pulling in plenty of customers to pay 33% of its working cost, significantly less its capital cost (Gasennelwe, 2011). Incorporating more transportation restrain, both roadway and travel doesn't generally decrease traffic, and the benefits of methods that decrease travel trips (and, consequently, pollution which contributes to environmental problems) are politically worrying and actually talked about.

With the lack of transportation frameworks, urban areas could never have developed **(**Banister, 2008). Cervero (2014), further states that as soon as they are created, transport frameworks remain forever part of the city and they help a perplexing economic and social growth. Transportation innovation enabled individuals to travel to areas with normal favorable circumstances for populace coordination. It enables present-day urban areas to abuse the benefits of integration to all the more productively give better service, as well as to exchange those benefits with different places, which allows for economic effectiveness (Hitge & Gqaji, 2011).

Economically and socially dynamic urban zones depend on a framework for transporting individuals, merchandise and enterprises. The wellbeing of urban areas and their capacity to create income and riches for community members is enhanced if the transport framework is productive and if its development and procedure takes into

account its effects on nationals, ecological, land use and financial development (Mulenga, 2013).

According to Deng and Nelson (2013), making any framework productive and reasonable (as such, influencing it to function admirably) begins with comprehension of circumstances and end results of the key attributes of the current urban transportation framework and components that are probably going to make it change later on.

For the purpose of this research, the first section of the literature section highlights on urbanization and transportation, transport integration and sustainability, as well as effectiveness in transportation. The second section broadly focuses on the BRT system, its origin in different countries (Brazil, China, UK, Canada Australia, India, Tanzania, and South Africa).

1.4.1 Urbanization and transportation

For as long as twenty years, both the extent and the number of individuals living in urban regions have been expanding quickly in developing nations (Mulenga, 2013). This expansion is likewise set apart by centralization of the populace in substantial urban communities. The connection between urban and transportation is maybe a standout amongst the most vital parts of improvement in a city. The arrangement of transportation assumes a noteworthy part in supporting advancement in a city, while in the meantime, improvement straightforwardly influences transportation need (Rode & Floater, 2014). Gasennelwe (2011) further states without a sufficient transportation framework, there would be a breaking point to development.

Most urban transportation issues happen when the need for transport surpasses the provided arrangements. As per Rode and Floater (2014), the need for transport is a determined request, which means it relies upon where individuals live and work, and on the area of creation, administration and recreation exercises. Any adjustment in the structure of the general public will change the need for transportation (Mees, 2009).

1.4.2 Integration and Sustainability

Transport Integration implies that whatever modes of transport are included they all work as one 'consistent' substance for the advantage of the paying customers (Dibakwene, 2011). Private transport, as a rule, gives door to door service (Yusuf & Allopi, 2010) and while this isn't generally a practical probability for public transport the idea of transport integration is to give a 'consistent' trip that is a door to door as could be expected under the circumstances (Walters, 2012)

As indicated by Hitge and Gqaji (2011) this is accomplished by arranging administrations with the goal that where a difference in the vehicle is required travelers can appreciate simple to use, charming and protected trade offices in addition to short waiting time for the next bus. Moreover, Rode and Floater (2014), highlight that customers got to have the ability to benefit through 'one buy' cards for the whole trip which can moreover allow them to easily access other transport modes.

1.4.3 Effectiveness in transportation

The expanding significance of transport in social and financial life requires its assessment not as it were from a specialized and organisational point of view but moreover in terms of macroeconomic effectiveness of the complete framework, i.e. guaranteeing effective application of the need to transport both products and individuals (Mulenga, 2013). Due to the complexity of the relationship between this division and the socio-economic framework, there's a need for an all-encompassing view that takes consideration of the usefulness of the whole framework and not as it were its isolated components (Carvalho, Syguiy & Silva, 2015).

Expecting that the transport framework may be a framework of organisational, practical and human needs related to each other in such a way as to effectively transport products and people in time and space and taking into consideration the desires with respect to the optimization and sustainability of transport advancement, it is vital to reflect on the issues of proficiency in its development (Lee & Vuchic, 2005). Effectiveness is a vague term utilized in different disciplines of science derived from Latin effectīvus „practi-cal", comparable to effect (us) “productive, effective," from effect-, stem of efficere (Pina & Torres, 2001).

Microeconomic effectiveness centres on the operations of a business unit, counting investments (Rode & Floater, 2014). As per the rule of rational administration, they ought to be satisfactory to the uses brought about, understood as the degree of consumption of generation components within the process of implementing an economic undertaking (Carvalho, Syguiy & Silva, 2015). The increment in efficiency can be executed in two ways (Carvalho, Syguiy & Silva, 2015): 1) expansion of impacts, i.e. getting the next level of impacts at a consistent level of consumption, 2) reducing consumptions, i.e. accomplishing certain financial impacts whereas lessening consumptions.

Efficiency in transport is regarded as the common connection between the utilization of common assets and the costs created on the one hand, as well as the advantages from their use on the other (Lee & Vuchic, 2005). Transport costs are most frequently thought on as those caused by clients and carriers. It now and then happened that external costs experienced by the common public, for example, costs of accidents or natural effect were overlooked within the assessment of transport effectiveness (Hitge & Gqaji, 2011). It is needed to give considerations to outside costs in cost-benefit examinations in the advancement of transport sustainability concept.

As per Pina and Torres (2001), effectiveness is well described in terms of environmental and social incorporation and in differentiating to economic, production and money related effectiveness, directed by the "invisible hand of the market" requires organization alteration of the market component through sectoral policy action coordinates with environmental policy. Effectiveness in public transport is dependent on various components, which include transport means capacity and framework capacity, the level of occupancy in vehicles as well as operating conditions (Mulenga, 2013).

Effectiveness may be a degree of how well the yields of a system accomplishes the expressed outcomes of that specific system (Lee & Vuchic, 2005). Effectiveness speaks to the benefit utilization by commuters, like the quantity of commuters benefit inputs (Deng & Nelson, 2011). The proportion of benefit utilization to benefit yields is characterized as service-effectiveness, with the difference between productivity and

viability stressing the diverse perspectives of execution assessment from the administrator and commuter point of view, separately (Lee & Vuchic, 2005).

1.4.4 Elements of effectiveness in transportation

Accessibility to stations is an essential element with regards to transportation development. Studies have demonstrated that enhanced access to transport gives various chances to poor people (Tiawoun, 2000). A maintainable transport framework gives access to fundamental administrations, for example, medicinal services and training (Tiawoun, 2000). The absence of transport accessibility will constrain access to open doors for underprivileged people (Sibiya, 2009).

Reliability is a vital perspective that most investigations featured and remarked on the dependability and timeliness of the *Rea Vaya* and *A Re Yeng*. However, there were various investigations that don't concur as they feature that the buses don't hold fast to the timetable at some point which postures issues for travelers who need to be transported to their work places and be on time. A framework like the *Rea Vaya* ought to be one on which workers can depend.

Affordability - one of the primary purposes of the BRT is to give a moderate method for open transport (Sibiya 2009), with smart card systems which allow for loading of a reasonable amount and enable commuters to have several rides with the loaded amount.

Time Spent Commuting and Assigned Bus Lanes - Designated paths isolate the buses from the movement congestion, allowing them a selective right of way which empowers the bus to achieve more noteworthy (Jennings & Covary, 2008). Deng et al. (2013:109), highlight that “the exclusive busway and use of transit signal priority in the heavily congested areas provides a dramatic increase of bus speeds”.

Speedier boarding: According to Litman (2011) onboard gathering of charges slows the boarding process, mainly when a number of passageways is used for numerous destinations. He furthermore emphasizes the alternative to this which would be the collecting of fares later on entering an enclosed bus station before the bus arrives. This framework allows commuters to enter and exit through all bus entrances.

Improved service - BRT frameworks, for the most part, incorporate quick travel features throughout the day service ranges, greater spacing between stations, and more continuous administration than other transport modes. The adaptability and low charges of BRT enable it to give a more prominent system scope.

Integration of transit development with land use policy- BRT can be sustainable when incorporated within a broad planning structure including land use strategies, zoning directions, and monetary and group improvement says (Todes, 2012).

State-of-the-art technologies - BRT joins ITS applications, for example, Transit Signal Priority, propelled correspondence frameworks, computerized scheduling and dispatch frameworks, and continuous travelling data on buses as well as at stations for speedier and helpful rides.

Increased capacity - Because of the alternative of bigger vehicles and more noteworthy frequency, BRT frameworks can offer bulks identical to other fast travel modes.

1.4.5 Bus Rapid Transit System (BRT)

A lot of explanations have been given on the term BRT and all of them highlight BRT as a bus framework that mirrors the high limit, superior qualities of urban rail frameworks at a lower cost. Curitiba and Brazil are credited with spearheading BRT and its leader at the time, Jaime Lerner former Curitiba mayor referred to the city's BRT framework as a "surface metro" an excellent bus transport service with comparative execution of a subway yet at a small amount of the cost (Wilkinson, 2006). As far as administration quality and costs, at that point, BRT is regularly thought of as involving the centre ground between traditional bus and urban rail frameworks. In ways, it offers the better of the two universes: the quickness and dependability of rail, and the working adaptability and lower cost of an ordinary transport (Walters, 2012).

New York-based Institute of Transportation and Development Policy (ITDP), which has risen as one of the innovation's most grounded proponents, characterizes BRT as “a high-quality bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and

frequent operations, and excellence in marketing and customer service" (Wright & Hook, 2007).

According to Diaz (2009), it is the component of a devoted right-of-way that differentiates "high end" BRT from lower quality administrations, which is regarded as "BRT Lite".

1.4.5.1 Origin of BRT in developed countries

Taking after a number of spearheading usage within the late twentieth century, BRT has developed as a primary mode of transportation beginning the 21st century. This is because of the proof of the capacity to execute mass transportation capacity rapidly at a reasonable cost, whereas tackling current assets and partners, with improved comprehension of its potential by national governments and advancement accomplices, for example the World Bank (Rode & Floater, 2014). The BRT frameworks have been actualized all through North America and Latin, Australia, China, Southeast Asia, and presently progressively in India and Africa. In Europe, the number of BRT frameworks is relentlessly expanding, particularly in the UK and France.

Other Latin American nations, remarkable Mexico and Colombia yet, in addition, Peru, Ecuador, and Chile have since taken after Brazil's lead. Latin America is today the epicenter of worldwide BRT development (Jiron, 2011). A third of BRT course kilometers and almost two-thirds of ridership are in Latin America (Pourbaix, 2011). Bogotá's 110km TransMilenio is perceived as the Gold Standard of BRT (Mobereola, 2009). Appointments of authorities and dignitaries from around the globe visit Bogotá to wonder about the framework (Deng & Nelson, 2011). Working on a two-path devoted carriageway, TransMilenio conveys up to 40,000 travelers for every 60 minutes per bearing, which coordinates the traveler throughputs of general metros (Ewing & Cervero, 2010). The framework likewise brags improved stations (reachable by systems of airways), smart card-based toll gathering, progressed administration frameworks, unmistakable pictures, and moderate charges. TransMilenio's support is developing at 10% yearly, from 800,000 day by day customers when it started operating in 2001 to around 1.7 million today, representing 74% of transportation drives in the urban area (Boncompte & Galilea, 2013). Finance strategy has assumed a part in TransMilenio's

prosperity. In 2000, a 20 percent extra charge was attached to all fuel deals in Bogotá, with a large portion of the incomes reserved for TransMilenio framework (Pourbaix, 2011). As a cross-sponsorship from the 19% of Bogotá's populace which had their own cars, the arrangement advanced social and also ecological sustainability (Mobereola, 2009).

Rouen, France, also has three BRT lines, called TEOR (Transport Est-Ouest Rouennais). Optical direction enables TEOR vehicles to keep running along firmly limited halls, providing customers solid, agreeable and available administrations (Deng, and Nelson, 2011). Other French urban areas, similar to Nantes, work comparably top-notch transport-based frameworks however utilizing more customary innovations. Nantes' 6.9km busway associates a ring street to the downtown area with a recurrence of 3-minute degrees of progress amid the peak time. The transport-based framework looks like the city's settled cable car lines focus, the devoted path for the vast majority of the tasks, ITS-prepared stations, and necessary treatment at convergences, different marking and stop at the stations (Finn et al., 2011).

The developed nations, such as France and the UK – rank next as far as quantities of urban cities with BRT frameworks. Except for restrictive busways like the Orange line in Los Angeles and Eugene, Oregon's EmX, most US frameworks fall in the classification of BRT lite (Ewing & Cervero, 2010). The purveyors of BRT in Europe were Runcon UK, which introduced a busway as a component of a master-planned new town, and Essen, Germany, the primary urban area to develop a monitored busway (Hildalgo & Graftieaux, 2008). Today, European BRT frameworks, especially the ones in France, appear to be more of a rail-like structure somewhere else, for example, in Caen, Paris, and Rouen. BRT frameworks in these spots work on their own lanes, bolstered by numerous regulating technologies, and have cars that an excessive number of are outwardly unclear from current tramways.

The UK likewise gloats a few top of the line controlled BRT benefits in Cambridgeshire, Ipswich, Crawley, Leeds, and Luton-Dunstable, demonstrated after the O-Bahn track-guided busways fabricated first in Adelaide and Essen (Duarte & Rojas, 2012). At 19km long, Cambridgeshire busway is supposedly the longest framework (Cervero, 2006).

Constructed busways without direction have likewise been constructed in the UK, for example, in Swansea and Kent. Kent ordinary Thameside Fastrak framework has gained recognition from travelers, 95% have appraised general Fastrack encounter as 'phenomenal' or 'great' (Jiron, 2011).

1.4.5.2 Origin of BRT in Developing Countries

To date, in excess of 150 urban communities have executed some sort of BRT system around the globe, caring 28 million customers each workaday. Currently, BRT structures general included 280 corridors, 4,300km of courses, 6,700 stations and 30,000 transports (Ewing & Cervero, 2010).

The justifications for the systems ventures have expanded with time. Early BRT developers, for example, Ottawa and Curitiba, built busways predominantly on the grounds that they were more reasonable than Light Rail Transit (LRT) (Khumalo & Ogra, 2018). As of late, urban areas like Seoul, Mexico City, and Bangkok have put resources into BRT as a vigorous supplement to previous urban rail frameworks. To a considerable number of cities that didn't have a suitable public travel framework, rather depending on the constellation of for the most part clumsy private transport and casual transit administrations, BRT is a piece of a noteworthy change, filling in as the foundation of the new public framework. This portrays urban communities like Lagos, Jakarta, and Ahmedabad. In quite a bit of Europe, especially in medium size urban communities, BRT also called BHSL (Buses with High Level of Service) is being presented as a more affordable other option to tramways in built up zones, with an emphasis on upgrading service reliability, promptness and comfort along existing roadways (Gilbert, 2008).

Brazil has risen as the worldwide pioneer by developing the Bus Rapid Transit frameworks, expanding the accomplishment of Curitiba's spearheading framework to 30 different urban areas. At the point when Curitiba propelled its 'Surface Metro' in 1976, it tried to impersonate numerous highlights of close-by São Paulo's Metrorail framework – dedicated right-of-way, appealing stations, off-board toll gathering and regular, quick administrations (Vuchic, 2007). Bi-articulated buses and very much composed boarding tubes altogether extended conveying limit. Curitiba is now well best recognized for

utilizing BRT to control city development along dense, mixed-use corridors that draw in transit riders (Boncompte & Galilea, 2013).

The strategy used by Curitiba

The choice to depend on buses was seen as a more adaptable and reasonable public transport arrangement than rail travel for a medium-sized advancing city. Both the advancement of the city and the transport fast travel framework are the consequence of approaches for this development for the most recent 30 years on land use, expressway, travel administration and tasks, and public participation (Delmelle & Casas, 2012).

According to Duarte et al. (2016), Curitiba has a master plan and, imperatively, an organization Instituto de Pesquisa e Planejamento Urbano de Curitiba (IPPUC), to screen, execute, and refresh the plan. IPPUC is a to a great extent autonomous foundation and therefore is less at risk to political pressures and changes than a region-based division (Delmelle & Casas, 2012). As per Santos et al. (2017), the achievement of IPPUC is amazing in Latin America, and the organization presents courses, in light of its encounters, to an extensive variety of focal and local government organization from different nations. The main highlights identified with land use and travel in the plan are the following:

- Land use and transport are coordinated; the structural axes idea of high development has made passageways with a movement request that is appropriate to be met by transit

- Land inside two pieces of the busway has been zoned for blended commercial residential employment. Past these two pieces, zoned private densities decrease with distance from the busways

- In particular, the zoning recommended by the structural axes has been acknowledged by a mix of control and motivators. This mix incorporates different rewards to develop as arranged; motivations to exchange improvement rights; firm control over large scale advancement); arrangement of motivators to designers to increment residential compactness near the corridors as well as advancement of travel terminals with an extensive variety of offices – both open

and private area. • The busway framework has been active in controlling land use improvement and has been utilized to animate advancement along the basic axes.

China has as well taken after Latin America's in forcefully assembling the system, with in excess of ten urban communities, including Hangzhou, Xiamen, Beijing, Guangzhou, and Jinan, with their own BRT lanes launched 2005. In the course of recent years, China has included BRT path km's at a speedier pace compared to other countries (Kishore, 2009).

Africa's ten BRT frameworks, Lagos, Marrakech, Tshwane, Johannesburg, Cape Town, Nelson Mandela Bay, George, Rustenburg, Dar-es-Salaam, and Kampala are part of the BRT Lite end of the range. Lagos' framework, which operated in 2008, cost US$1.7 million for every kilometer to construct, which is one of the least expensive anyplace (Crambeck & Qu, 2015). All things considered, it conveys right around 200,000 travelers every day or a fourth of open transport trips along its hallway, despite the fact that BRT vehicles make up only 4% of vehicles on the course (Crambeck & Qu, 2015). Despite the increased pace of BRT ventures of the previous decade, there remains a lot of space for development. During the year 2011, the about 28 million traveler trips delivered by BRT frameworks around the globe were yet 2.2% of all open transport trips and a negligible 0.3% of all mechanized individual outings made that year (McCaul & Ntuli, 2011).

Johannesburg turned out to be the main city to deliver South Africa's BRT framework, introducing another period of top-notch transport in the nation. The *Rea Vaya* (meaning "we are moving") in Johannesburg initial stage 1A was launched to the general population on 30 August 2009 (Khumalo & Ogra, 2018). The framework was launched for the 2010 World Cup with the framework connecting the dominant part of Johannesburg from Soweto to past Sandton in the northern side (Khumalo & Ogra, 2018). The bus station enables the usage of boarding on both sides of the station and general stops, others are enunciated and can utilize only the stations.

The Cape Town's *MyCiTi* framework began working May 2010 (South Africa, 2011). Its initial administration was traveling from the Airport to the city centre. The underlying Phase 1A trunk and feeder administrations began working in May 2011 (South Africa, 2011).

The Tshwane *A Re Yeng* meaning let's go in began with its developments in July 2012 and began working in April 2014. The system in Tshwane comprises a sum of approximately 80 kilometers of transport lines, containing 62 stations and operates from Mabopane through Pretoria city centre, past Menlyn and on to Mamelodi. This framework has around 340 buses, and some of them are operating by gas (Van der Westhuizen, 2007).

According to Khumalo and Ogra (2018), taxis were and still are a most used mode of transport within the Johannesburg city however with its rapidly growing issues like inefficiency and unreliability, the framework was developed in Johannesburg all together to lessen the difficulties in the city of Johannesburg. With the start of the BRT framework in 2009, the National Department of Transport and the City of Johannesburg guaranteed various advantages for the city. The point of delivering this framework was to change the city into a 'World class African city' while giving a sheltered and productive open transport framework (Khumalo & Ogra, 2018). Moreover, the *Rea Vaya* was composed with the goal to expand access to work openings, and in addition to instructive and social exercises (Khumalo & Ogra, 2018).

The BRT system is intended to give a world class open transport framework which is proficient, dependable, protected and shabby. The venture is a piece of the urban community's renewal design, keeping in mind the end goal to convey business back into the downtown area (Weinstock, 2009).

1.4.5.3 Structure of the BRT

Passengers travel through an entrance-controlled space when arriving or exiting the station. Gilbert (2008), further states that depending upon commuters' request, a station may serve in excess of one bus in the same direction at the same time; along these lines, a flexible design is the most suited to provide for viable interest at various

stations. To enhance the simplicity of boarding and lessen postponements at stations, buses stop at specific position onboarding platform. The outline of the stations varies from each other in its size, its length, and its inter alia, usefulness requirements and the environment inside which they are found (Pai & Hidalgo, 2009).

A BRT station is an encased bus shelter that incorporates different facilities and by and large, situated in the centre of the streets, contingent upon the particular street type classification, accessible space (Gilbert, 2008). Passenger access the stations through one end of the station and the two sides are used for landing and exiting of the BRT buses inversely. Travelers travel through an entrance-controlled zone when accessing the station.

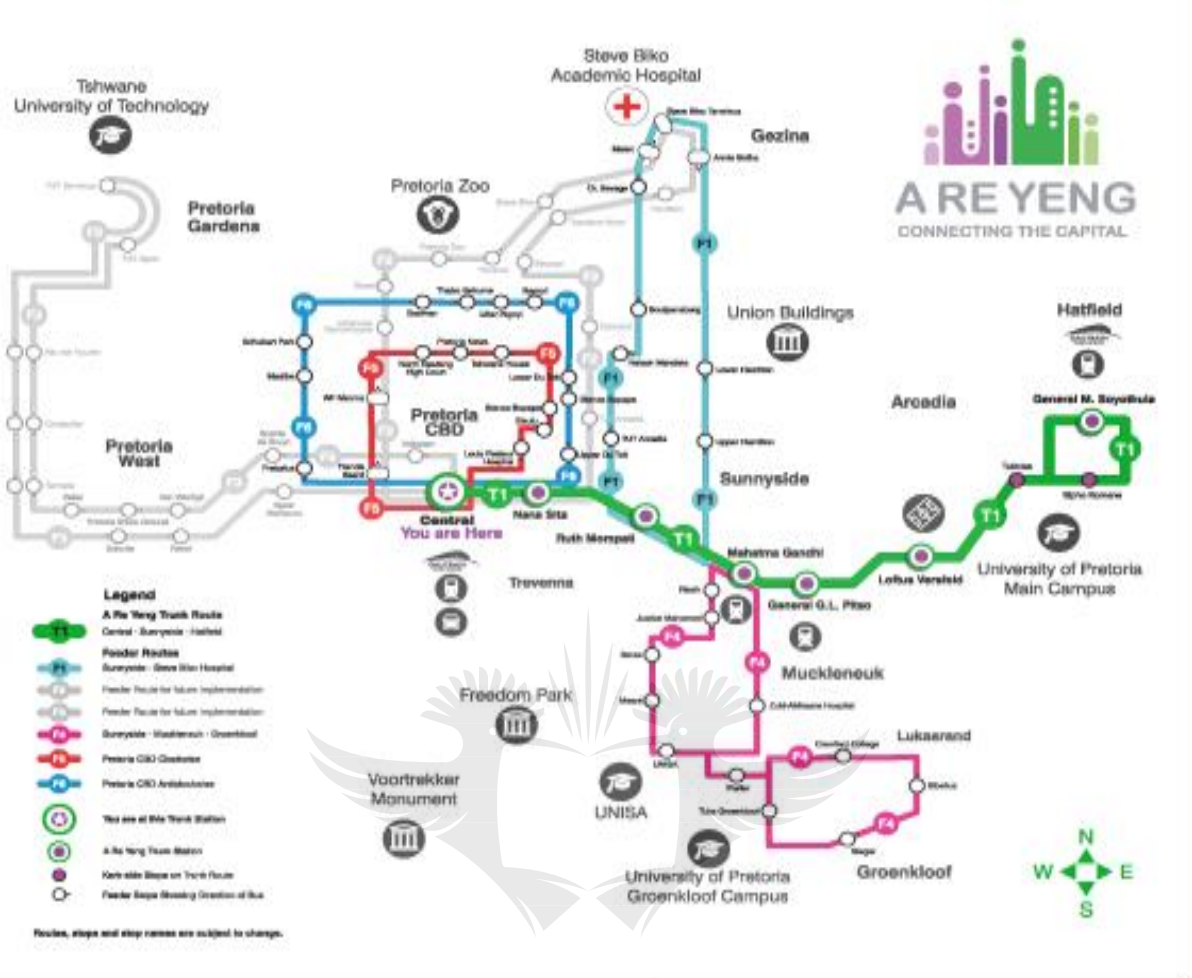
Feeder routes - The trunk routes are served by feeder routes, and the feeder rotes are served by other informal modes of transport (Pai & Hidalgo, 2009).

- In Johannesburg, there are presently 5 feeder courses. F1 keeps running from Naledi though Thokoza to the city centre, F2 from Protea Glen through Thokoza to Ellis Park, F3 keeps running from Jabavu though Lakeview to the city centre, F4 keeps running from Mofolo by means of Boomtown to the CBD and F5 keeps running from Eldorado Park through Lakeview to Ellis Park (Rea Vaya, 2014).
- In Tshwane, buses run on mixed-traffic lanes bringing passengers to the trunk route. From Steve Biko Terminus, Tuks Groenkloof to CBD Central Station (City of Tshwane, 2018)

Trunk route have dedicated buses which function only on trunk routes.

- Buses function on devoted paths, with stations situated in the focal area of the street from CBD to Hatfield. Beginning from Central Station in the CBD to General M. Soyothula Station in Hatfield.

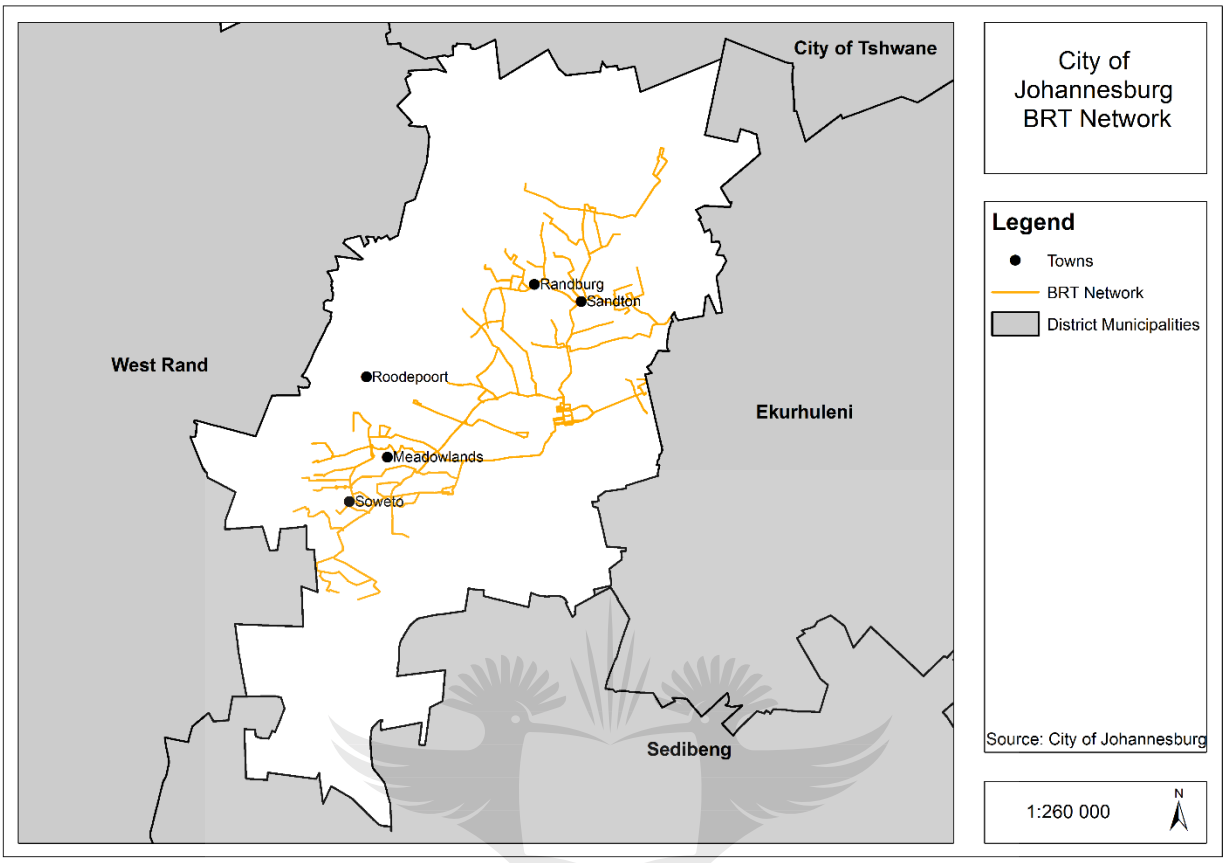
The following is the Tshwane *A Re Yeng* BRT outline of feeder and trunk routes:



Map 1: A Re Yeng BRT
Source: (City of Tshwane, 2018)

Complementary routes- this system has three complementary course; C1 operating from Dobsonville and the CBD, C2 between Dobsonville and Maponya Mall and C3 is around inward city course. These routes run in blended traffic roads and on trunk courses (South Africa, 2011).

The *Rea Vaya* was propelled in stages because of the broad cost and development required with the BRT framework (Hetherington, 2011). The primary stage of the venture comprised of 25.5 km of trunk course, with 70, 000 outings, 10 courses made up of 1 trunk course and 5 feeder routes, 20 stations from Soweto to the Ellis Park Stadium, 143 buses, BRT administration centre and the utilization of smart card innovation (Dibakwane, 2011).



Map 2: Rea Vaya BRT

Map 2 above demonstrates the total course of stage 1. The finished stage 1 was intended to be finished in 2013 (Mabena, 2010). In any case, the city has neglected to meet this due date and to date stage 1 b has been finished. Stage 1a: was finished in 2010. It comprises of the first trunk course from Bertrams in the inward city to Thokoza Park in Soweto, a few feeder courses around Soweto and around the course in the internal city through Joubert Park and Braamfontein (Schmid & McKenzie, 2012).

Stage 1b: This stage was anticipated to be finished in January 2012, but because of various difficulties Phase 1b was finished in 2013. It comprises of 18km trunk course from Noordgesig through the University of Johannesburg to the downtown area. This stage will comprise an extra 650 buses and will cover 122 km's (Rea Vaya, 2014)

Stage 1c. This includes the third trunk course amongst Parktown and Sandton, along with Oxford and Rivonia streets (Rea Vaya, 2014). The finished Phase 1 of the

undertaking was intended to be finished in 2013 and involves 7 courses of 123 km and 150 stations (Rea Vaya, 2014). These courses are essentially overhauled by the local Taxi Industry that was at first contrary to the *Rea Vaya.*

1.4.5.4 Fundamentals of an Effective BRT

Accessibility to stations is an essential element with regards to transport planning. Studies have demonstrated that enhanced access to transport gives various chances to poor people (Tiawoun, 2000). A maintainable transport framework gives access to fundamental administrations, for example, medicinal services and training. Inability to access transport can constrain access to opportunities for poor communities (Mees, 2009).

Reliability is a vital perspective that most investigations featured and remarked on the dependability and timeliness of the BRT (Liao & Davis, 2011). However, according to (Mees, 2009), there were various investigations that don't concur as they feature that the buses don't hold fast to the timetable at some point which postures issues for travelers who need to travel to their work places and arrive on time. A framework like the BRT ought to be one on which workers can depend.

Affordability in BRT refers to the ability of commuters to purchase transportation services in order to access basic goods and services without compromising the ability to maintain school, work, shopping, social activities and healthcare (Tirachini, 2013). Tirachini (2013), further highlights that affordability in transport refers to commuters' ability to save money, ability to respond to financial cost such as reduced income and increased total transport cost. As per Litman (2017), affordability can be assessed based on customers' capacity to save money if wanted, which is sometimes called option value. In this regard, BRT offers smart card systems which allows for loading of a reasonable amount and enable commuters to have several rides with the loaded amount

Assigned Bus Lanes and Time Spent Commuting- Designated lanes isolate BRT buses from the movement congestion, giving them the selective right of way, which empowers the buses to achieve more noteworthy velocities (Wright & Hook, 2007). Tiawoun (2000)

highlight that "the exclusive busway and use of transit signal priority in the heavily congested areas provides a dramatic increase in bus speeds".

Speedier boarding: According to Litman (2011), fast and easy access to the buses from enclosed bus stations and bus stops through a number of entrances promotes speedier boarding. The BRT bus structure allows commuters to board through a number of entrances on each side of the bus and station structure. With this kind of entrance doors in the station, passengers are given freedom and space in entering and exiting the buses which results in lesser time boarding and less congestion on the entrances as opposed to have one door.

Improved service - BRT frameworks, for the most part, incorporate quick travel features throughout the day service ranges, greater spacing between stations, and more continuous administration than other transport modes (Tirachini, 2013) The adaptability and low charges of BRT enable it to give a more a prominent system scope (Tirachini, 2013).

Integration of transit development with land use policy- BRT can be sustainable when incorporated within a broad planning structure including land use strategies, zoning directions, and monetary and group improvement says (Todes, 2012).

State-of-the-art technologies - BRT joins ITS applications, for example, Transit Signal Priority, propelled correspondence frameworks, computerized scheduling and dispatch frameworks, and continuous traveler information on vehicles and at stations for speedier and helpful rides (Sun et al., 2014).

Increased capacity - Because of the alternative of bigger vehicles and more noteworthy frequency, BRT frameworks can offer bulks identical to other fast transport modes.

1.4.5.5 Urban Density and BRT Usage

This system delivers ecological and transport benefits only if it draws in riders, particularly previous private car drivers instead of the individuals who already utilized a traditional transport or relied on train systems. One investigation in the US evaluated that 24% to 33% of travelers catered by the BRT frameworks are new travel clients,

most having changed from private cars (McCaul & Ntuli, 2011). In Adelaide, 40% of those traveling track-guided bused were previous car drivers (McCaul & Ntuli, 2011).

The connection between BRT ridership and elements such as vehicle ownership and family income, it is safe to state, is, for the most part, an inverse one (Estupinan & Rodriguez, 2008). Notwithstanding factors like wage and privately-owned cars, urban compactness additionally impacts travel ridership, regardless of whether for bus-based or rail frameworks (McHugh, 2013). Mass transit needs mass or density.

There's a solid relationship between urban compactness and ridership. Muñoz-Raskin (2010) states that Latin American BRT urban communities, in any case, normal low densities than their Asian counterparts yet they tend to pull in impressively an increasing number of commuters, by and large, and on a per kilometer premise. Basically, in Latin America, BRT affordability and delivery quality, have assumed a part in pulling in travelers and increasing profitability (Waldeck & Van Heerden, 2017). The quantity of travelers per BRT kilometer tends to change more as urban mass increases. Nonetheless, the positive relationship between ridership and urban densities efficiency favor of BRTOD – Bus Rapid Transit-Oriented Development.

1.5. Research Questions

- What is the spatial setting of the BRT system in Johannesburg and Tshwane?
- What are the determinants of the effectiveness of BRT system?
- What are the social & economic impacts and map the perception of users?
- What are the levels of accessibility to transportation?

1.6 Research objectives

- **To determine the status quo of BRT in Johannesburg and Tshwane.**
    - What is the spread of BRT framework in the urban areas?
    - What are the determinants of BRT (routes, ridership, affordability, infrastructure, carrying capacity, safety and security, surveillance, under-utilized routes, high volume routes)?

- **To determine the cross-sector benefits of accessible transport planning/development.**
    - Is BRT serving the disadvantaged zones?
    - What is the level of accessibility of BRT compared to other modes of transport?
    - Has it achieved its goal of meeting the needs of commuters in the city?
- **To determine its integration (BRT) to other public transport.**
    - How is the BRTs integration with other informal public transport modes?
    - What measures are required for integrating other modes of transport with BRT?
- **To investigate the perception, social and economic effect of the Rea Vaya and A Re Yeng on commuters who use the system.**
    - To what extent is *Rea Vaya* and *A Re Yeng* meeting the socio-economic needs of the commuters?
    - Has the system improved travel conditions?
    - What are the challenges and opportunities for an inclusive and comprehensive mobility system?

1.7 Purpose and significance of the study

The purpose of the study was to comparatively assess the effectiveness of BRT systems of Johannesburg and Tshwane metropolitan cities. The study specifically sought to identify the impacts, status quo, and benefits of this newly introduced fast-growing system, as well as its integration to other modes of transports. In view, thereof the study elaborated on the importance of integration in planning, transportation integration as well as integration in policy as an enhanced approach to the effectiveness of BRT in these cities.

1.8 Study Area

The study area in Johannesburg and Tshwane was determined based on the initial assessment of the existing routes of BRTS and spatial dynamics. For the purpose of this study, particular BRT framework courses were chosen from both cities as study

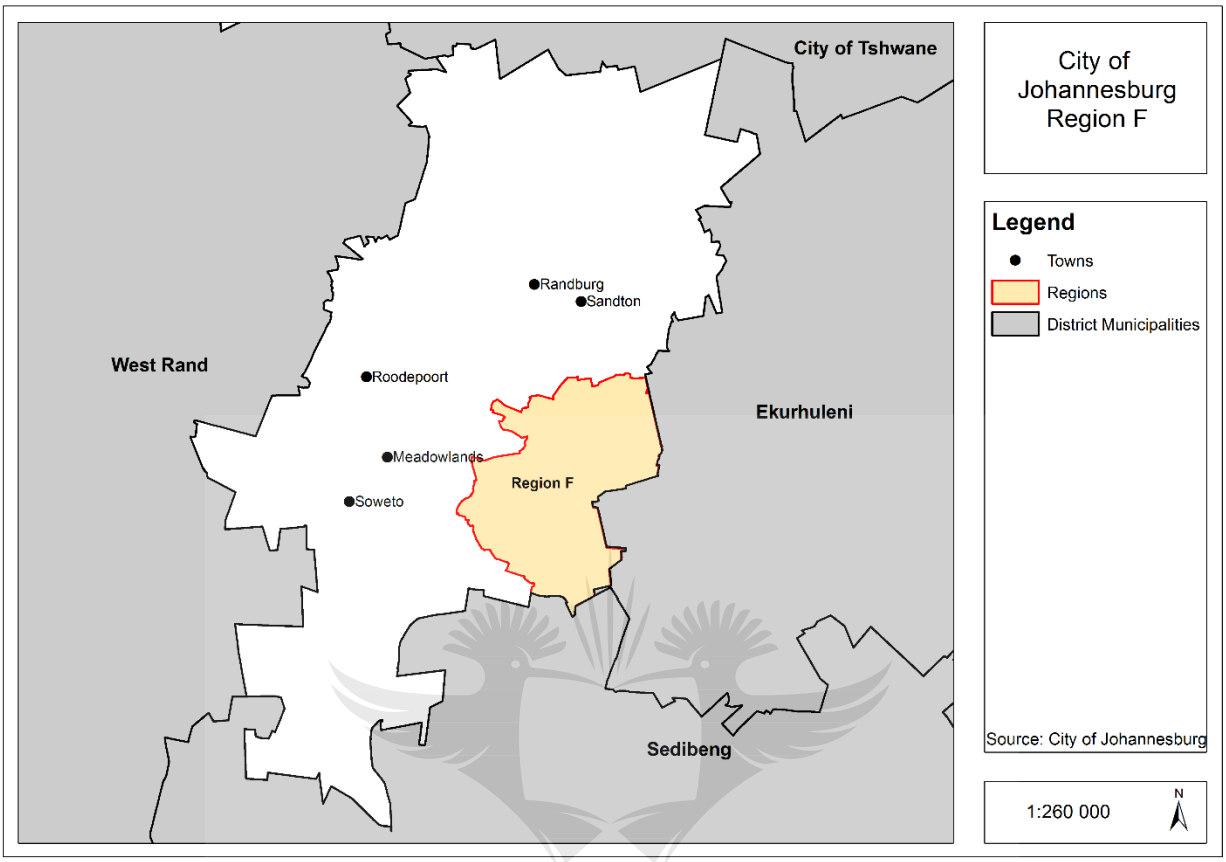
areas. In order to get consent to enter the stations and conduct the study, it was fundamental to forward a letter from the University, where the researcher is enlisted to clarify the reason of the researcher's visits to the BRT stations.
The following is an indicative detail of the locations of BRTS as part of the study area:

1.8.1 City of Johannesburg and City of Tshwane

The City of Johannesburg is one of the chosen study areas located in Gauteng province. The city has an area of 1,648km^2 with a total population of 4,4 million people as per Census Community Survey (2016) and is one of the 40 largest metropolitan areas in the world (City of Johannesburg, 2018). The cities spatial distribution starts from Orange Farm in the south to Midrand in the north.
The City of Tshwane is one of the country's three capital cities, serving as the national capital and is the biggest district, as measured by land mass. Tshwane is among the six biggest metropolitan regions in South Africa and the second biggest in Gauteng, as measured by Gross Domestic Product (GDP) (City of Tshwane, 2018). The Tshwane locale covers 6,368km² of Gauteng's 19,055km² and houses around 2,9million residents (City of Tshwane, 2018).

The chosen study areas are the major metropolitan cities in Gauteng, the City of Johannesburg (presented in red on the map) and the City of Tshwane (presented in green on the map). These metropolitan cities are neighboring each other with Tshwane in the north and Johannesburg in the south. Nonetheless, the study focuses specifically on the central business district of these metropolitans due to time constraints.

1.8.1.1City of Johannesburg Region F

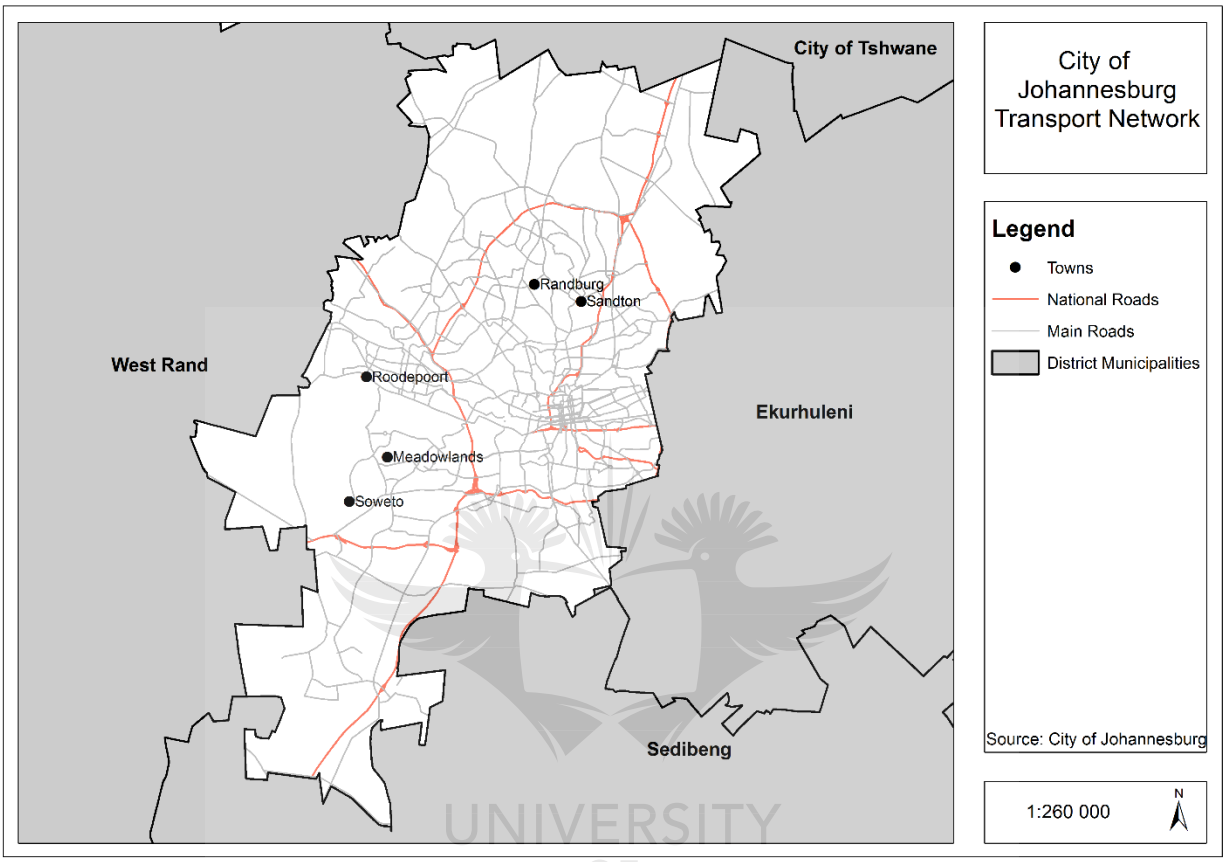


Map 3: COJ Region F

Region F which has a population of 433,054 individuals and a CBD area coverage of 1.09km^2 (City of Johannesburg, 2018). Region F is bound by Killarney Ridge in the north, Regions E (Houghton and Orange Grove) and B (Parktown), the Ekurhuleni Metropolitan Municipality to the east, the Klip River to the south, and to the west by Regions D (Soweto) and G (Joburg South) (City of Johannesburg, 2018). It combines Johannesburg's inner city and its lower density, predominantly residential areas to the east of the City Centre. The higher density suburbs of Berea and Hillbrow are to the northeast, and the zones of Vrededorp, Newtown, Pageview, and Fordsburg are to the west (City of Johannesburg, 2018). The southern boundary of Region F includes the southeastern corner of the metro and is commonly known as Johannesburg South (City of Johannesburg, 2018). To the north, it meets the inner city along the mining belt and the M2 freeway.

Region F is a zone of differences; it varies from tainted residential areas such as Bertrams and the steadier commercial suburb of Braamfontein to the rich center- and upper-income rural areas of Mulbarton, Bassonia, and Glenvista along the region's southern border (City of Johannesburg, 2018). The CBD includes a dynamic street life, with an expected over a million customers moving around the internal city day by day. It operates as a territorial shopping hub for Johannesburg inhabitants and guests from other African nations. Since of great sustained infrastructure, Region F is well coordinated with the encompassing urban zones. All major roads begin from the inner city spreading out to other surrounding urban and rural areas of the city. The main railroad station, taxi ranks as well as bus terminuses are moreover arranged within the city centre.

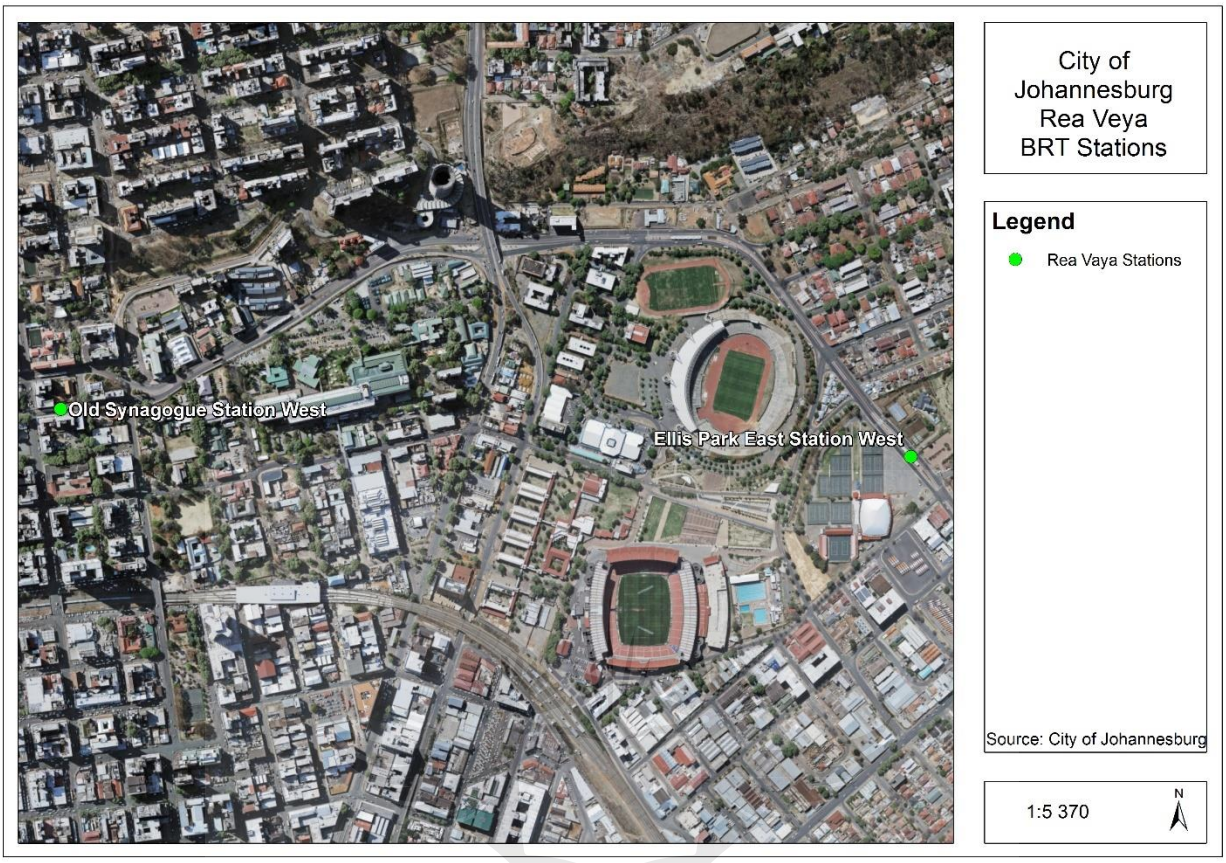
Existing transport network of City of Johannesburg



Map 4: Existing transport routes in COJ

Ellis Park Station to Old Synagogue Station West with Saratoga Avenue in the middle

The chosen routes for this study in Johannesburg are located in Doornfontein (Ellis Park East Station to Old Synagogue Station West with Doornfontein Campus station in the middle) as well as the central area of the city (Johannesburg Art Gallery to Fashion Square Northbound station).



Map 5: Johannesburg stations (T1 route)

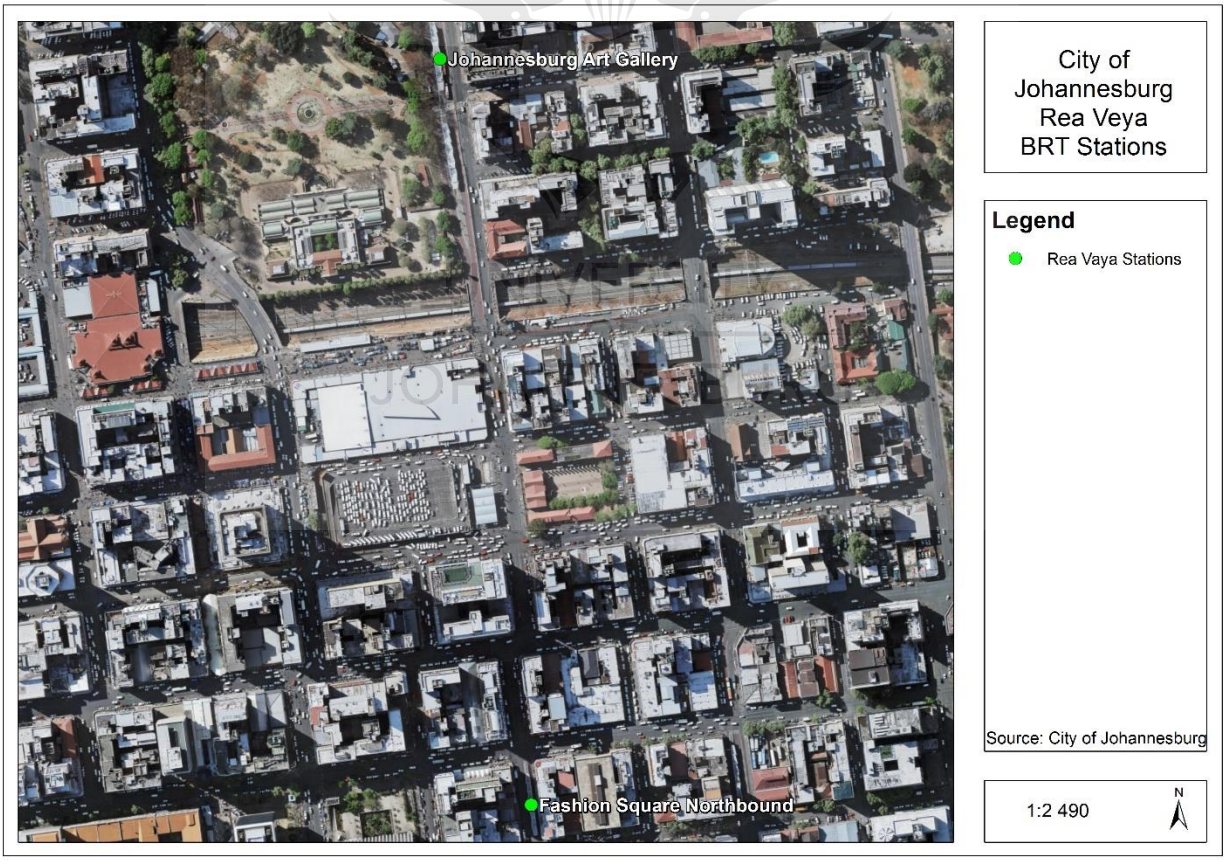
These two stations in Doornfontein are chosen because they service the T1 (Trunk route), which transports individuals from Thokoza Park to Ellis Park. The stations are also situated closer to student accommodation and the University of Johannesburg which will allow for a number of interviews from the regular commuters and a number of students. The Ellis Park station is situated on Charlton Terrace Street, opposite the Ellis Park stadium centrally situated in the road with traffic lanes on both sides, and the Old Synagogue station is located on Wolmarans street in Doornfontein.

On site pictures:

Figure 1: Ellis park station
Source: Khumalo (2018)

Figure 2: Old Synagogue Station West
Source: Khumalo (2018)

Johannesburg Art Gallery Station and Fashion Square Northbound station



Map 6: City of Johannesburg stations

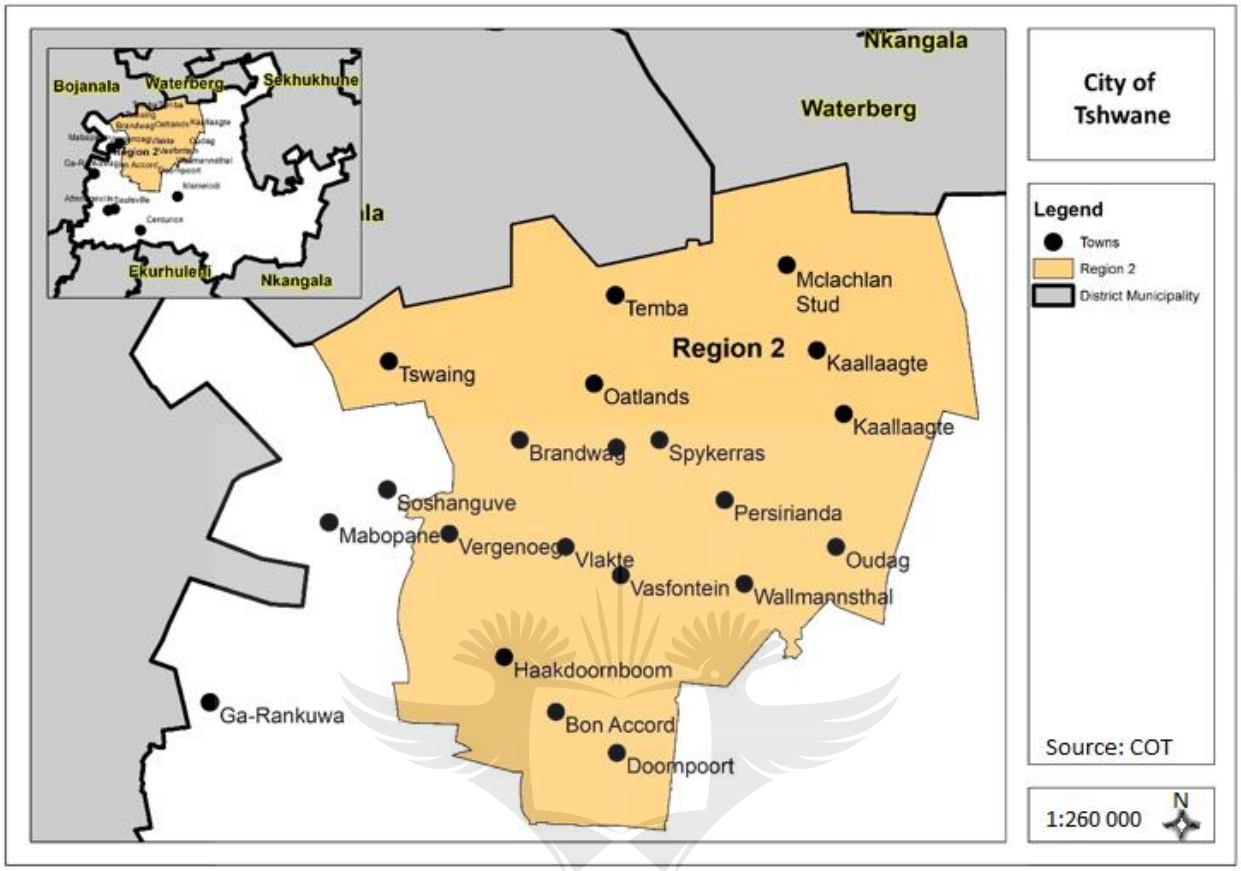
These stations are chosen because they are located on the busiest Twist Street which gives access to the Noord taxi rank. The Noord taxi rank is located in between the stations and the street has a high volume of people and taxis transporting people from and to the taxi rank. The stations are arranged in a portion of Johannesburg that is encountering urban rot, with waste pollution on the roads, and large amounts of noise pollution and unmaintained structures. The Johannesburg Art Gallery station is situated inverse the Johannesburg Art Gallery in the city centre on Twist Street.

The Johannesburg Art Gallery station is fundamental since it has the foundation to help travelers with questions in regard to movement and the smart card as it has a client care centre. Also, it consists of a different client help section. The station has entrances on either side of the station with specific gates for entering and exit.

Figure 3: Johannesburg Art Gallery
Source: Khumalo (2018)

Figure 4: Fashion Square Northbound station
Source: Khumalo (2018)

1.8.1.2 City of Tshwane Region 2



Map 7: City of Tshwane Region 2

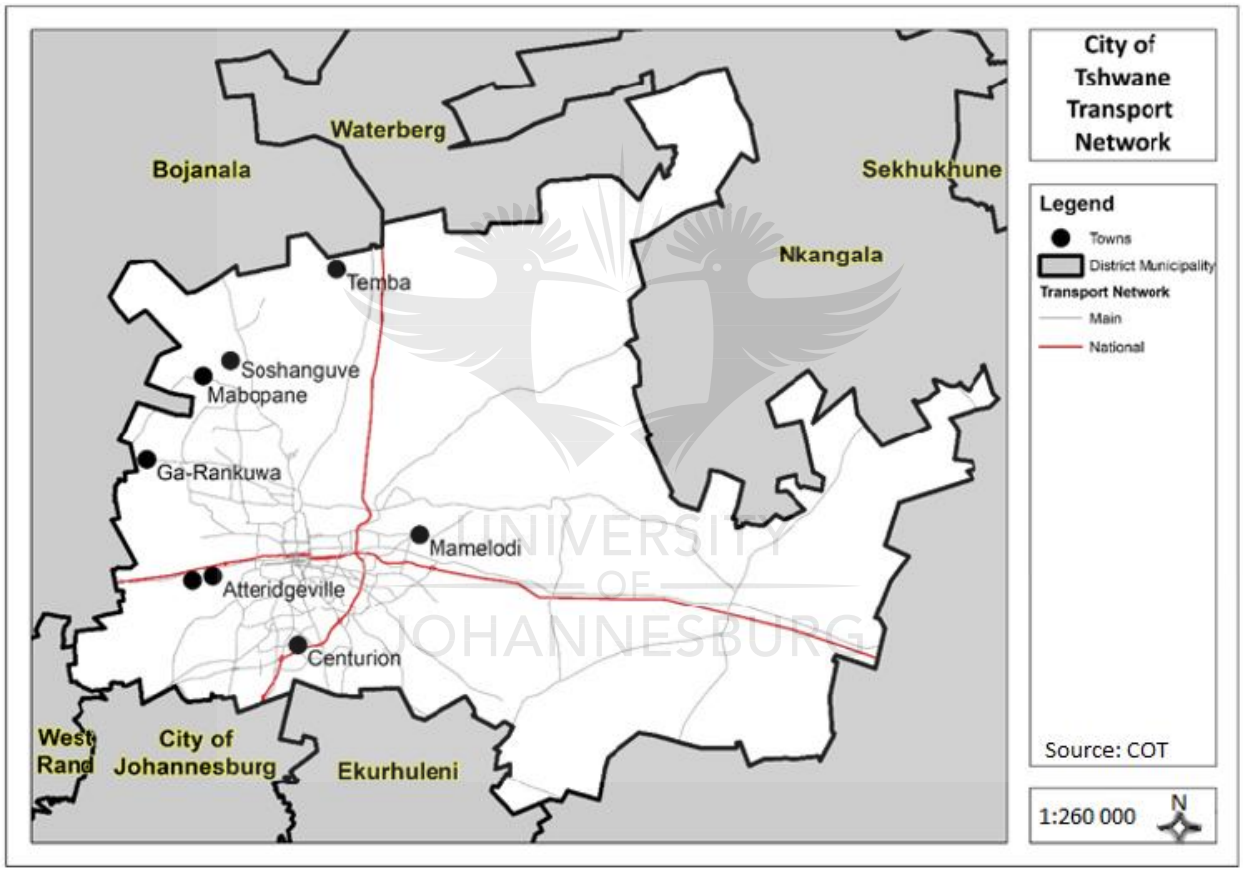
Region 2 is bounded by the Magaliesberg Mountain range to the south and the PWV 9 freeway to the West. The N1 runs through the middle of the region (City of Tshwane, 2018). The city consists of the N1 highway in the East, the Gauteng Provincial Boundary, including Hammanskraal, Temba and twelve other areas up to the Tswaing Nature Reserve in the North and Eastern boundaries of Winterveld, Soshanguve and Pretoria North in the West, all of which has a total area coverage of 1,062 km^2 (City of Tshwane, 2018).

The region has an expected populace of 33,975 individuals and 115,882 households (City of Tshwane, 2018). It has a differing character and different zones can be distinguished; the urban North, counting the urban centre range of Hammanskraal (Kudube x4) accommodating low-income people; the central and eastern Agriculture and Preservation Zones (west and east of the N1 highway) essentially undeveloped; the

Southern Zone counting the urban centre zone nearby Kolonnade centre and the Zone of Choice, a low density formally developed rural zone (City of Tshwane, 2018).

The northern ranges of the region incorporate Suurman, Stinkwater, Babelegi, Kudube, and Hammanskraal and are found on the northern outskirts of the city (City of Tshwane, 2018). The area is consisting of low-density settlements, with concentrations of subsidized lodging and informal settlements.

Existing transport network of City of Tshwane

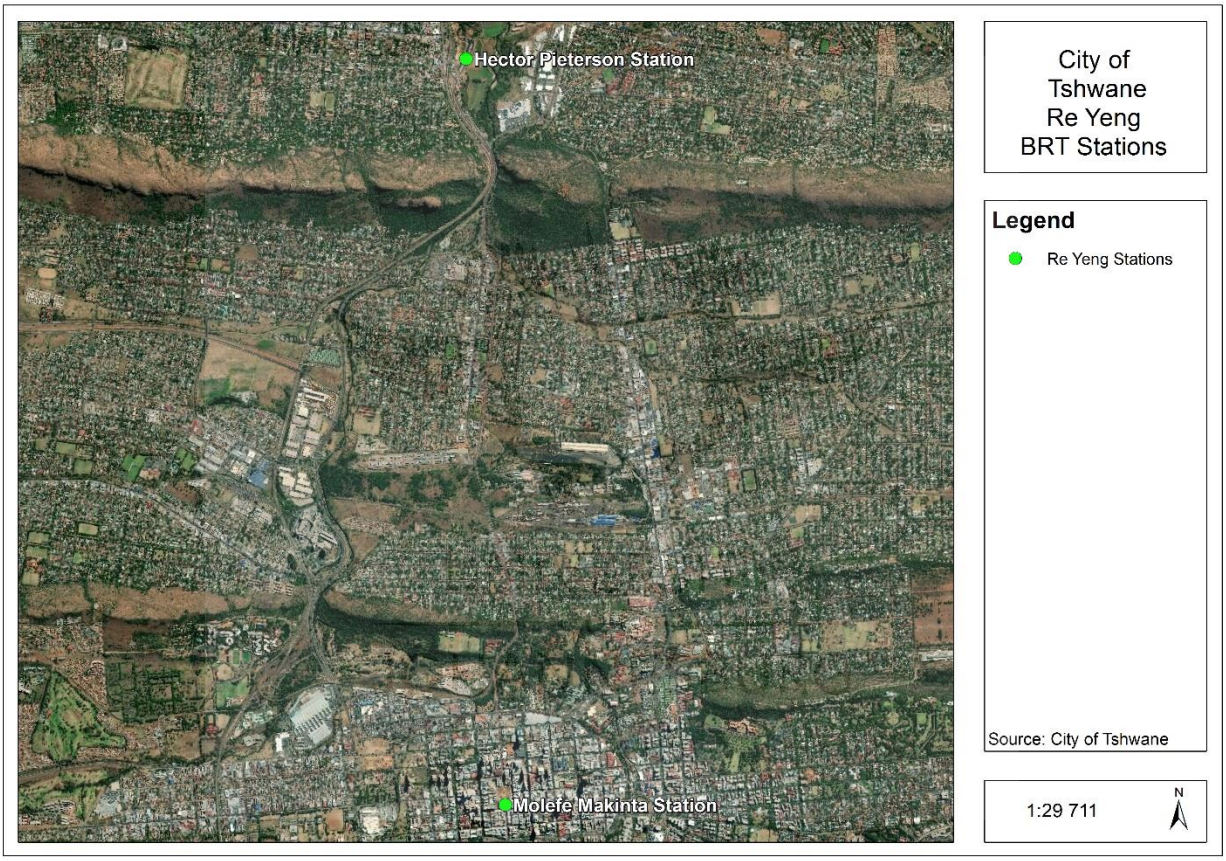


Map 8: COT transport network

The chosen routes for this study in Tshwane are in Pretoria central to Pretoria North (Hector Pieterson station to Molefe Makinta Station with 4 other stations in between) and in Sunnyside (Mahatma Gandhi station to TUKS Groenkloof station with 5 other stations in between)

Hector Pieterson station to Molefe Makinta Station

Hector Pieterson station (in Pretoria North) to Molefe Makinta Station (in Pretoria central) is one of the routes chosen for the purpose of this research. The rationale behind choosing this station is because of its good location. The Hector Pieterson station is adjacent to the Wonderboom Rail Station, therefore catering for bus, taxi and rail interchange. This route connects the Tshwane CDB to Pretoria North through Paul Kruger Street.

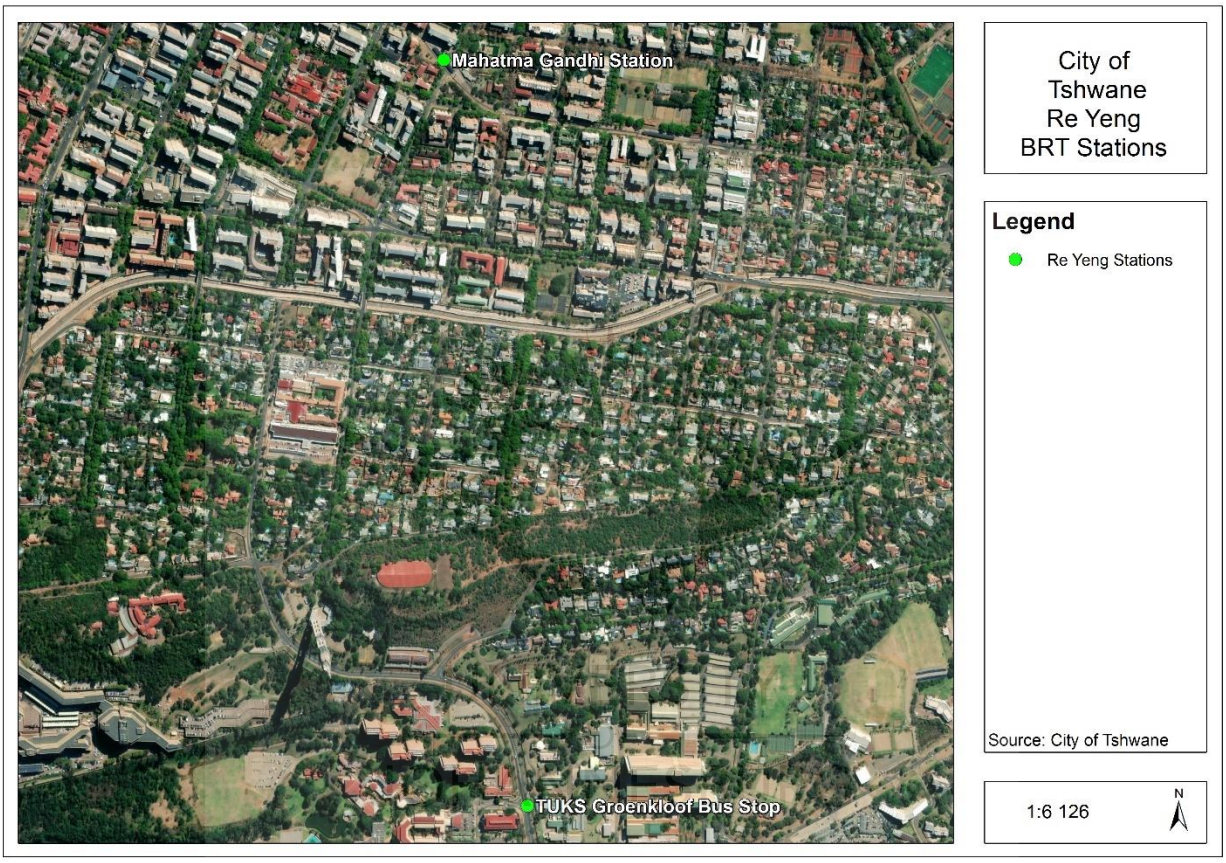


Map 7: T2 route - Hector Pieterson station and Molefe Makinta Station

Mahatma Gandhi station to TUKS Groenkloof bus stop

The rationale behind choosing this route as the study area is that Sunnyside comprises for the most part of high-density residential zones, which within the 21st century ranges from the upmarket to run-down. The Esselen Street is bordered by a belt of retail businesses, clubs, and restaurant. The day time road scene is exceptionally active, with overwhelming pedestrian activities and sellers hawking nourishment or products on

road corners. Student accommodations and residential houses are located within the eastern portion of the city that is not busy. Like much of the city centre, this suburb's retail, amusement, and nightlife area have gotten to be less attractive since the 1980s, and messy in places (City of Tshwane, 2018). The stations are on feeder route. The map of the research sites appears below:



Map 8: F4 route - Mahatma Gandhi Station to TUKS Groenkloof bus stop

1.9. Research methodology and design

1.9.1 Methodology

1.9.1.1 Qualitative

Qualitative research is flexible and produces rich and descriptive data from peoples' own experiences (Babbie & Mouton, 2001). In this research enlightening explanations are made about the subject in view of observations and interviews.

1.9.1.2 Quantitative

The input, surveys, and reviews uncover measurable numbers which were analyzed. This approach pulled participants in different ways and matched real and truthful numbers to the inquiries asked. This strategy indicated real number outcomes which are displayed in diagrams at a later phase of the research.

1.9.2 Research Design

1.9.2.1 Descriptive research

The research describes the characteristics of a phenomenon being studied. The aim of this study was to comparatively assess the effectiveness of BRT systems of Johannesburg and Tshwane metropolitan cities. Therefore, descriptive research was consequently used to describe who utilizes public transport (BRT), the impacts and benefits of utilizing *Rea Vaya* and *A Re Yeng*, and the systems integration to other modes of transport. The study further elaborates on the importance of integration in planning, transportation integration as well as integration in policy as an enhanced approach to the effectiveness of BRT in these cities. Detailed elaborations are provided on effectiveness and approaches in measuring effectiveness. It as well provides detailed benefits of transport effectiveness, specifically of BRT system.

1.9.2.2 Correlational research

The research used a non-experimental research method where variables were measured, understood and assessed the statistical relationship between the variables. The purpose of adopting this method was to figure out which variables are connected. The research identified the preferred transport modes by looking at what type of public transport is more frequently used by passengers in the cities.

Variables used

Interval variables were used in this study for data collection. The interval variable is similar to an ordinal variable, but the intervals between the values are equally spaced. The units of measurement are equal throughout the full range of the

scale. In this research, for example, the interval variable used was time it takes to catch the bus e.g. 5-10minutes, 10-15 minutes, 15-20 minutes.

Categorical or nominal variables which are have no order. In this study data was classified into categories with no particular order. Examples of categorical variables in this study are gender, marital status, race, etc.

Ratio scales are comparable to interval scales, in that equal differences between scale values have equal quantitative meaning. Nonetheless, ratio scales have a true zero point, for example distance and money.

1.9.2.3 Sampling design

A sample of 200 people was used in this research. Distribution of 100 participants from the City of Johannesburg and 100 participants from City of Tshwane. Most part of the sample size is for answering questionnaires. The interviews were conducted with only 10 participants (5 participants from each city) of the total sample, answering 7 Additional Questions (Interviews) on a different questionnaire section. A large sample size is used because more representative of the population, adequately expansive sample size is additionally fundamental to deliver outcomes among factors that are essentially distinctive.

1.9.3 Data Collection Methods

1.9.3.1 Qualitative assessment methods

Observations – observations in the stations, along the route and bus stops while collecting data was also useful in affirming some of the perceptions surrounding the use of BRT. It involved the observation of the arrivals and departure of the buses, the state of the amenities within the stations and bus stops, the behavior of the commuters while they wait for the buses as well as the interactions between the BRT staff and the commuters.

Interviews – collecting data for this study also involved meeting a number of people face to face to ask relevant short questions. Face-to-face interview grants straight questions and follow-ups, which allows a questioner to better gauge the exactness of answers. It may be an adaptable procedure in the sense that ensuing questions can be tailored to

clarify prior answers. Additionally, it removes with any conceivable twisting by having third parties present.

1.9.3.2 Quantitative assessment methods

Questionnaires – a number of questions were distributed to different people.

GIS- the research also involved the use of GIS tool, specifically the ArcGIS tool in order to map the cities current transport routes, taxi routes within the cities, the BRT routes of the initial stages, the current status quo as well as the chosen case study routes. The ArcGIS tool also assisted in mapping the integration interchanges within the cities.

Preexisting records - gathering information from pre-existing records ordinarily takes the shape of insights that were already collected for other purposes. Usually simple to get and compare, with the current status quo.

1.9.4 Data Analysis & Presentation

Coding: the collected data was reorganized systematically into subthemes which can be analysed by software. It was then entered into a spreadsheet and cleaned, checked consistency and accuracy.

The analysis of data in this study was done through the use of the SPSS statistics software for statistical analysis. It is a "Statistical Package for the Social Sciences" launched in 1968 and it's formally known as IBM SPSS Statistics (Bailey, 1938).

Statistical analysis:

Descriptive statistics- the research used statistics to describe the distribution of and relationship amongst variables. It allows for a simple interpretation of data and is shown in meaningful ways.

Inferential statistics – the research studied the relationship between variables within a sample and conclusions are made through generalizing or predictions about a bigger population. It allows us to infer trends about a larger population based on samples of the subject taken from it. Sample accurately represent the population.

Data presentation- statistical graphs:

Tubular representation – organized postings of codes and demonstration of occasions of code samples, together with samples of corresponding discourse text data (Freedman, 1960).

Textual information – used to compliment table data. Data which is not part of the current study can be used for comparative purposes.

Likert scale, Graphs and other diagrams – representation of data trends, frequency, distribution and comparison of data during analysis. Various format; bar, line, scatter plots, histogram and pie chart. Other illustrations, such as the representation of theoretical frameworks used in guiding the research process.

Context – all the representations contextualized the findings in terms of linking findings back to the raw data.

Word – the final results were presented in a word document stating all the current conditions and reasons to the findings of the relevant research questions and possible strategies to overcome stated problems.

1.10. Ethical Considerations

The research involves consultation and interviews and therefore ethical permission was approved from the University of Johannesburg. The study is based on a human subject; therefore, harms and risks were minimized; respect for privacy, human dignity, and autonomy. Special precautions with vulnerable population were taken and strived to distribute the benefits and burdens of research fairly. With regard to external institutions like BRTS operators, they were approached for further permissions for the successful conduct of case studies.

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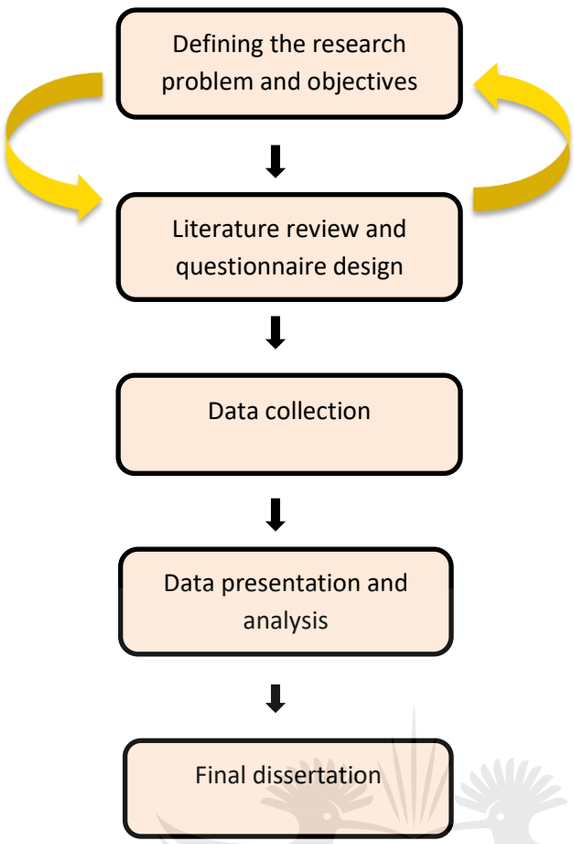
Table 1: Structure of the research

Research Objectives	Research Questions	Data Collecting Instruments		Sampling	Target Group
		Primary	Secondary		
To determine the status quo of BRT in Johannesburg and Tshwane.	What is the spatial setting of BRT system in Johannesburg and Tshwane?	Questionnaire Observation GIS	Municipality documents. Journals. Books. Internet.	Simple random sample Stratified sampling	BRT Commuters BRT Managers
To determine the cross-sector benefits of accessible transport planning/development.	What are the levels of accessibility to transportation?	Questionnaire Observation	Municipality documents. Journals. Books. Internet.	Simple random sample Stratified sampling	BRT Commuters BRT Managers Town Planners
To determine its integration (BRT) to other public transport.	What are the determinants of the effectiveness of BRT system?	Questionnaire	Journals. Books. Internet.	Simple random sample Stratified sampling	BRT Commuters BRT Managers Taxi Managers Town Planners
To investigate the perception, social and economic effect of the *Rea Vaya* and *A Re Yeng* on commuters who use the system	What are the social & economic impacts and map the perception of users?	Questionnaire	Journals. Books. Internet.	Simple random sample	BRT Commuters BRT Managers Taxi Managers

1.11. The research framework



1.12. Indicative Chapter Outline

Chapter-1: Introduction - Provides details on the research outline, what is covered as part of the research, research problem, significance, aims and objectives, study area, research approach and methodology, limitations, conclusions, further scope etc.

Chapter-2: **Literature Review** - This chapter unpacks several aspects around effectiveness of the BRTS, its factors, drivers, case studies from developed and developing world, South African context and perspectives from Johannesburg and Tshwane.

Chapter 3: Data Collection – This chapter provides details on the case study data collection and elaborates more on the BRTS data from Johannesburg and Tshwane.

Chapter 4: Data Analysis and Interpretation – This chapter details out the analysis emanating from the data collected and the case studies analysed from Johannesburg and Tshwane. The interpretation of the analysis of the comparative analysis of BRTS would be further elaborated.

Chapter 5: Discussion and Conclusion – This section provides discussion on the findings and analysis and elaborates more on the linkages with objectives and the findings.

Chapter 6: Recommendations – This section largely provides the conclusions based on the findings, discussions, and conclusions of the research completed.

1.13 Conclusion

There has been an increasing global research on transportation, particularly the Bus Rapid Transit research studies. The focus of this study was to investigate how BRT has been effective in Johannesburg and Tshwane. The findings on this study highlight the different status quo, perceptions, experiences, and challenges from the different sources of data collected. As per the results, the BRT framework in both the City of Johannesburg and the City of Tshwane is perceived in a positive light by a number of commuters, however, there are some challenges with regards to the system that require the adoption of different approaches which are highlighted by the BRT management and the cities representatives from the Town Planning Department. Transport integration has been an ongoing process for both cities, and it is a possible solution to some of the transport problems including the conflicts between the BRT and Taxi Association experienced in both the City of Johannesburg and City of Tshwane.

CHAPTER 2: LITERATURE REVIEW

2.1 PUBLIC TRANSPORTATION

The numerous financial, social and natural issues around the world are moreover basically urban issues: cities are where the individuals are. This leads to a consistent prescription: cities ought to deal with these issues in a coordinate's way, with coordination over topography, issues, disciplines, and agencies. The terms "quality of life" and "livability" are presently commonly used not only in environmental and land-use planning but moreover in planning for infrastructure as well as economic development (Muñoz-Raskin, 2010).

Urban congestion is still worsening even after massive private and public investments, and most transit isn't pulling in sufficient commuters to pay even a third of its operational cost, much less its cost (Rode & Floater, 2014). Franklin (2014) further states that adding more transportation capacity either transit or highway does not continuously diminish clog, and the advantages of guidelines that diminish motor-vehicle trips is politically troublesome and theoretically argued.

Informal suppliers of public transport are a critical portion of the transport scene in numerous informal nations. Informal transit is ordinarily characterized as services given by small private administrators considerably outside of the sphere of government guidelines, and ordinarily utilizing small vehicles (Polis, 2015).

Nowadays, both public and private transports all over the world are confronting issues due to growth in automobile possession and the suburbanization of both organisations and homes (Mulenga, 2013). Within the past, public transport centred basically on the city centre where high populace and business compactness empowered high occupancy rates, regular services, and numerous courses. As development is coming to the rural areas from the metropolitan areas, the challenge emerges to extend public transport services to serve commuters better, and to coordinated rural administrations with metropolitan administrations (Preston, 2012).

Whereas informal administrators have been contended to offer points of interest to clients, outstandingly in terms of high accessibility and low fares (Gwee & Currie, 2013), numerous investigators too point to their negative effects counting high fares, low commuters comfort measures, destitute street security records, and critical commitments to ecological and blockage externalities (Litman, 2014) as avocations for more noteworthy government association in and control of their operations. As a result, informal public transport has verifiably been viewed as "a problem to be solved" by the government, official states of mind towards informal administrators extending from inactive toleration to by and large antagonistic vibe. At the same time confinements associated with the informal business model have avoided noteworthy advancement to rise from inside the industry itself. Accounts of the assortment of strategies that have

been formulated to bring administrators inside the overlap of government's authoritative, financial and planning administrative components extending from the redoing of authorizing and administrative regimes (Gwee & Currie, 2013) to commercial contracting (Makhura, 2015) to constrained fleet renewal (DOT, 2006) highlight the trouble of accomplishing victory, due to a combination of constrained usage capacity, and dynamic resistance from the informal industry itself (Rode & Floater, 2014).

The degree to which a transport framework is considered to be cost incompetent is of concern to public transport specialists, transport administrators, and managers as public transport frameworks play a noteworthy part within the urban regions all through the world (Gwee & Currie, 2013). Rapidly increasing blockage has encouraged decision-makers to pursue for high-quality transport modes and high-capacity to moderate activity issues. For a long time, rail-based transport frameworks, such as Metro, have been the favoured transport change choices. Be that as it may, the high capital cost and subsequently high operating cost related with these modes have restricted their advancement in numerous budget-constrained cities (Gwee & Currie, 2013).

With the lack of transportation frameworks, urban areas could never have developed. As soon as they created, transport frameworks remain forever part of the city and they help a perplexing economic and social growth. Transportation innovation enabled individuals to travel to areas with normal favorable circumstances for populace coordination. It enables present-day urban areas to abuse the benefits of integration to all the more productively give better service, as well as to exchange those benefits with different places, which allows for economic effectiveness (Maunganidze, 2011).

Economically and socially dynamic urban zones depend on a framework for transporting individuals, merchandise and enterprises (Cervero, 2014). As per Mulenga (2013), the wellbeing of urban areas, and their capacity to create income and riches for community members is enhanced if the transport framework is productive and if its development and procedure takes into account its effects on nationals, ecological, land use and financial development.

Making any framework productive and reasonable (as such, influencing it to function admirably) begins with comprehension of circumstances and end results of the key attributes of the current urban transportation framework and components that are probably going to make it change later on (Seftel & Peterson, 2014).

For the purpose of this research, the first section highlights on the origin of the BRT system within other countries (Curitiba, China, Rouen, France, Brazil, China, US, France, UK, India, Tanzania, and Africa).

The second part of the literature broadly focuses on transport in Gauteng, Johannesburg, and Tshwane to be specific and the implementation of the BRT system in these cities.

2.1.1 Urbanization and transportation

For as long as twenty years, both the extent and the number of individuals living in urban regions have been expanding quickly in developing countries (Ang & Marchal, 2013). This expansion is likewise set apart by centralization of the population in substantial urban communities. The connection between urban and transportation is maybe a standout amongst the most vital parts of improvement in a city. The arrangement of transportation assumes a noteworthy part in supporting advancement in a city, while in the meantime, improvement straightforwardly influences transportation need (Banister, 2011). Ang and Marchal, 2013) further states that without a sufficient transportation framework, there would be a breaking point to development.

At the point when there are a couple of assets accessible for the administration of development, the circumstance regularly prompts overpopulated urban communities having framework arrangements of low quality (Cervero, 2014). Such circumstances are highly obvious as soon as the city transportation system comes to a standstill due to traffic congestion.

These days, the need to illuminate issues linked to urban and agglomeration transport is getting to be increasingly critical. Cities creating critical advantages for the economies improvement of the districts while confronting issues of high populace densities, clog and intemperate pollution. As of now, 64% of all kilometres travelled relate to every day persons travel within the urban areas, and it is anticipated that their length will triple by 2050 (Rode & Floater, 2014). It is expected that by 2050, the time went through in traffic congestion by an individual will multiple to 106 hours (Mulenga, 2013). Expanding torrential slide mobility concerns cities to a more prominent degree than rural regions. Individuals in European cities as of now constitute more than 70% of Europeans and, as per the forecast, the quantity of tenants of urban ranges by 2030 will surpass 80% of the European populace, worsening related the issues (Byiers & Vanheukelom, 2014). Traffic blockage, whose cost in European urban ranges is esteemed at EUR 100 trillion, in a specific negative way within the range of cities influences the working of society and the economy (Rode & Floater, 2014). As per Mulenga (2013), about 70% of road accidents happen and the foremost discernible is the effect of transport on environmental contamination: 70% of pollutants transmitted in transport are created in them and 40% of the total CO_2 emitted by street transport. Mindfulness of the negative effect of transport on the environment, counting wellbeing and quality of life, but moreover, change in climate and the related danger to biodiversity is reflected within the concept of economical transport and impacts the rise of neighborhood local interested in transport policy. The development of transport movement in line with sustainable development principles is a critical challenge in building sustainable cities.

During the year 2001 within the South African country, South Africa urbanization was estimated at 56% which is 4.3% expansion in the vicinity of 1996 and 2001 (Gasennelwe, 2011). Conditions tend to be distinct in South Africa contrasted with the

example normal for whatever is left of sub-Saharan Africa (Deng & Nelson, 2013). The arrival of refugees into urban communities could to a limited extent be a reaction to the consummation of many years of prohibitive politically-sanctioned racial segregation enactment which misleadingly held down the level of urbanization (Gasennelwe, 2011). In view of the expansion in mechanized transportation in urban communities, individuals are less on cycling and walking. This has brought about decreased accessibility to transportation for underprivileged communities. Expanded utilization of private vehicles, particularly motorbikes, has diminished the interest for and the general effectiveness of open transport in a few urban areas in South Africa (Hitge & Gqaji, 2011). In numerous different urban areas, the fast increment in populace brought about an increase and regularly neglected interest in public transport (Maunganidze, 2011). These urban communities confronted challenges in taking care of this expanded demand, coming about to a diminishing in the nature of transportation administrations delivered.

As per (Sibiya, 2009), the urban transport issue, be that as it ought not to be thought of just as overcrowding, however:

- Challenges of mobility where problems remain experienced in fulfilling the transportability need.
- Challenges of non-development, where problems are experienced in making, travel as a result of lack of amenities.
- Challenges of location, where problems are experienced because of nearness or inaccessibility of the transport framework arrangements as well as administrations.
- Challenges of progress, where problems are made because of changing or enhancing existing amenities.

Most urban transportation issues happen when the need for transport surpasses the provided arrangements (Badami, 2005). The need for transport is a determined request. In other words, it relies upon where individuals live and work, and on the area of creation, administration and recreation exercises. Any adjustment in the structure of the general public will change the need for transportation (Banister, 2011).

2.1.2 Sustainable transport: the challenging realities

The idea of maintainability is prominent in transport vision statements for regions. Be that as it may, as Vaz and Venter (2012) debate that what sustainable transport implies is frequently an issue because its meaning is of wide and undistinguishable ideas which regularly gets abused. According to Badami (2005), transportation systems are a noteworthy element that contributes towards the financial, environmental as well as the social sustainability of urban areas. Manageability as an idea which incorporates all of the zones, it is basic that the financial, environmental as well as social challenges are tended to in the transportation field of research for the future (Muñoz-Raskin, 2010).

It is reasonable to start a volume on supportability with a few definitions of supportability and sustainable transport that have shown up within the writing over the past 15 years or so. Sustainability can allude to something that can be kept up or something that perseveres (Ang & Marchal, 2013). As per (Ang and Marchal (2013), sustainable transport is transport that fulfills the present transport and mobility needs without compromising the capacity of the end of the era to meet their needs. Pojani and Stead (2015) state that sustainable transport is transport where the recipients pay their full social costs, counting those that would be paid by the future generation. It is noted that changes in transport are related with a number of potential externalities counting pollution, car accidents, traffic, harm to the species' living space, an increase in carbon dioxide generation, and the bringing in of oil. It is these externalities, not transport or travel per individual that undermine the sustainability of the system.

As per Rode and Floater (2014), the Centre for Sustainable Transport in Canada states that a sustainable transportation framework: (1) permits the essential access needs of personal and social orders to be met strongly and steady with biological and human system wellbeing, and which equity amongst generations; (2) is affordable, works effectively, gives a choice of mode of transport, and bolsters a dynamic community; and (3) restricts pollution in the environmental capacity to retain them, reduces the use of nonrenewable assets, recycles and reuses its components, and reduces the exhaustion of resources and noise generation.

Litman (2013) characterizes sustainable transportation as "one that provides transport and mobility with renewable fuels while minimizing emissions harmful to the local and worldwide environment and avoiding unnecessary fatalities, injuries, as well as blockage". There's no question that we are distant from accomplishing this objective. We proceed to depend intensely on fossil fuels, a limited asset, and indeed in spite of the fact that our vehicles are 90% cleaner than they were during the 1960s, they still cause air contamination and contribute to worldwide climate change (Bocarejo & Tafur, 2013). Also, our streets and highways stay congested, and numerous individuals still die in car crashes each year in spite of colossal forces in safety.

In a critique of transport operations centred exclusively on financial supportability, Rode and Floater (2014) clarify that sustainable transport is that which, at the side budgetary viewpoints, starts to consider bigger social as well as ecological issues. The centre on guaranteeing the financial sustainability of transport frameworks in confinement of the social and environmental impacts on wider society is notified.

Within the process of encouraging local economic advancement, the local government is confronting sequence of issues where environment issue is the key one (McCaul & Ntuli, 2011). (Vaz and Venter (2012), highlight that since the most cause of environment issue is the transportation issue, earlier to creating a sustainable transportation framework, finding out reasons for transport issue is the vital step. Muñoz-Raskin (2010) is of the opinion that poor connection in transit framework is one of the foremost

important reason to cause transport issue and that adequate transit network connections can incredibly diminish travel time.

Unclear road use work is another awful impression for drivers. Mismanagement can be dealt with by valuable strategies connected by city planning. Within the past, “regularly road amending” is the phenomenon of local government’s corruption. Presently, Chinese central government has carried out an arrangement of activities to anti-corrupt, “regularly road amending” isn't planning to happen anymore, as it were only the constructing transportation project causes inconvenience for road use due to old narrow road and construction ventures, then urban central congestion becomes a daily norm (Venter, 2011). Additionally, poor connection of transit framework increases the use of private cars in urban areas.

Dibakwene (2011) is precarious of the capacity of SA’s metropolitan regions to develop transport arrangements that are sustainable in addition contends that not even the administrative concentration or necessary ability is apparent for these regions to be able to do all things considered. Hitge and Gqaji, (2011) in their paper they examine the Transit program that situated a manageable transportation master inside one of the SA’s metropolitan municipality, the Cape Town within development during the Soccer World Cup in 2010. McCaul and Ntuli (2011) as they examined the Transit program insinuate at comparative decisions to those of (Yusuf & Allopi, 2010) who highlight the unmistakable limit shortage as well as need clashes in the endeavor to give practical transportation resolutions. Yusuf and Allopi (2010) as well as Dibakwene (2011), their work highlights that despite the fact that sustainability is a talk need, a similar accentuation isn't put on the practicality of sustainability. It is credited generally on these components: the absence of technical as well as political management vigorously planning and working on sustainable plans; and the absence of civic staffs who have the comprehension as well as the skills in the conveyance of sustainable transport arrangements.

The idea of sustainable transport is widely inclusive and thus having numerous viewpoints which it accommodates. The South African urban areas, culturally and socioeconomically isolated spatial landscape to a great extent acquired from politically-sanctioned racial segregation planning demands focus on the transformation of broke spatially spreading urban frames, and additionally the path where individuals reside and work within these urban areas. The customary methods towards transport planning embraced in South Africa are driven by Mother Nature encouraging the atmospheres that try to fundamentally inspire effective travelling of means of transportation (Seftel & Peterson, 2014). Therefore, the field of sustainable transport planning has had a number of writings which cover the movements in the direction of more sustainable practice and planning of transportation in South African urban areas (Seftel & Peterson, 2014).

2.1.3 Revised Mobility Policy Framework in South African Cities

South Africa is coming up short on choices and for it to overcome the current transport challenges, it needs to adopt sustainable transport arrangements. Strategies that concentrate on developing extra streets framework and costly transportation frameworks, for example, metro rails as well as Gautrain. It has firmly influenced the city personal satisfaction, in addition, it has gone ahead to the detriment of all the more ecologically reasonable transportation frameworks comparable to non-motorized transportation as well as affordable BRT frameworks (South Africa, 2011). Urban areas in South Africa desperately require a strategy system that emphasizes the conveyance of people as well goods rather than just automobiles. A successful and practical transportation framework for individuals and merchandise that can manage the normal fast evolving need, is essential for maintainable monetary development (Bocarejo, 2012). Enhanced accessibility to all individuals particularly the underprivileged, to their work environments, wellbeing and institutional administrations, will assist in improving the quality of life for these people.

A noteworthy strategy reorientation necessitates working on different official limits and administrative systems, a land-use planning idea that incorporates moderate, ecologically responsible open transportation as well as recognize non-mechanized means of transport (South Africa, 2011). Alterations of such greatness don't originate effortlessly. Managed political will is essential in order to achieve the necessary modifications. Isolated and clashing institutional obligations regarding transportation strategies amongst the city and national stages should be handled. Reexamined as well as enhanced institutional orders should be monitored by a thorough limit building program for all associations included. South African urban communities frantically require extended interests in transportation and its infrastructure. The capacity of urban areas to take care of the expanding need for transportation and the monetary necessities for the upkeep of transport resources is a noteworthy issue that should be tended to. Public transportation is inadequately financed in numerous South African urban areas, accordingly adding to the weakening of open transportation all-in-all in addition restricting the potential outcomes for government to finance transportation networks in rural-urban areas in need (South Africa, 2011)

South African public transport policy

White Paper on National Transport Policy (1996)

As per the Department of Transport (1996), the White Paper of National Transport Policy is a crucial transport policy document in South Africa (Department of Transport, 1996) which guides all other legislations in transport and planning. Transport aims for ‘well-organized interaction which permit the people and the economy to take up their favoured form’ (Department of Transport, 1996). White Paper sees the delivery of public transport as crucial to enhancing accessibility and mobility also that it ought to be delivered affordably, effectively, and efficiently. The policy is separated into

infrastructure, as well as operations and control. Land passenger transport is a heading where public transport is situated in the extensive part of control and operations (Department of Transport, 1996.

The following are the highlighted duty of department of transport with regards to land transport;

Advancement of an efficient, reliable, safe, co-ordinated, integrated, effective, as well as ecologically responsive transport framework in South African urban and rural areas, as well as the southern African region, coordinated in a responsible method to safeguard people's encounters enhancing access ability as well as flexibility (Department of Transport, 1996). The policy states that, in terms of infrastructure for public transport, there ought to be effectiveness in the delivery, upkeep as well as the functioning of the main economic road infrastructure system and more consideration will focus on the delivery and the upkeep of the lowest order roads, in all areas with the city.

Moving South Africa (1998)

The Moving South Africa project (MSA) was intended to deliver a data-driven database for strategic action that expands the short to medium-term strategy recognised within the Transport White Paper into a long-term strategic detailing symbolizing the bunches of trade-offs and choices fundamental to figure out the vision as set out within the White Paper (Department of Transport, 1998).

As per Department of Transport (1998), the overall vision in the White Paper is supported by the vision for urban transport that this document creates. It provides a sustainable and effective urban transport framework, arranged and directed through the least conceivable level of government, based on competition and to a great extent private segment operation, which diminishes framework costs and enhances customer service to meet client and national objectives for travel times, safety, user cost and choice.

National Development Plan (2012)

The National Development Plan (NDP), is intended to address and eliminate poverty as well as to lessen inequity within the South African cities. The plan had presented a long-term approach that takes into consideration a number of aspects effecting the society and economy in South African cities which includes transportation.

The enhancement of public transport as well as investing in transport infrastructure are regarded as crucial growth areas that are vital in attaining the 2030 objectives. The recognised objectives by the NDP in order to eliminate poverty and improve public transport are:

- To benefit the low-income households, invest in public transport in order to enable mobility (National Planning Commission 2012:18).
- Development of affordable, effective and safe public transport that will empower numerous policy objectives (National Planning Commission, 2012:24).

• Enhancing access to socio-economic opportunities and improved mobility will alleviate poverty. As per National Planning Commission (2012) the delivery of effective and safe public transport is important in order to achieve these objectives.

The NDP further recognises the need to attend to problems associated with BRT frameworks and make it a sustainable mode of transport: this is crucial given the considerable spatial and financial investments contributed as well as the envisioned enhancements to public transport presented by the system (Seftel & Peterson, 2014).

The above strategy initiatives show that the main pushes are (Deng & Nelson, 2011); a reliable, affordable, and safe mode of transport; decentralisation to the

- Minimise system costs
- Travel time
- Affordability
- Comfort
- Safety
- Travel time
- Access for all
- Funding
- Flexibility/innovation
- Convenience, choice, etc.

2.1.4 Spatial dynamics and transportation systems

Transport geology underlines the significance of particular spatial highlights, for example, hubs, areas, courses, and systems. Accordingly, system analysis turns into a customary method to investigate frameworks in this subject, and space language structure has turned into a mainstream procedure in geospatial examination also (Gasennelwe, 2011).

Numerous measures, for example, network, cyclomatic number, and distance across are produced to evaluate spatial qualities of transport frameworks (Deng & Nelson, 2013). With the advancement of computer innovations, Geography Information Science (GIS) gives a proficient method to speak to and explore transportation organizes in a computer domain, and it additionally advances transportation as an interdisciplinary theme (Deng & Nelson, 2013).

As a fundamental piece of substructure frameworks, the examples and advancement procedures of transport frameworks can, to an expansive degree, mirror the monetary as well as social improvement of an urban area or a nation. Particularly with the globalization, proficiency and comfort are winding up more basic than any time in recent memory, which drives urban planners and policymakers to give careful consideration to enhancing public transportation frameworks. Under these conditions, investigating the attributes and components of transportation frameworks has turned into a functioning

examination theme in numerous subjects. Without a doubt, much advance has been picked up in different viewpoints, including execution assessment, stream demonstrating, location-based service (LBS), and structure streamlining (Carvero, 2013a).

Rodriguez & Targa (2004), highlights that with regards to spatial type of city development, scholars have concocted models clarifying the manner in which urban areas develop, yet in straightforward terms, one might say that development can take two structures, exhaustively, by making the city denser, without changing the essential outline of the city; or considerably, by scattering the development to the city surroundings forming new rural areas; or by a blend of the two. At the point when development is just exhaustive, the amount of transport network interest increases and, in this way, the limit of the current system turns into the principal centre for disappointment. At the point when there is a component of broad development the expansion additionally incorporates the travel distance, in which case, an expansion of the system itself is required (Waldeck & Van Heerden, 2017). The connection between spatial growth and the transport framework is collaborative. Any adjustment in transport framework, including changed speeds, new courses, or expenses will impact the spatial development by modifying the urban economic equilibrium (Hidalgo & Yepes, 2005). As per Estupinan and Rodriguez (2008), additionally, the blend of spatial growth and improved land use likewise prompts modifications in transport need.

2.1.4.1 Spatial dynamics and Accessible transportation

Accessibility to transport is anticipated to be a primary driver of urbanization. The greatness, factors, rate, the spatial dispersion of urban development are major concerns for policy creators. Accessibility, neighborhood relations, and spatial approaches are contended to be the foremost compelling components on modern land use change (Rosenberg & Weiste, 2007). Transport framework is thought to direct and inspire urban development by accessibility enhancement (Polis, 2015).

This supposition is illustrated in a long convention of policies and strategies trying to channel urban development by contributing in transport framework. It is additionally known that urbanization is more likely to happen close to already existing urban regions, cases being the concentric improvement of cities or the appearance of rural areas adjacent to major cities (Muñoz-Raskin, 2010). Besides, where urbanization happens or not, is related to spatial arranging and approaches which assign regions for or protect areas from advancement (Cervero, 2014).

According to Delmelle and Casas, (2012), spatial conveyance of urban regions is collected of urbanization which may be a procedure incompletely driven by access in transport, somewhat by the attraction of existing urban regions, and mostly by policies pointed at affecting independent processes.

Change in population, as well as changes of the spatial dissemination of the populace, mirrors a land use component of accessibility (Rosenberg & Weiste, 2007). The spatial difference of the dominance of the transport or populace components may be a result of interaction between them. The transport component within the accessibility of transport may be demonstrated by the advancement of the framework, congestion or travel pricing.

2.1.4.2 Land use and transport integration

Integration of land-use and transport choices to accomplish travel conduct that is sustainable, has been considered a vital factor for economical urban progression (Albalate & Bel, 2009). It can be stated that some time recently the notoriety of urban sustainability concept, transport interaction, and land-use had been examined as entirely partitioned substances in planning (Bocarejo & Tafur, 2013). Nonetheless, it had been explained within the setting of spatial interaction and as a key figure of neighbourhood financial improvement and community enhancement (Cervero, 2001). Their interaction had not been expounded in a way that completely covers a set of interconnected subjects, such as travel conduct and designs, transport-related environmental externalities, residential choice, built environment and wellbeing relationships.

Indeed, in spite of the fact that modern land-use and transport models have been existing for a long time, classical 'predict and provide approach' has won within the planning practice because of high costs in making these models functional (Cervero, 2001). After incorporation of integration as a critical policy objective in accomplishing the economical urban environment objective, transport and land-use interaction point has ended up unavoidable in regional and neighbourhood plans (Albalate & Bel, 2009).

Land-use and transport integration is normally referenced by state or local government planning organizations and has been incorporated in territorial plans around the world. The Department of Infrastructure, for example, states that transport, business as well as land-use integration all play an important part in accomplishing environmental, social, as well as economical sustainability.

By forming the development pattern and impacting the location, density, scale, plan and blended land-uses, integrated planning can develop broad neighbourhoods (Cervero, 2001). Besides, the advantages of integrating transport and land-use can be clarified as 'it decreases the necessity for commuters; encouraging well-organized land and existing infrastructure use; improved easy access to services, jobs, and schools; results in shorter journeys; and supports environmentally sustainable developments (Bocarejo & Tafur, 2013).

2.1.5 Approaches in transportation and their limitations

If the land-use pattern of a town or city could be defined for some future date, then the associated traffic pattern could also be determined, and suitable transport system designed to fit in.

2.1.5.1 Systems approach

The approach considers the simple interaction between transportation and land use (Hull, 2011). Transport facilities fulfill a market role in determining the amount of land that is available for development at different levels of accessibility. A transport system should not be chosen exclusively on its ability to meet travel demand (Knowles, 2012). Hull (2011) further states that the design of a transport system should be achieved by a process of successively constrained choices.

The sequence of constrained choices for the systems approach (Knowles, 2012):

- Specify the long-run developmental objectives for the region. e.g. Have strong central area and avoid low-density peripheral (outside) areas
- Identify the location and investment decisions which together move in the direction of the first level objectives. e.g. Housing investment would have to be diverted from peripheral areas into the existing built-up area;
- Specify the levels of accessibility needed to induce (create) the locational and investment changes required to achieve the long-run developmental objectives. e.g. ensure poor accessibility to the peripheral areas, and good accessibility within the built-up area
- Designate the levels of service implied by the accessibility conditions. e.g. high-speed public transport within the built-up area, with low-speed motor vehicle access on dual-purpose streets from peripheral (outside) areas.

As per Marshall (2013), a systems approach is described by the need to classify and describe the objectives of the general urban system, counting transport system as well. This procedure is based on the use of criteria and standards which are related to the original objectives (Marshall, 2013).

Advantages:

- It allows for the implementation of transport plans to be used positively as a determinant of urban form.
- It can be applied to assess the transport plans impacts on short-term mobility habits.
- It can be useful in evaluating transport proposals effect on the long-term locational behavior of individuals as well as companies.
- It likewise enables modifications to be made to the preferred urban structure in light of the impact of the implementation of transport proposals.

Disadvantages:

- It is very challenging to develop true alternative structures and policies if the starting point of the exercise is one set of common objectives.
- The complex interrelationships involved in its application could well be self-defeating unless handled by experienced professionals.
- This approach fails to recognise that traffic movements change in response to varying land-use patterns and vice versa. A city should be seen as a system which evolves, where land uses and traffic flows are interdependent.

2.1.5.2 The Cyclic Approach

The cyclic approach is concerned primarily with the development of true alternative sets of plans or policies (Knowles, 2012). Rather than having a traditional and basically linear progression from a common set of objectives there should be alternative sets of plans and policies to evaluation and selection. A cyclic planning process solves this with each cycle commencing with the formulation (or re-formulation) of design, criteria, standards and proposed policies for each alternative to be tested (Hull, 2011). At the end of each cycle, conclusions are drawn, and decisions made in order to determine which aspects of the alternatives should be considered further (Hull, 2011).

Advantages:

1. It guarantees that diverse objectives can be derived from each alternative (in contrast to the traditional and systems approaches which rely on the formulation of one set of common goals).
2. This, in turn, makes it easier to develop plans and policies, which are true alternatives.

Disadvantage:

Difficult to practically implement

2.1.5.3 Integrated Transport Planning Approach

Integrating transport means uniting modes of transport that are different in order to increase capacity and ensure easy access and efficiency in comfort, cost, time, accessibility, convenience and safety (Diaz, 2009). The purpose of integrated transport planning is to resolve transport issues as per the goals and objectives of the authority. Branches of community planning have to be integrated in all forms which includes transport, land use and development planning.

Integrated transport includes the joining of diverse transport modes to boost comfort and effectiveness for the client in terms of cost, time, safety, convenience, comfort as well as accessibility (Hull, 2011). The reason for integrated transport planning is to solve challenges associated with transportation and issues in line with the objectives of the government. Transport planning ought to be coordinated with other neighborhood planning divisions, strikingly development and land use planning.

The process includes (Hull, 2011):

1. Classifying goals and objectives;
2. Making, assessing and applying strategies, policies, as well as projects to attain the stated goals and objectives;
3. Issues and problems are the reason for undertaking transport planning;
4. Goals and objectives provide its focus and policies; and
5. Strategies and projects are its products.

Thus, an integrated transport plan might include all or some of the following (Knowles, 2012; Hull, 2011; & Marshall, 2013):

- A land use framework and strategy;
- Policies and strategies for infrastructure provision;
- Travel and congestion management policies and strategies;
- Public transport policies and strategies;
- Private transport policies and strategies regulating the movements of private cars, vans, light delivery vehicles (LDVs), motorcycles, bicycles, and pedestrians;
- Freight movement and loading;
- A supply management strategy for public transport detailing the integrated network and permission policies for corridors and routes;
- Road traffic safety policies and strategies;
- An integrated long-term, financial plan;
- A business marketing plan for public transport; and
- A short-term prioritised rolling budget for implementation of the plan.

The main components of an integrated transport plan can be differentiated as: Core activities - planning activities which are common to all the major components of an integrated transport plan; and Functional activities or plan - which are specialist plans within the overall integrated transport plan.

Marshall (2013), highlights the principles underlying the Integrated Transport Planning Process:

- Planning as a continuous process - this entails endless evaluation and testing of goals and objectives compared to key performance indicators (KPIs).
- The balance between long-term and short-term planning - need this to attain a balance of low-capital and high-capital projects and for investments in transport infrastructure.
- Realistic handling of future uncertainties.
    - A single future is inflexible when other future eventuates.
    - Future uncertainty should be provided for in the planning process.
    - Specific.
    - Scenarios, or visions, should be benchmarked against best and worst case scenarios.

- The balance between the elements of planning studies.
- Encouraging constructive public participation.
  - Planning should not be undertaken solely from a technical standpoint.
  - Constructive public participation is an essential component.
  - This will prevent public opposition towards plans which can easily result in delays and frustrations for all.
- Integration of transport and land use planning
  - Transportation of goods and people is not an end in itself, but a means to achieve wider community objectives like economic development.
  - Transport is a significant cost factor in manufacturing, distribution and retail activity.
  - Integrating transport and land-use can minimise the cost of production and distribution and contain (keep from increasing) the mobility costs for households and individuals.
- Consideration of all modes- to be comprehensive, all transport modes has to be taken into consideration

Hull (2011), highlights the main elements of an integrated transport plan listed below:

- A description of the current transport condition (status quo). The description should include existing goals and objectives, the public and private (road and rail) transportation networks, population and employment distribution, land use, trip-making characteristics, transport problems, issues, and environmental constraints.
- A comprehensive mandate for mobility by public or private transport modes along the courses which contain the coordinated transport plan networks;
- A long-term or strategic plan outlined to address different transportation needs of that specific zone in terms of the embraced policies.

2.1.6 Integration

2.1.6.1 Integration and Sustainability

Transport Integration implies that whatever modes of transport are included they all work as one 'consistent' substance for the advantage of the customers who are paying (Dibakwene, 2011).

Private transport, as a rule, gives door to door service (Yusuf & Allopi, 2010) and while this isn't generally a practical probability for public transport the idea of integrating transport is to give a 'consistent' trip that is a door to door as could be expected under the circumstances (Walters, 2012)

As indicated by Hitge and Gqaji, (2011) this is accomplished by arranging administrations with the goal that where a difference in the vehicle is required travelers can appreciate simple to utilize, charming and protected trade offices in addition to short

waitings for the next bus. Moreover, Litman and Burwell (2006) state that similarly as when a driver purchases fuel they do as such once for the entire trip so with traveler transport the traveler ought to have the capacity to profit through 'one buy' cards for the entire trip.

2.1.6.2 Integrating different modes of transport

At the same time, the complementary role of other modes of transport, such as minibus taxis, as well as "last mile" services such as local taxis, should be taken into account. BRT stations, McCaul and Ntuli, (2011) said**,** should enable the integration of transport modes by providing for bicycle storage as well as minibus and metered taxi drop-offs.

McCaul and Ntuli, (2011) also shared with the delegates the latest developments in the *Rea Vaya* network, saying the Phase 1C expansion of *Rea Vaya* would include the construction of a number of interchanges that would serve as focal points for further transit-oriented development. This will allow for safe as well as easy transmission and incorporation with cycling, walking, and minibus taxis, and also play a part in changing areas that are underprivileged through the provision of good transport infrastructure.

Rea Vaya Phase 1C is being improved in the north-eastern side of the city, from the city centre towards Sandton, Alexandra, Greenstone, Randburg, Rabie Ridge, Midrand and Ivory Park (Rea Vaya, 2014).

The framework also lays out improvements that will take place, including:

- Improved coordination with different types of transport at stations including, buses, rails, BRT routes as well as taxis;
- Better pavements and pathways to *Rea Vaya* stations and routes;
- *Rea Vaya* stations with better-equipped bike station;
- Cycling lanes linking to the bus stations with the city and its surrounding territories;
- Rides and parking advantageously situated to improve the change from private cars to public transport;
- Accessibility that is improved for all public transport users;
- Avoiding traffic circles as well as one-way combined transport ways.

2.1.6.3 Achieving successfully integrated transport networks

According to Pojani and Stead (2015), there are a few essentials to the accomplishment of fruitful incorporated transport systems: (i) incorporated foundation, (ii) coordinated planning, as well as (iii) coordinated processes.

Planning is a noteworthy problem that is making every one of the administrative centre (national, provincial and local) in charge of planning transport systems in order to facilitate their endeavors as well as guaranteeing that strategies, systems, and administrations are produced as a coordinated framework (Gasennelwe, 2011). Integrating development for the different types of transportation can guarantee that they

promptly link at interchanges, bringing about excursions with least interruption, distress, or security worries.

Transport sub-structure needs the different modes of transport to flawlessly link in order to empower the best suitable as well as the most noteworthy quality of travel conditions. For instance, exchanges have to guarantee consistent associations amongst ride and park stations and amenities, guarantee associations between cycle ways and stations, as well as to link public transportation stations with trade and business areas (Todes, 2012). The process of administrations at interchanges is predominantly vital, so as to avoid long waiting time at stations (Rea Vaya, 2014).

Procedures in a combination of integrated transport sub-structures and public transport administrations should be corresponding to guarantee consistent associations amongst administrations (taxi to bus, bus to train and train to taxi) from pick up spot to the last stop (Maunganidze, 2011). Distinctive types of transport need to supplement each other, as opposed to function individually or to compete with each other. Integrating tickets and fares for public transport administrations is basic to empower consistent exchange from one administration or mode onto the next, without any extra payment.

2.1.7 Common public transportation challenges

2.1.7.1 Infrastructure

Great transport framework relies on dependable transport framework. Transport foundation necessitates expansive speculations and needs consistent support to anticipate it from being unacceptable for drivers to utilize (Louw, 2003). The increasing costs of paved street development is likely to constrain majority of major street interventions to the public segment (Toth-Szabo and VÃ¡rhelyi, 2012). As per Gould and Schmalbruch (2015), in Southern Africa, particularly in Zimbabwe, the street foundation has disintegrated at a disturbing rate, with the streets getting smaller with potholes harming cars and expanding the required cost to maintain these roads. There's a dissimilarity amongst urban and rural transport infrastructure. Street infrastructure in rural ranges isn't as modern as in urban ranges, resulting in public transport challenges in rural areas. An additional challenge that is presented by the infrastructure is its accessibility (Guo, 2008). For modes of transport like trains, the tracks are as of now in place and the problem is overseeing the trains that run on tracks every day, and slight tracks upkeep.

2.1.7.2 Access in rural areas

Laborers within the primary sector (horticulture and mining) are in farther rustic regions as are regular specialists of certain crops. Rural ranges are regularly ignored in transport arranging which as a result presents a challenge for travelers within these areas (Gebeyehu & Takano, 2007). Conversely, rural regions are associated with spatial issues of individuals being sparcely arranged and the irregularity of their

movements. This makes it troublesome to present a resolution that fulfills transport suppliers, government, as well as the travelers. Neglecting provincial areas in transport arranging could be a genuine challenge that numerous Southern African nations confront (Louw, 2003).

2.1.7.3 Government and Politics

Government and politics in African cities play a huge part in public transport choices (Bocarejo & Tafur, 2013). For example, in Nigeria, in spite of the gigantic development of its inter-urban paved street framework amid the 1970s and early 1980s oil boom, insufficient development quality and inability to upkeep roads led to serious disintegration (Wilkinson, 2006). Legislative issues impact who is given road limits, coming about within the prohibition of certain regions which don't benefit the temporary worker, and upkeep for a specific area while abandoning others. The choice to enhance roads is based on legislative issues instead of value, resulting in effective public transport being a greater issue (Louw, 2003).

The direction and approaches of transport are too politically decided. For instance, the African National Congress (ANC) in South Africa which is the administering party, presented a National Development Plan with a Vision 2030. In case the administering party were to alter, they would introduce their preferred development plan which influences the transport approach. There's no set transport policy that's not influenced by political parties which could be a challenge to overcome.

Within the minibus taxi industry, there are no strict laws to direct their movement and control isn't prioritized. Law Enforcement should be held more responsible amid roadblocks so they can really uphold the laws in regions that don't profit the temporary worker, and enhancement for a specific area while ignoring other areas. The choice to enhance roads is based on legislative issues, making effective transport a greater issue (Gebeyehu & Takano, 2007).

There are no rules to direct the movement within the minibus taxi industry, and with ownership of taxis by government officials, guideline isn't treated as of importance. Law Enforcement should be held more responsible amid roadblocks so that they can really implement the laws in which don't advantage the temporary worker, and support for a particular zone while dismissing others.

Budgetary asset assignment is another government-related issue of public transport (Bocarejo & Tafur, 2013). When charges are collected and government investing increments, there are other significance divisions besides transportation (Marrian, 2001). In most occurrences, extra capitals are allocated on housing, institutions, and healthcare.

2.1.7.4 Access to fuel and prices

For public transport, the accessibility and the cost of fuel may be a serious challenge. Accessing fuel at a reasonable cost may be a significant factor in transportation and politically sensitive (Diaz, 2009). Mobereola (2009) further states that Fuel may be a factor of the transport fare paid and when it is adjusted it influences the travelers generally.

2.1.7.5 Safety and pollution

Greatest types of transport are now well taken care of and are ancient, which makes theses transport modes a threat to individuals as well as the ecological space. Buses work at a low speed due to them having a speed restrain (Badami, 2005). Taxi administrators as a rule cause noise contamination by hooting for customers. As per Diaz (2009), a few public transport administrators are uninformed about ecological awareness, this often leads to challenges for future transportation in Southern Africa. Transport has risen as the most elevated single energy-consuming human activity in most nations (Badami, 2005). This implies that transportation has to consider its cause to climate change and make effort to decrease contamination by contributing in elective fuels.

2.1.8 Effectiveness in Transportation

The expanding significance of transport in both economic and social life needs its assessment not as it were from a specialized and administrative point of view but moreover in terms of macroeconomic effectiveness of the complete framework, i.e. guaranteeing effective application of the necessity to transport both products and individuals. As a result of difficulty of the relationship between this division and the socio-economic framework, there's a need for an all-encompassing view which considers the usefulness of the whole framework and not as it were its isolated components.

Expecting that the transport framework may be a framework of technical, organizational, and human means related to each other in such a way as to effectively move the products and people in time and space and taking into consideration the desires with respect to the optimization and sustainability of transport advancement, it is vital to take into consideration the issue of proficiency in its planning (Lee & Vuchic, 2005). Effectiveness is a vague term utilized in different disciplines of science derived from Latin *effectīvus* „practi-cal”, comparable to effect (us) " productive, effective," from *effect*-, stem of *efficere* (Marshall, 2013).

Microeconomic effectiveness centres on the working of the business unit and its processes, counting investments. It mirrors the advantages of this action. As per the rule of rational management, they ought to be satisfactory to the uses brought about, understood as the degree of consumption of generation components within the procedure of implementing an economic undertaking (Lee & Vuchic, 2005). The

increment in efficiency can be executed in two ways (Muñoz-Raskin, 2010): 1) expansion of effects, i.e. getting the next level of impacts at a consistent level of consumption, 2) diminishing consumptions, i.e. accomplishing certain financial impacts whereas lessening consumptions.

Transport efficiency is assumed as the common connection amongst the utilization of common assets and the charges created on the one hand, and the advantages coming about from their use on the other (Lee & Vuchic, 2005). Costs in transport are most frequently thought on as those caused by clients and transporters. It now and then happened that external costs experienced by the common public, for instance, accidents costs or natural effect were overlooked within the assessment of transport effectiveness. With the advancement of the notion of sustainable transport, it is essential to reflect outside charges in cost-benefit examinations.

As per Pina and Torres (2001), effectiveness is assumed on in terms of societal and environmental incorporation and in differentiating to production, economic and money related effectiveness, directed by the "invisible hand of the market" necessitates organization alteration of the market component through sectoral policy action coordinates with environmental policy. According to Marshall (2013), public transport effectiveness relies on a sum of components, such as framework capacity and transport means capacity, the level of occupancy in vehicles as well as operating conditions.

Effectiveness represents the service consumption by commuters, which includes passenger number or passenger-km compared to service inputs (Deng & Nelson, 2011). The proportion of benefit utilization to service yields is characterized as service-effectiveness, with the refinement between effectiveness and adequacy stressing the diverse angles of execution assessment from the administrator and customer point of view, individually (Lee & Vuchic, 2005).

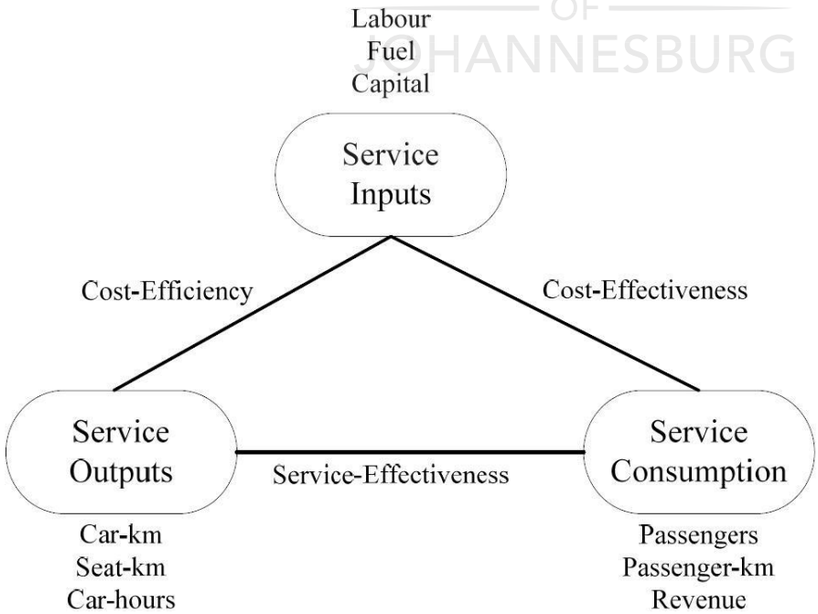
Bus Rapid Transit system can be a cost-effective way of giving a first-class benefit. It can essentially decrease travel time, increment ridership, give adequate volume and actuate transit-oriented development. Lee and Vuchic (2005) contended that BRT can be more successful when incorporated with land-use approaches as well as financial and community plans. Examination of the effectiveness of transport can be the beginning to the improvement of transport administrations within the city, including the social determined to secure and enhance the quality of life.

An impressive sum of research has been carried out in recent years within the area of effectiveness and efficiency of distinctive travel frameworks (e.g. Chu et al., 1992; Kerstens, 1996; Viton, 1997; Mulley, 2003; Karlaftis, 2004; Von Hirschhausen & Cullmann, 2010; Jarboui et al., 2015; Munoz et al., 2013; Tsai et al., 2015).

2.1.8.1 Efficiency and Effectiveness in Transport Sector

Ayadi and Hammami (2015) measured the performance of public transport frameworks at the early stages of public transport performance research by utilizing simple indicators and assessment of proficiency, efficiency and quality of administrations. As per Boame, (2004), Fielding et al., 1978, Fielding et al., 1985 set service indicators on their adopted framework (inputs, outputs and consumption) to assess the effectiveness and efficiency of public transport execution as graphically appeared below. Efficiency in this system alludes to the full benefit output, more often than not measured by car-km voyage or car-hour worked with regard to service inputs (fuel utilization, operating cost and labour) for rail-based frameworks, though effectiveness characterises the benefit utilization by travelers, such as passenger-km, or the quantity of travelers compared to service inputs (Deng & Nelson, 2011). Cost efficiency is additionally alluded to as supply-side efficiency in differentiate to cost effectiveness which is additionally alluded to as demand side efficiency (Ayadi & Hammami, 2015). The proportion of service utilization to service outputs is characterized as service-effectiveness, with the difference between effectiveness and efficiency emphasising the diverse viewpoints of performance assessment from the administrator and customer point of view, separately (Caulfield et al., 2013). In recent writing on performance assessment within the setting of public transport Daraio et al. (2016) presented a comparable system affirming the significance of both efficiency and effectiveness within the sense of considering the pertinence of diverse perspectives of clients (quality), producers (efficiency), and the community (effectiveness) (Markert et al., 2017).

Public transport efficiency and effectiveness



Source: Markert et al., 2017

The functioning of public transport administrations includes a critical effect on the budget of most regional public bodies (central state, provinces, districts and municipalities). Additionally, in numerous cases as it were a little division of these costs

is recuperated through client tickets and memberships. The use of public money as a rule is defended both in terms of equal goals and welfare effectiveness, given the inescapable natural and socio-economic effects of public transport (Deng & Nelson, 2011). As highlighted by Diaz (2009), with equity goals, reasonable accessibility to transport services is consistently considered a fundamental right in a majority rule society; with efficiency goals, shareholders are concerned with both the direct impacts (progressing the productivity and the quality of public transport framework), and within the outside impacts such as decreasing contamination and blockage and enhancing urban opportunities in city centres.

Astoundingly, these “external effects” regularly establish the essential method of reasoning for such interventions in more specialized investigation of the transport planning documents and within the political field (Boame, 2004). Of concern is how the intervention influences the transport framework entirely by adjusting local access, ecological footprint, and land use patterns and for the most part, how the use of social assets influences a course of social objectives (Caulfield et al., 2013). Whereas this issue is ordinarily reflected in the actualizing of strategic decision, such as the development of a transport framework, this vision is at times applied at the more strategic level.

It ought to all things considered be recognized that any assessment strategy ought to consider this system, to supply truly valuable signs to policy decision makers in transportation. Civil engineers and transport specialists are as a rule cognizant of the diverse suggestions that regularly underlie any investment in a public transport framework and are inquisitive about examining the systems performance (Ayadi & Hammami, 2015). This for the most part describes a set of indicators, since this strategy allows to mutually consider varied sorts of information (such as, commercial speed, decrease of toxins outflows and public subsidies) in a clear explanatory way, regularly including straightforward scientific operations.

2.1.8.2 Efficiency and Effectiveness in Bus Rapid Transit Systems

The degree to which a transport framework is regarded to be cost inefficient or ineffective is of concern to public transport specialists, transport administrators, as well as controllers as public transport frameworks play a critical part within the urban regions all through the world (Ayadi & Hammami, 2015). Assessing public transport gives data to have an understanding of how possible changes in service quality (effectiveness), efficiency, and monetary plans may be actualized with possible implications for price determination.

In looking at the elements of BRT effectiveness, the examination has to set up an inclusive single performance indicator which considers different inputs and outputs of the BRT delivery procedure. While the detail and strategy to decide the single performance indicator has possible effect on the discoveries, the accessibility,

determination and suitable utilization of input and output information may have bigger results on the effectiveness performance benchmarking of BRT frameworks (Caulfield et al., 2013).

Benchmarking BRT frameworks all-inclusive isn't as direct as the accessibility, consistency and quality of information are challenging which includes service outputs such as car-km which is not easy to get from most administrators (Deng & Nelson, 2011). Even passenger-km and most fetched information related to BRT frameworks, with the special case of BRT infrastructure cost, numerous administrators are not as it is reluctant to share any information but more critically claim that they do not indeed have that data (Ayadi & Hammami, 2015). The way in which most specialists run mixed BRT and ordinary transport operations, make it not as it were challenging to separate cost over the diverse type of operations but moreover tricky to share such data due to sensitivity matters linked to competitive advantage, public transport and regulation (Caulfield et al., 2013).

Remarkably in any case may be to consider the community point of view by including a fourth key indicator, to be specific input-effectiveness (adding to cost-effectiveness). Comparative to the concept of efficiency, this indicator does not require any input cost information and permits the survey of viable use of physical measures of BRT capital inputs such as BRT network length and fleet size in connection to accessible BRT service utilization output such as quantity of travellers and incomes (Ayadi & Hammami, 2015).

Centering on cost-effectiveness and input-effectiveness, these first-stage single performance indicators are figured utilizing the Data Envelopment Analysis (DEA) strategy and are at that point utilized in a second stage regression to thoroughly recognize key determinants of BRT performance in terms of basic characteristics such as BRT standard, plan, administration or statistic variables of the working region (Daraio et al., 2016). As per Caulfield et al. (2013), the use of two-stage DEA is prevalent to Stochastic Frontier Analysis (SFA) within the BRT setting as the last mentioned does require much bigger samples as well as cost minimization presumptions that tend to be improbable for BRT frameworks (i.e. for those in public ownership)

2.1.8.3 Approaches to measuring effectiveness by previous scholars

In performance measurement approaches, researchers (e.g., Windle and Dresner, 1992) have utilized Partial Productivity Measures (PPM) which are naturally simple for policy decision-makers to get it and or communicate since they rotate around a proportion of a single yield to a single input within the public transport framework setting (Wilkinson, 2006). Be that as it may, Venter (2011), highlights that indeed with numerous definitions, PPMs consider as it were a subset of inputs and yields and can possibly create a deceiving by and large sign of efficiency and can indeed lead to clashing results in case different PPMs are utilized. Total Factor Productivity (TFP) strategies have also been utilized to assess the proficiency and viability of public

transport frameworks (Albalate & Bel, 2009) but as a technique, it necessitates exceptionally noteworthy assets to be committed to wide-scale information collection.

The progress of computing control and the improvement of more modern strategies have implied that unused approaches have gotten to be more common for assessing public transport execution, most strikingly Stochastic Frontier Analysis (SFA) (e.g., Cambini et al., 2007; Lin et al., 2010; Sakai and Shoji, 2010; Holmgren, 2013; Jarboui et al., 2015; Ayadi and Hammami, 2015) and Data Envelopment Analysis (DEA) (e.g., Viton, 1997; Cowie and Asenova, 1999; Pina and Torres, 2001; Boame, 2004; Karlaftis, 2004; Odeck, 2008; Chiuet al., 2011; Caulfield et al., 2013; Georgiadis et al., 2014; Zheng et al., 2014). Both SFA and DEA utilize numerous inputs and yields to gauge a single productivity marker in this way giving an advancement over the different indicators needed for PPM observing (Wilkinson, 2006).

In SFA, a cost function or generation is evaluated utilizing econometric (parametric) strategies to get efficiency based on benefit inputs (Wilkinson, 2006). This strategy needs expansive (regularly longitudinal/panel) information sets to convey strong outcomes (Albalate & Bel, 2009) conjointly requires the presumption of cost minimisation as the key objective of all firms under evaluation. This might be unreasonable as an objective within the setting of many public transport frameworks. DEA does not need this assumption and is additionally less demanding in sample size for yielding vigorous outcomes (Ayadi & Hammami, 2015). DEA may be a non-parametric strategy and employments straight programming to distinguish the proficient generation frontier and after that gauge's wastefulness by deciding the distance of person perceptions from the proficient frontier (Wilkinson, 2006).

Within the public transport setting, DEA has been basically utilized to comprehend the factors of ineffectiveness. As such Ahmed (2004) was able to illustrate a negative relationship between public transport framework proficiency and viability; so frameworks with higher effectiveness appraisals were recognized as having low-efficiency scores and vice versa. Recent studies have distinguished the causes of public transport firms' ineffectiveness by utilizing second-stage regression models (e.g. Tsai et al., 2015 within the metropolitan prepare operation setting). In another later study, Wilkinson (2006) isolated stochastic and orderly specialized inefficiencies and examined determinants for the last mentioned, most eminently appropriations and control. The outcomes propose that capital use appropriations for single mode bus public transport frameworks have a really critical positive affect on public transport effectiveness (Ayadi & Hammami, 2015).

2.1.8.4 Measuring effectiveness in BRT by various scholars

In spite of the fact that the execution of BRT frameworks has expanded universally, research and scholarly journal studies on BRT benchmarking efficiency are rare for a complete survey on effectiveness and efficiency studies related to urban PT see (Daraio et al., 2016). As outlined by Wright and Hook (2007), archived execution based data of specific BRT frameworks did not apply econometric strategies; Hensher and Golob

(2008) assessed 44 BRT frameworks in operation all through the world by comparing framework costs and a run of plan and benefit details through a formal statistical analysis but depended on PPM measures as it were; Hidalgo and Graftieaux (2008) checked on BRT frameworks of 11 cities in Latin America and Asia and found that enhanced speed had a positive effect on ridership of BRT frameworks; Hensher and Golob (2008) surveyed 46 BRT frameworks in 15 nations and found recurrence of benefit, advertised capacity and network are the foremost critical affect variables for expanding ridership; Currie and Delbosc (2011) surveyed BRT framework execution in Australasia and uncovered that BRT ridership development had outperformed non-BRT travel ridership changes in all of their examined cities, with noteworthy effect variables being high benefit levels, speed of vehicles, shorter station dividing, isolated rights of way, present day available vehicles, lower fares, framework integration and pre-boarding ticketing.

There's limited BRT benchmarking efficiency. From the above mentioned, a number of scholars have measured BRT performance/effectiveness identifying various components for different cities using the mentioned approaches. Following this review, components of effectiveness in BRT are elaborated in the next section with their measurable factors to determine the BRT's effectiveness.

2.1.8.5 Components of effectiveness in BRT and measurable factors under each component

2.1.8.5.1 Accessibility

Accessibility to stations is an essential element with regards to transport planning. Studies have demonstrated that enhanced access to transport gives various chances to poor people (Muñoz-Raskin, 2010). A maintainable transport framework gives access to fundamental administrations, for example, medicinal services and training. Inability to access transport can constrain access to opportunities for poor communities.

System accessibility is determined by the distance between passengers' home and nearby bus stops, and the distance between the stations and intended last stop (Muñoz-Raskin, 2010). Shorter distances allow for higher route availability which increases spatial coverage, thereby providing freedom for individuals to move from one stop to designated destinations.

Measurable factors:

- Percentage of population living within one kilometer of a metro station/suburban rail station.
- Average distance, in meters, from metro station to the nearest bus/tram/trolley stops.
- Average transfer time between public transport modes.
- Availability of citywide wayfinding system.

2.1.8.5.2 Reliability

Reliability is a vital perspective that most investigations featured and remarked on the dependability and timeliness of the *Rea Vaya* and *A Re Yeng*. However, as highlighted by Jarboui et al. (2012), there were various investigations that don't concur as they feature that the buses don't hold fast to the timetable at some point which postures issues for travelers who need to travel to their work places and arrive on time. A framework like the BRT ought to be one on which workers can depend.

Dependability is measured by uncertainty of bus timetables, by the number of punctuality of buses/trips compared to the number of trips that are interrupted and by how much they've been postponed (Carvalho et al., 2000). A reliable mode of transport attracts passengers' faith and commitment to the system. Reducing travel time increases average speed, which is a significant quality for public transport.

Measurable factors:

- Congestion: how is the system affected during rush hour travel time compared to free flow travel time.
- Average speed during morning rush hour.
- Time it takes the bus to complete a trip.
- Number of accessible buses per one hour.

2.1.8.5.3 Affordability

Affordability in BRT refers to the ability of commuters to purchase transportation services in order to access basic goods and services without compromising the ability to maintain school, work, shopping, social activities and healthcare. Affordability in transport refers to commuters' ability to save money, ability to respond to financial cost such as reduced income and increased total transport cost. As per Litman (2017), affordability can be assessed based on customers' capacity to save money if wanted, which is sometimes called option value. In this regard, BRT offers smart card systems which allows for loading of a reasonable amount and enable commuters to have several rides with the loaded amount.

Measurable factors:

- Cost of monthly public transport ticket.
- Number of funded passenger categories.
- Cost of a one-kilometer bus ride.

2.1.8.5.4 Assigned Bus Lanes and Time Spent Commuting

Selected paths isolate BRT buses from the movement congestion, giving them the selective right of way, which empowers the buses to achieve more noteworthy velocities (Wright & Hook, 2007). Deng et al (2013:109), highlight that "the exclusive busway and use of transit signal priority in the heavily congested areas provides a dramatic increase in bus speeds".

Travel time is decided by speed and geometry of routes. According to Jarboui et al. (2012), velocity may be a work of road quality, traffic conditions, and distance. The geometry of routes could be a work of the improvement of a complex association of more coordinate and minor routes. Litman (2017), further highlights time is the key measure of efficiency at the level of transit routes, looking at the time taken by the vehicle to conduct a trip. Taking less time allows for all equity in other things (e.g. serving a uniform quantity of passengers unchanged fares charged), resulting in more proficient and productive route.

Measurable factors:

- Average effective speed during morning rush hour, km/h.
- Average above-ground transport waiting time.
- Congestion: rush hour travel time compared to free flow travel time.
- Dedicated bus lanes, as percentage of the road network (excluding highways).

2.1.8.5.5 Speedier boarding

According to Litman (2011), fast and easy access to the buses from enclosed bus stations and bus stops through a number of entrances promotes speedier boarding. The BRT bus structure allows commuters to board through a number of entrances on each side of the bus and station structure. With this kind of entrance doors in the station, passengers are given freedom and space in entering and exiting the buses which results in lesser time boarding and less congestion on the entrances as opposed to have one door.

Measurable factors:

- Average Bus waiting time on boarding stations.
- Number of bus and station door infrastructure allowing for boarding.

2.1.8.5.6 Improved service

BRT frameworks, for the most part, incorporate quick travel features throughout the day service ranges, greater spacing between stations, and more continuous administration than other transport modes (Carvalho et al., 2000). The adaptability and low charges of BRT enable it to give a more a prominent system scope.

Measurable factors:

- Percentage of buses and stations that are wheelchair-accessible.
- Operating hours per week.
- Availability of travel card for public transport.
- Number of public transport casualties, per million people.
- Safety enforcement index.
- Quantity of passengers per day.

2.1.8.5.7 Integration of transit development with land use policy

BRT can be sustainable when incorporated within a broad planning structure including land use strategies, zoning directions, and monetary and group improvement says (Todes, 2012). Movement necessities, that is, developed transport routes must be equally spread to cover the total range and permit flexibility in choosing any suitable route.

Measurable factors:

- Number of vehicles in car-sharing services per million people.
- Number of public transport interchanges.
- Total route spread for public transport accessibility to service areas.

2.1.8.6 Issues around effectiveness in BRT

BRT system are operating at a loss. For example, the MEC for transport in Gauteng province, Ismail Vadi, recently asked whether government was getting value for money from the BRT systems (Ayadi & Hammami, 2015). He suggested that it was time to rethink and redesign the systems to "stop draining money from the fiscus". The productivity of each bus is slow. The number of daily boarding's per km of busway can affect the effectiveness of the BRT system. Travel distances are long due to apartheid spatial planning and low densities. A limited number of passengers are accessible within areas that are far from city centre. This has resulted in subsidizing of BRT systems much more than planned for cities like Johannesburg and Cape Town. Planners anticipated fare revenues to cover functioning costs. Subsidies aren't the problem, the problem is that South Africa's BRT subsidies are too high and haven't produced the anticipated outcomes (Sutcliffe, 2016).

There is an increased dependency on motorised transport. The issue is that less people than predictions are utilizing the framework. Fares revenues are lower than expected. This, for BRT has resulted in under provision. There's only a number of routes assigned for BRT operation and this affects the effectiveness of the system if there is no integration with other feeding modes of transport to the system (Albalate & Bel, 2009).

Increasing cost and reduced incomes. Operating costs ought to naturally decrease as the framework develops, but to raise income levels, BRT must end up way better coordinated with housing and other transport administrations so that more individuals utilize them and offer assistance in paying for them. BRT ought to work with minibus-taxis to assist broaden the net of BRT utilization. The nation needs better planning and subsidizing for this to happen.

There's a lack of revision of the cities transport system so as to create an efficient and effective public transport network (Walters, 2012). The municipalities are also unable to fund the transport strategy alone, however, and therefore require the provision of financial support from national government.

As per Albalate and Bel (2009), it appears that in all cities implementing the BRT system, concession-making with the taxi industry has required a significant outlay – both to buy out taxis from existing routes and to pay them for their involvement on an ongoing basis. As a result, costs have escalated enormously (Sutcliffe, 2016).

2.2 BUS RAPID TRANSIT (BRT)

Several explanations have been given on the term BRT and all of them highlight BRT as a bus framework that mirrors the high limit, superior qualities of urban rail frameworks at a lesser cost. Brazil and Curitiba are recognized with spearheading bus rapid transit and its leader at the time, Jaime Lerner former Curitiba mayor alluded to the framework as a "surface metro" an excellent bus transport service that has comparative execution of a subway yet at a less costly amount (Wilkinson, 2006). As far as administration quality and costs, at that point, this system is regularly believed to be involving the centre ground amongst urban rail framework and traditional bus. It provides the better of the two universes: the quickness as well as dependability of rail, and the working adaptability and lesser cost of an ordinary transport (Walters, 2012).

New York-based Institute of Transportation and Development Policy (ITDP), which has risen as innovation's most grounded supporters, characterizes BRT as “a high-quality bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service” (Holtzhausen & Abrahamson, 2011)

It is the component of a distinct right-of-way that differentiates "high end" BRT from lower quality administrations, that some allude to as "BRT Lite”. A number of countries have adopted on the Bus Rapid Transit System which includes Curitiba, China, Rouen, France, Brazil, China, US, France, UK, India, Tanzania, and Africa. The origin of this system in these countries is discussed below.

2.2.1 Origin of BRT systems in developed and developing countries

2.2.1.1 Developed countries

United Kingdom

The UK likewise gloats a few tops of the line-controlled BRT benefits in Cambridgeshire, Ipswich, Crawley, Leeds, and Luton-Dunstable, demonstrated after the O-Bahn track-guided busways fabricated first in Adelaide and Essen (Duarte & Rojas, 2012). At 19km long, Cambridgeshire busway is supposedly the longest framework (Pourbaix, 2011). Constructed busways without direction have likewise been constructed in the UK, for example, in Swansea and Kent. Kent ordinary Thameside Fastrak framework has gained recognition from travelers, 95% have appraised general Fastrack encounter as 'phenomenal' or 'great' (Jiron, 2011).

In the UK, BRT is progressively viewed as a high-profile quick travel mode, proposing an inventive arrangement to traffic issues. There are a number of public transport plans drawing closer BRT, such as the Cambridgeshire Guided Busway, Crawley Fastway, Kent Thameside Fastrack and Luton-Dunstable Busway (Leibbrandt et al., 2010). The Crawley Fastway framework, consolidating most of the highlights related with a tram framework, has demonstrated that a busway framework was more appealing than initially expected, with support a few 40% higher than estimate (Jones et al., 2014).

Cambridgeshire County Council is building the longest guided busway framework (25 km), connecting the city of Cambridge to obsequious towns and rural areas and Luton-Dunstable Busway has as of late been endorsed (Polis, 2015). The benefit will be given by extraordinary busway vehicle, which is able of running both on the track and public roads. In Leeds, the Super Busway concept was presented in 1995 and works on Scott Lobby Street between the Northern rural areas and the CBD (Pourbaix, 2011). The guided transport innovation successfully avoids illegal use by other activity permitting buses to maintain a strategic distance from traffic clog during peak hours. As per Albalate and Bel (2009), in 2001, another guided busway propelled on the east of the city (York Street). As of late, after the refusal of the Leeds capital-intensive Supertram proposition, a BRT framework has been proposed by Leed (Polis, 2015)

Canada

The BRT involvement in Canada encompasses a long and fruitful history. Ottawa features a notoriety for running one of the foremost broad and effective BRT frameworks, known as Transitway (Boncompte & Galilea, 2013). The beginning section opened in 1983, developed basically on a railroad right-of-way (Pourbaix, 2011). It gives travel from remote private ranges to the CBD. The Transitway framework comprises of 60 km roadway, counting 26 km of bus-only grade-separated roadway, with most of the remaining distance on the saved paths (Jiron, 2011). It joins to the rail, as well as park-and-ride stations.

The Transitway framework gives a high-frequency benefit, working nearly all day: 22 hours every day (4:30 am–2:30 am) with 3–5 minute top headways and a 5–6 minute off-peak. It can serve 200 000 travelers regular, with the peak loading of 10 000 travelers (Canadian Urban Travel Affiliation, 2004) cited by (Waldeck & Van Heerden, 2017). Within the light of its striking execution, the City of Ottawa has arranged to grow the travel course arrange to serve the expanding numbers of travelers. As of late, York University busway, opened in November 2009 in Ontario, gives a quicker travel alternative for commuters (Boncompte, & Galilea, 2013).

Australasia

Four cities in Australasia have executed BRT frameworks as a cost-effective mode of giving quality benefit for cities with comparatively low density. Australasia has one of the most seasoned BRT frameworks, the Adelaide Northeast Busway (opened in 1986) (Franklin, 2014). It moreover has a few of the world's most up to date frameworks: the

Brisbane Southeast Busway, the Brisbane Internal Northern Busway and the cross-hallway Sydney Transitways (Parramatta to Liverpool and Parramatta to Awaken Slope), opened in 2001, 2004, 2003 and 2007, separately (Franklin, 2014). These frameworks work completely different and independent states advertising the opportunity to distinguish the effect of the organization environment as well as unmistakable mechanical and operational viewpoints. Auckland opened its initial selected busway, the Auckland Northern Busway, in 2008 and it has its own park and ride offices, considered as a key portion of Auckland's rapid transit network (Franklin, 2014).

India

Development of the bus rapid transit system in India can be drawn back to the declaration of the National Urban Transport Policy in 2006 by the Government of India (Sibiya, 2009). Amid this stage, the government got numerous requests for financing the bus rapid transit undertakings.

Urban communities of Pune and Delhi remained the main cities to begin with BRT undertakings in the nation, with plans for 257 km and 100 km networks correspondingly (Deng & Nelson, 2013). Be that as it may, with just 15 km operational in Pune and 5 km in Delhi, these frameworks were restricted in scope and were vigorously reprimanded for their low quality of execution (Leibbrandt et al., 2010). Seeing this system only as an adjusted transport path implied that these pilots did not address the requirement for BRT-particular administration designs, coordination with existing transport operations. The requirement for supporting framework and implementation measures were additionally disregarded.

During the year 2009, another phase of excellent BRT framework in India began with the execution of Janmarg in Ahmedabad. From its underlying operational length of 12.5 km, the framework was extended to an 88 km organize during the year 2014, giving network connectivity over the urban area (Waldeck & Van Heerden, 2017). The achievement of Janmarg propelled comparative BRT endeavors like Rajmarg (Rajkot) in 2012, iBus (Indore) in 2013 and Citilink (Surat) in 2014 (Waldeck & Van Heerden, 2017).

The pilot BRT project in Delhi has endured from serious media feedback ever since the primary trial run, due to destitute plan and need of coordination with distinctive partners. Resistance from drivers was started since BRT requires its own right of- way which needs twice the street space of a car (Leibbrandt et al., 2010). In any case, the BRT framework has obtained overpowering bolster from the commuters. Crambeck and Qu, (2015), highlights that concurring to a joint discernment study of commuters travelling on the BRT hallway conducted by the Center for Science and Environment, Delhi Greens and the Indian Youth Climate Arrange (2008), 83% of commuters were upbeat with devoted BRT paths and accepted that BRT ought to be proceeded within the city. Twenty-six percent of car and two-wheeler commuters were willing to alter mode in

case the BRT framework had a well-covered network and associated with the Metro (Leibbrandt et al., 2010). More empowering evidence is detailed from Ahmedabad's Janmarg (opened in October 2009), India's initial fully-featured BRT service with middle stations, level boarding, and central control. ITDP (2009) contended that Janmarg had the potential to assist restore the picture of public transport in India.

Tanzania

Dar es Salaam BRT is a framework that started procedures on 10 May 2016 in Dar es Salaam, Tanzania (Cervero & Luchi, 2017). The system comprises of 6 phases and the development of the initial stage started in April 2012 by the Austrian development organization Strabag International GmbH and was finished in December 2015 at an aggregate cost of €134 million subsidized by the African Development Bank, World Bank and the Government of Tanzania (Deng & Nelson, 2013). Phase1 has an aggregate length of 21.1 kilometers with devoted transport paths on three trunk courses with a sum of 29 stations (Crambeck & Qu, 2015). The whole framework is managed by The Usafiri Salama Dar es Salaam Rapid Transit (UDA-RT) under the reconnaissance of the Surface and Marine Transport administrative specialist (Sumatra). Present a fleet of 140 Chinese Golden Dragon buses service the route, giving rapid transport and local administration from 05:00 am to 11:00 pm on a daily basis.

Africa's BRT frameworks, Lagos, Marrakech, Tshwane, Johannesburg, Cape Town, Nelson Mandela Bay, George, Rustenburg, Dar es Salaam, and Kampala are part of the BRT Lite end of the range. Lagos' framework, which operated in 2008, cost US$1.7 million for every kilometer to construct, which is one of the least expensive anyplace (Crambeck & Qu, 2015). All things considered, it conveys right around 200,000 travelers every day or a fourth of open transport trips along its hallway, despite the fact that BRT vehicles make up only 4% of vehicles on the course (Crambeck & Qu, 2015). Despite the increased pace of BRT ventures of the previous decade, there remains a lot of space for development. During the year 2011, the about 28 million traveler trips delivered by BRT frameworks around the globe were yet 2.2% of all open transport trips and a negligible 0.3% of all mechanized individual outings made that year (McCaul, and Ntuli, 2011).

2.2.1.2 Developing countries

Curitiba

As indicated by Yusuf and Allopi (2010) the idea of Bus Rapid Transit system started in 1937 in Chicago, be that as it may, the full system was just actualized in 1974 in Curitiba, Brazil. The first system in Brazil was worked in 1974 in the city of Curitiba by the mayor, architect Jaime Lerner, and turned into the primary BRT on the planet with the objective to give amazing rail travel administration to clients and at a practically identical cost (Wright & Hook, 2007). Vuchic (2007), likewise includes that Curitiba's prosperity motivated the execution of comparable plans in excess of 100 urban communities around the globe, including the Brazilian urban areas of Brasília, São

Paulo, Belo Horizonte, Rio de Janeiro, Manaus, Goiânia, Porto Alegre Aracaju, Recife, and Salvador.

BRT as intends to address these problems, the development of a rail-based metro framework was well-thought-out be that as it may, an option must be looked for because of the absence of assets (Boncompte & Galilea, 2013). Open transport before the execution of the BRT framework was loose, ruled by private division administrators and neglected to address customer issues (Wilkinson, 2006). Keeping in mind the end goal to locate a less expensive type of transport, the BRT framework was created.

Brazil has risen as the worldwide pioneer by developing the BRT frameworks, expanding the accomplishment of Curitiba's spearheading framework to 30 different urban areas. At the point when Curitiba propelled its 'Surface Metro' in 1976, it tried to impersonate numerous highlights of close-by São Paulo's Metrorail framework – dedicated right-of-way, appealing stations, off-board toll gathering and regular, quick administrations (Vuchic, 2007). Bi-articulated buses and very much composed boarding tubes altogether extended conveying limit. Curitiba is now well best recognized for utilizing BRT to control city development along dense, mixed-use corridors that draw in transit riders (Boncompte & Galilea, 2013).

The strategy used by Curitiba - The choice to depend on buses was seen as a more adaptable and reasonable open transport arrangement than rail travel for a medium-sized advancing city. Both the advancement of the city and the transport fast travel framework are the consequence of approaches for this development for the most recent 30 years on land use, expressway, travel administration and tasks, and public participation.

Curitiba has a master plan and, imperatively, an organization Instituto de Pesquisa e Planejamento Urbano de Curitiba (IPPUC), to screen, execute, and refresh the plan. IPPUC is a to a great extent autonomous foundation and therefore is less at risk to political pressures and changes than a region-based division. The achievement of IPPUC is amazing in Latin America, and the organization presents courses, in light of its encounters, to an extensive variety of focal and local government organization from different nations. The main highlights identified with land use and travel in the plan are the accompanying:

Land use and transport are coordinated; the structural axes idea of high development has made passageways with a movement request that is appropriate to be met by transit. Land inside two pieces of the busway has been zoned for blended commercial residential employment. Past these two pieces, zoned private densities decrease with distance from the busways

In particular, the zoning recommended by the structural axes has been acknowledged by a mix of control and motivators. This mix incorporates different rewards to develop as arranged; motivations to exchange improvement rights; firm control over large scale

advancement); arrangement of motivators to designers to increment residential compactness near the corridors as well as advancement of travel terminals with an extensive variety of offices – both open and private area. • The busway framework has been active in controlling land use improvement and has been utilized to animate advancement along the basic axes.

Other Latin American nations, remarkable Mexico and Colombia yet, in addition, Ecuador and Chile, Peru, have since taken after Brazil's lead. LA is currently the epicenter of the worldwide Bus Rapid Transit development (Jiron, 2011). A third of BRT course km's and almost two-third of ridership are in LA (Pourbaix, 2011). Bogotá's 110km TransMilenio is perceived as the Gold Standard of BRT. Appointments of authorities and notables from around the globe visit Bogotá to wonder about the framework (Deng & Nelson, 2011). Working on a two-path devoted carriageway, TransMilenio conveys up to 40,000 travelers for every 60 minutes per bearing, which coordinates the traveler throughputs of general metros (Ewing & Cervero, 2010). The framework likewise brags improved stations (reachable by systems of airways), smart card-based toll gathering, progressed administration frameworks, unmistakable pictures, and moderate charges. TransMilenio's support is developing at 10% yearly, from 800,000 day by day customers when it started operating in 2001 to around 1.7 million today, representing 74% of transportation drives in the urban area (Boncompte & Galilea, 2013). Finance strategy has assumed a part in TransMilenio's prosperity. A 20 percent extra charge in the year 2000 was attached to all fuel deals in Bogotá, with a large portion of the incomes reserved for TransMilenio framework (Pourbaix, 2011). As a cross-sponsorship from the 19% of Bogotá's populace which had their own cars, the arrangement advanced social and also ecological sustainability.

China

China has as well taken after Latin America's in forcefully assembling the system, with in excess of ten urban communities, including Xiamen, Guangzhou, Hangzhou. Beijing and Jinan with their own BRT lanes launched in 2005. In the course of recent years, China has included BRT path kilometers at a speedier pace compared to other countries.

The foremost outstanding BRT framework in China is the Southern Pivot BRT Line 1 in Beijing (the primary BRT passage in China), which is portrayed by Deng and Nelson (2009). Beijing is one of the foremost congested cities in China. After a long time of overwhelming speculations in building rail frameworks, particularly the Metro and LRT, the Beijing specialist has confronted expanding troubles in paying off the obligations, subsidizing Metro and LRT operation, and extending the rail framework (Leibbrandt, Woolard, McEwen, & Koep, 2010). Regarded a more affordable way to supply a high-quality transport benefit, a driven program of BRT framework execution has been propelled in Beijing. The Southern Axis BRT Line 1 begun commercial operations in December 2004 (Leibbrandt et al., 2010). Most lanes are physically isolated within the

middle of the street. As per Jones, Turner, and Heydecker (2014), this rubber-tired travel framework has accomplished nearly 40% travel time diminishment and high ridership, but with as it were 1/15 capital cost of a Metro line. When complete, it is arranged the BRT framework will total to 300 km in length.

Rouen, France, also has three BRT lines, called TEOR (Transport Est-Ouest Rouennais). Optical direction enables TEOR vehicles to keep running along firmly limited halls, providing customers solid, agreeable and available administrations (Deng & Nelson, 2011). Other French urban areas, similar to Nantes, work comparably top-notch transport-based frameworks however utilizing more customary innovations. Nantes' 6.9km busway associates a ring street to the downtown area with a recurrence of 3-minute degrees of progress amid the peak time. The transport-based framework looks like the city's settled cable car lines focus, devoted path for the vast majority of the tasks, ITS-prepared stations, and necessary treatment at convergences, different marking and stop at the stations (Finn et al., 2011).

The developed nations, Brazil, China, and the US, France, and the UK – rank next as far as quantities of urban cities with BRT frameworks. Except for restrictive busways like the Orange line in Los Angeles and Eugene, Oregon's EmX, most US frameworks fall in the classification of BRT lite (Ewing & Cervero, 2010). The purveyors of BRT in Europe were Runcon UK, which introduced a busway as a component of a master-planned new town, and Essen, Germany, the primary urban area to develop a monitored busway (Hildalgo, & Graftieaux, 2008). Today, European BRT frameworks, especially the ones in France, appear to be more of a rail-like structure somewhere else, for example, in Caen, Paris, and Rouen. BRT frameworks in these spots work on their own lanes, bolstered by numerous regulating technologies, and have cars that an excessive number of are outwardly unclear from current tramways.

South Africa

- **City of Johannesburg**

The City of Johannesburg turned to be the main city to deliver South Africa's BRT framework, introducing another period of top-notch transport in the nation. The *Rea Vaya* (meaning "we are moving") in Johannesburg initial stage 1A was launched to the general population on 30 August 2009 (Khumalo & Ogra, 2018). The framework was launched for the 2010 World Cup with the framework connecting the dominant part of Johannesburg from Soweto to past Sandton in the northern side (Khumalo & Ogra, 2018). The bus station enables the usage of boarding on both side of the station and general stops, others are enunciated and can utilize only the stations.

According to Khumalo and Ogra (2018), the city has a past filled with public transport under investment, in addition, is enduring outcomes of notable accentuation on private autos transportation planning. Majority of extensive urban areas have a considerable mass travel framework that backs movement and the economy. The Johannesburg BRT

is named *Rea Vaya*. This is an idea that is as a rule effectively utilized as a part of developing nations and is rapidly taking course in developed nations as well (Seftel & Peterson, 2014).

Prosperity of this system is dependent on the ability to transport travelers easily and rapidly within the city utilizing its particular assigned courses (Suzuki et al., 2013). The covered stations beside the courses support fast boarding. The frameworks plan is to enhance public transports nature for better-improved experiences for its clients yet additionally be adequately alluring to other private cars users (Khumalo & Ogra, 2018). The system is a solution to the city's clogged streets as well as its challenges of transportation

Bus rapid transit system has been effectively executed in Europe as well as in South America as it is presently picking up recognition in other nations like China and North America (Suzuki et al., 2013). The system is effectively utilized as a part of numerous developing nations with the same challenges surrounding transportation as South Africa thus considered the ideal answer for Johannesburg's transport problems.

"We are addressing the ill effects of the past and implementing programmes that are stitching the City together, creating a more impact city ensuring that economic opportunities and services are closer to the people. Therefore, allowing people to live, work, play and pray in a much more cost effective and efficient manner" as per the transport minister (Sibiya, 2009).

Diminishing traffic blockage and minimizing private transport usage is the main role of presenting coordinated open transport in Sandton as well as Alexandra. Putco, Gautrain, *Rea Vaya*, Uber, Taxis, as well as Metrobus, will in a long run lessen movement blockage within the city's urban areas. Moreover, as per Gasennelwe (2011), the enhanced traffic portability between the Sandton central area as well as the exit ramp from the M1 is a result of the broadening of Kathrine Drive and Zandspruit Bridge to the Marlboro exit ramp.

- **City of Tshwane**

The Tshwane *A Re Yeng* meaning let's go, began with its developments in July 2012 and began working in April 2014. The system in Tshwane comprises a sum of approximately 80 kilometers of transport lines, containing 62 stations and operates from Mabopane through Pretoria city centre, past Menlyn and on to Mamelodi. This framework has around 340 buses, and some of them are operating by gas (Van der Westhuizen, 2007).

The City of Tshwane is also another metropolitan city that is faced with challenges of movement clogs within the city and has opted for the adoption of the BRT system as the solution to its issue of traffic congestion especially amid peak hours (Vaz & Venter, 2012). In the meantime, populations of less privileged regions rely upon the use of public transportation to successfully access their places of employment as well as the

ability to move around the city. The executing of this proficient and financially effective transport framework is enhancing the wellbeing of commuters and in addition decreasing the movement blockage, thus increasing the resident's freedom of movement (Holtzhausen & Abrahamson, 2011). With the implementation of this system in the city, accidents are anticipated to decrease.

Transport improvement in the City of Tshwane is expected to change public transport by developing affordable and high-quality frameworks that are in line with the National Transport Strategy of 2007 (Bocarejo, 2012). The integrated rapid public transport network is relied upon for the enhancement of the services provided by the public transport, lessen the general travel times for the commuters as well as improving transport accessibility to main economic hubs of opportunities in the city.

- **City of Cape Town**

The Cape Town's MyCiTi framework began working May 2010 (South Africa, 2011). Its initial administration were trips from the Airport to the city centre. The underlying Phase 1A trunk and feeder administrations began working in May 2011 (South Africa, 2011).

- **EThekwini City**

The eThekwini municipality has adopted on the development of the BRT system in the city. Go Durban! is the name of the newly implemented BRT framework in eThekwini that intends to deliver a cost-effective, safe, seamless and flexible transport system. The eThekwini municipality was preparing for the launch of the eThekwini Go Durban! first route in April 2018. The first phase of the Go Durban! BRT system was expected to be completed in 2018. EThekwini Mayor Zandile Gumede says this newly introduced bus system is a procedure that represents a significant shift for the city (IDP, 2015).

- **City of Ekurhuleni**

The Ekurhuleni Public Transport Industry has partnered with Ekurhuleni Metropolitan Municipality (EMM) to be the operatives of the Ekurhuleni's Integrated Rapid Public Transport Network and deliver the BRT transport services through a special purpose vehicle, KTVR Bus Service (City of Ekurhuleni, 2018). In March 2017, the recently developed Ekurhuleni bus operative, KTVR, signed loan agreement with the DBSA to fund the buying of 210 buses necessary for the implementation of phase 1 of the Ekurhuleni Harambee BRT project (City of Ekurhuleni, 2018). The objectives of the Harambee BRT framework is to link the places under Ekurhuleni municipality, this includes Germiston, Benoni, Brakpan, Kempton Park, Nigel, Springs, Edenvale, Alberton and Boksburg to overcome the challenges of apartheid planning, delivering the residents with an affordable and accessible transport. The project is meant to restore historical differences and generate socio-economic revival.

Integrated Rapid Public Transport Network has the following objectives (Deng & Nelson, 2013):

- Enhancing the transport movement as well as the ability to access public transport by all transport users.
- Improving transport frameworks that are economic growth drivers in urban areas.
- Enhancing the safety of transport framework
- Introducing a framework which mirrors the image of the city.

National goals on public transport systems are (Carvero, 2013a):

- Enhancing the nature of open transport in every single city
- Decreasing the expenses of administration conveyance
- Diminishing the funding weight on all circles of government
- Improving reasonable transport fares
- Lessening traffic congestion as well as the number of private cars on road networks to gain on benefits of enhanced travel time and transport security with diminished air pollution and road accidents.

According to (Todes, 2012), taxis were and still are a most used mode of transport within these cities however with its rapidly growing issues like inefficiency and unreliability, the framework was developed all together to lessen the difficulties experienced in the cities. Various advantages were guaranteed by the National Department of Transport for the city during the development of the BRT framework in 2009. This framework is meant to change these cities into world-class African cities while giving a sheltered as well as productive transportation frameworks (Holtzhausen & Abrahamson, 2011). Moreover, these systems were composed with the goal of expanding access to areas of employment openings, and in addition to instructive and social exercises (Fourace et al 2006).

The BRT system is intended to give a world-class open transport framework which is proficient, dependable, protected and shabby. The venture is a piece of the urban communities' renewal design, keeping in mind the end goal to convey business back into the downtown area (Vaz & Venter, 2012).

2.2.2 Significance of BRT

2.2.2.1 Affordability of Rea-Vaya and A ReYeng

BRT systems goal of providing a safe, fast and affordable option for commuters seems to be the draw for its passengers. Ever since operations began, the system has been a breath of fresh air for commuters who have saved money and have been able to travel safely and timeously to their destinations. BRT charges are decided on based on travelled distance, travel fares are charged per km and they decrease as the distance of the trip increases (Bickford, 2014). According to Vaz and Venter (2012) at certain times *Rea Vaya* offers 10% discount for off-peak travel to its commuters**.** It applies during off-

peak hours. People travelling in the course of off-peak hours between 8:00 am and 3:00 on Mondays to Fridays, as well as on Saturdays, Sundays including public holidays.
Rea Vaya management reacted to the complains raised by the commuters with regards to the increase in fare price and had decreased the fare prices which resulted in occasional as well as one-way trips cheaper (Hitge & Gqaji, 2011). Reducing the fees has resulted in *Rea Vaya* being more appealing to commuters needing to get around Joburg quickly and in comfort.

Excellent BRTs, similar to all city transportation, has the ability to influence the personal satisfaction, profitability, wellbeing, as well as security of individuals living in urban communities (Hetherington, 2011). Such effects have been investigated in shifting profundity in the current research as ecological effects, security benefits, general wellbeing, movement time benefits, as well as urban improvement changes. A concise outline of the existing investigation in regard to these classifications of advantages is given at this point.

2.2.2.2 Travel Time Impacts

Adewumi and Dhiren (2013) express that few design components of superb BRT frameworks can stimulate traveler loading up and landing times, decreasing general traveling time - Level boarding: the bus station stages that are leveled with transport boarding bases; doesn't include any stairs to access and exit the bus; Pre-paid boarding: bus fares gathered at the station entrance; High-limit transports with different entryways: a few, frequently wide, entryways for boarding.

Besides, a physically isolated path for BRT administrations isolates buses from blended traffic and raises business speeds (Maunganidze 2011). As indicated by Mabena (2010), complex movement flag administration can assist in limiting interruptions by holding green signs for BRT transports moving toward a crossing point. At last, high-recurrence transport benefit (now and again in excess of 60 buses for each hour) limits the amount of time that passengers wait for the bus (Bechstein, 2010).

Hetherington (2011) says that travel time savings aren't just about investing less time on transport however more effective travel alternatives enable travelers to get to their places of work a bit early and thus get more hours to do their work. Notwithstanding general travel time saving, sustainable BRT administrations also enhance travel time reliability.

2.2.2.3 Environmental Impacts

BRT frameworks can have positive impacts to the environment by lessening ozone-depleting substances that add to worldwide environmental change and also air toxins, which prompt citywide air contamination and exhaust cloud (Adewumi & Dhiren, 2013). Vehicle emanations reductions can be done in these accompanying different approaches, with minimizing vehicle kilometers travelled (VKT) as well as refining the fuel productivity in addition with the machinery of the BRT transport (Todes, 2012).

Commuters moving away from using private cars to highly populated public transport limit over-all VKT within urban spaces (Hetherington, 2011) Likewise, a number bus rapid transit frameworks unite informal transport frameworks involved low-inhabitance vans which can use all the more polluting powers and old transport equipment. According to Bechstein (2010), new bi-enunciated bus rapid transit transportations can transport a large number of commuters per travel kilometer and most are fit to meet the maximum rigorous discharges benchmarks.

Diminishments in Greenhouse Gases - Eleven BRT frameworks crosswise over China, Mexico, South Africa, and India have enrolled their carbon dioxide proportionate discharges decreases through the United Nations Framework Convention on Climate Change's (UNFCCC) Clean Development Mechanism or different emanation confirmation plans (Vaz and Venter, 2012). Through the span of ten to twenty years of the frameworks' activities, beginning from 2000, these enlisted BRT ventures are estimated to lessen discharges by 31.4 million CO2e (Dibakwene, 2011) a sum proportionate to the yearly ozone-harming substance emanations from in excess of 6.5 million traveler autos (Walters, 2012)

Concentrates from a few urban communities substantiate the extent of ozone-depleting substance outflows reductions from a BRT framework:

- In Bogota, the execution of TransMilenio joined with new controls on fuel quality is evaluated to decrease discharges by almost 1 million tCO2 every year (Dibakwene 2011).
- Johannesburg's Phase 1A and 1B of the *Rea Vaya* BRT framework are relied upon to diminish outflows by 40,000 tCO_2 e every year (Schmidt and McKenzie, 2012).
- When Mexico City's Metrobus Line 1 initially opened it was evaluated to diminish outflows by about 27,000 tCO_2 e for each year (Hetherington, 2011).

By rearranging and solidifying informal transit and regular transports, Istanbul's Metrobüs BRT framework is assessed to decrease CO_2 discharges by 167 tons/day and cut every day fuel utilization by in excess of 240 ton-liters (Dibakwene, 2011).

2.2.2.4 Public Health Impacts

BRT likewise offers important general public health advantages to civilization in the following main means: lessened exposure to pollution, lessened road accidents, and expanded physical movement for bus rapid transit clients (South Africa, 2012).

2.2.2.5 Road Safety Impacts

With literature study is limited on aspects of road security effects of BRT frameworks is less concentrated compared to a portion of the other elements, Hetherington (2011) states that ongoing literature have demonstrated that the bus rapid transit corridors have the ability of posing positive effects on transport wellbeing by lessening the traffic incident frequency and transport accidents. Mpofu (2008) state that the Bogota's

TransMilenio has added to the decrease in accidents of the framework's fundamental routes. Cervero (2014) confirms such discoveries for Bogota and shows extra proof of constructive security influences related to the Macrobus BRT in Guadalajara, Mexico. Previous writings likewise demonstrate transport security upgrades from the bus rapid transit frameworks in Australia: Melbourne's SmartBus BRT added to diminishments in accidents at all seriousness levels in the city where it was executed (Bechstein, 2010)

2.2.2.6 Employment Impacts

Development, procedures, and upkeep of BRT frameworks can make employment. This may bring about a net increment in the number of working individuals, or a move of employees starting with one occupation or division then onto the next. Much of the time, BRT frameworks make new employment in the formal economy that supplant casual occupations from the current customary transport framework (Weinstock, 2009). The occupation effect because of the operation of TransMilenio was affirmative. This framework brought about a net pick of 1,900 to 2,900 long-lasting employments in operations, in addition to 1,400 to 1,800 brief occupations for every month amid development (Badami, 2009). This net pick up occurred in spite of the necessity for the end of customary transports between Phase I and Phase II. It is additionally important that these were new occupations in the formal part supplanting informal employments from the customary framework.

Phase 1 of the BRT framework helped move previous taxi drivers to formal employments from the informal division as *A Re Yeng* and *Rea Vaya* transport drivers (Kane, 2010). Yearly income for these drivers expanded more than two-crease and they profit from formal work plans (Pojani & Stead, 2015). These buses hire in excess of 780 individuals between the bus working organization (as drivers and administrator staff), stations (as client benefit envoys, clerks, security and cleaners), and the city's BRT specialty unit workplaces (Venter, 2011). Amid development of Phase 1A *Rea Vaya*, in excess of 15,000 development employments (characterized as no less than 55 days of consistent work per individual) were made (Hitge & Gqaji, 2011)

2.2.2.7 Impacts of Crime

Offering sufficiently stations operated by security personnel, surveillance cameras in stations and on buses as well as on pedestrian scale nearby bus stations, BRT frameworks have the ability to make a more secure condition in regions which they operate. As indicated by stats from the Center for Criminal Investigations of the Bogota Metropolitan Police, crime within the zone nearby Av. Caracas decreased by 85% between the 1999 and 2000 period the period and following 2001 to 2002 the execution of the TransMilenio framework (Gasennelwe, 2011). Investigators credit this to expanded and better sorted out financial action and development. Then again, swarmed stations and transports may grow minor crime, for example, mugging inside the bus rapid transit framework.

2.2.3 Elements of the BRT

2.2.3.1 Wide choice of running ways - BRT frameworks can work on a wide range of running ways—blended stream arterials, blended stream freeways, dedicated lanes, managed lanes paths as well as in passageways (Gilbert, 2008).

2.2.3.2 Upgraded stations - Esthetically-planned stations make BRT frameworks appealing while at the same time giving commuters facilities, for example, seats, shelter, lighting, ticket machines, security, and traveling information.

2.2.3.3 Innovative vehicles - Stylized and specified transports can work along BRT hallways, with accentuation on comfort, stylish upgrades, simple access, traveler course, and environmentally friendly momentum. Buying costs for higher end BRT vehicles can go from $370,000 to $1.6 million, contingent upon the size and impetus innovation (Jennings & Covary, 2008).

2.2.3.4 Enhanced fare gathering - Electronic fare cards, off-load fare gathering, or proof of payment alternatives take into account shorter general travel times.

2.2.3.5 State-of-the-art innovation - BRT consolidates ITS (intelligent transportation system) applications, for example, travel flag need, propelled communication frameworks, computerized booking and dispatch frameworks, and continuous commuting information at stations and on vehicles for quicker and more advantageous excursions (Gilbert, 2008).

2.2.3.6 Enhanced administration - BRT frameworks, for the most part, incorporate rapid transit features, for example, throughout the day benefit ranges, more prominent space amongst stations, and more successive administration than informal transport benefit (Hetherington, 2011). The adaptability and lower-cost of BRT enable it to give a more noteworthy system scope.

2.2.3.7 Modern branding and marketing - Unique logos, styling, colors, and advances for vehicles and offices help build up a framework personality. BRT administrations can be showcased as another transport course or another level of administration or as a major aspect of a multi-modal rapid transit system (Hitge & Gqaji, 2011).

Passengers travel through an entrance-controlled space when arriving or exiting the station. Contingent upon passenger request, a station may serve in excess of one bus in the same direction at the same time; along these lines, a modular design is the most suited to provide for viable interest at various stations (Hetherington, 2011). To enhance the simplicity of boarding and lessen delays at stations, buses stop at defined positions onboarding platform (Jennings & Covary, 2008). The outline of the stations varies from each other due to; inter alia, its size and length, usefulness requirements and the environment inside which they are found.

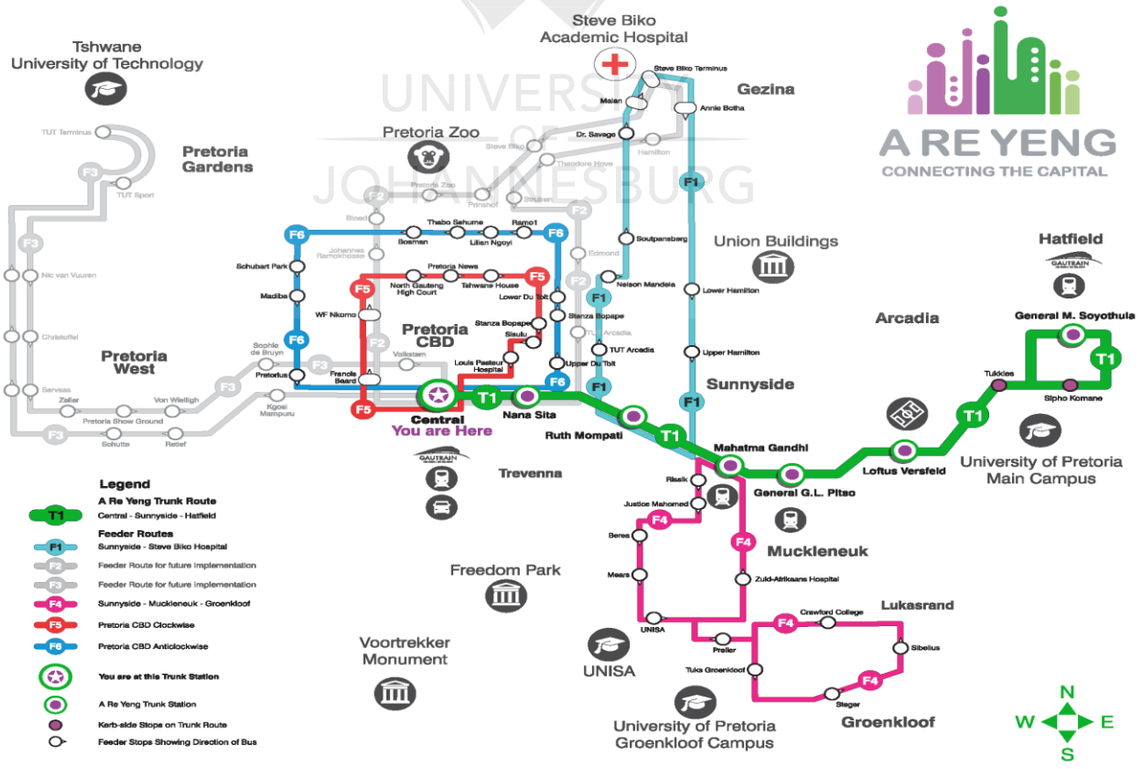
A BRT station is an encased bus shelter that incorporates different facilities and by and large, situated in the middle of the streets, contingent upon the particular street type

classification, accessible space or geometry (Pai & Hidalgo, 2009). Passenger access to and from the station is at the one end of the station and the two sides are used for landing and exiting of the BRT buses in the two inverse ways. Travelers travel through an entrance-controlled zone when entering or exit the station.

Feeder routes - The trunk routes are served by feeder routes, and these routes could be served by normal buses or taxies (Pai & Hidalgo, 2009). There are presently 5 feeder courses in Johannesburg. F1 keeps running from Naledi though Thokoza to the city centre, F2 from Protea Glen through Thokoza to Ellis Park, F3 keeps running from Jabavu though Lakeview to the city centre, F4 keeps running from Mofolo by means of Boomtown to the CBD and F5 keeps running from Eldorado Park through Lakeview to Ellis Park (Hitge & Gqaji, 2011).

In Tshwane, buses run on mixed-traffic lanes carrying travelers to the trunk route. From Steve Biko Terminus, Tuks Groenkloof to CBD Central Station. Trunk route buses keep running on the devoted path and just stop at the BRT stations, these are the transports that are not permitted to make a stop anyplace else but certain stations (Rea Vaya 2014). Buses operate on devoted paths, with stations situated in the focal area of the street from the city centre to Hatfield. Beginning from Central Station in the CBD to General M. Soyothula Station in Hatfield.

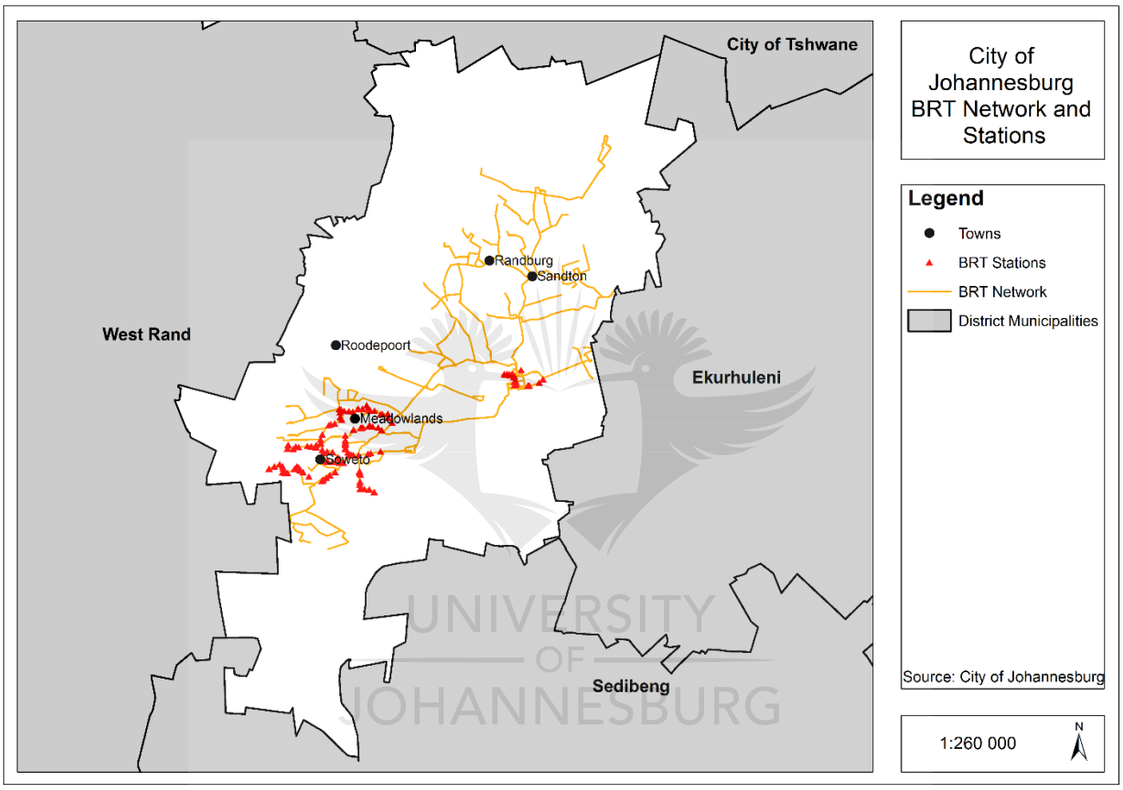
The following is the Tshwane *A Re Yeng* BRT outline of feeder and trunk routes:



Map 9: A Re Yeng BRT
Source: (City of Tshwane, 2018)

Complementary routes- this system has three complimentary courses. C1 operating from Dobsonville and the city centre, C2 between Dobsonville and Maponya Mall and C3 is a round inward city course. These routes run in blended traffic roads and on trunk courses (Holtzhausen & Abrahamson, 2011).

Because of the development requirement and the broad cost of the bus rapid transit framework, the *Rea Vaya* was propelled in stages. The primary stage of the venture incorporated: 25.5 km of trunk course, with 70, 000 outings, 10 courses made up of 20 stations, 1 trunk course and 5 feeder routes, from the Ellis Park Stadium to Soweto, 143 buses, BRT administration centre and the utilization of smart card innovation (Maunganidze, 2011).



Map 10: Rea Vaya BRT

The above figure demonstrates the total course of stage 1. The finished stage 1 was intended to be finished in 2013 (Waldeck & Van Heerden, 2017). In any case, meeting this due date was a challenge for the city. However, stage 1a was finished in 2010. It comprises of the first trunk course from Bertrams through the city centre to Thokoza Park in Soweto, a few feeder courses in Soweto and around course in the internal city through Braamfontein and Joubert Park (Schmid & McKenzie, 2012).

Stage 1b: This stage was anticipated to be finished in January 2012, but because of various difficulties Phase 1b was finished in 2013. It comprises of 18km trunk course from Noordgesig through the University of Johannesburg to the downtown area. This stage will comprise an extra 650 buses and will cover 122 km's (Deng & Nelson, 2013)

Stage 1c. This includes the third trunk course amongst Parktown and Sandton, along Oxford and Rivonia streets (Gasennelwe, 2011). The finished Phase 1 of the

undertaking was intended to be finished in 2013 and involves 7 courses of 123 km and 150 stations (Suzuki, Cervero & Luchi, 2013). These courses are essentially overhauled by the local taxi Industry that was at first contrary to the *Rea Vaya*.

2.2.4 BRT Challenges

2.2.4.1 Challenges associated with the global introduction of the BRT

BRT has been eagerly installed in 147 cities spread over six landmasses. But as developing nations in Africa and Asia have pumped millions of dollars into new buses, re-engineered streets, and smart stacking stations, the outcomes have been baffling in cities like Cape Town, Modern Delhi, and Bangkok (Todes, 2012). As expressed by (Preston, 2012), the neighborhood authorities in these cities are finding significant resistance from drivers and private travel administrators, lower than anticipated ridership, and swelling costs that debilitate the long-term reasonability of their BRT programs

BRT offers some opportunities in terms of traffic management, faster boarding, integration of transit development with land use policy, and improved facilities and amenities. However, its challenges, according to (Mulenga, 2013), are as enormous as its benefits.

According to (Dawood & Mokonyama, 2015), the challenges facing BRT scheme in Lagos include poor road network, inadequate operational buses, ineffective bus maintenance, traffic congestion, inability to meet service demand, bad driving habit among drivers; hot and suffocating circumstances in the buses in the afternoon due to the prevailing tropical weather condition and lack of professional conduct among staff.

2.2.4.2 Challenges associated with the introduction of BRT in South Africa

Arrangements for the Bus Rapid Transit systems have comprised of exhaustive discussions with different taxi members within the taxi business (Todes, 2012). Municipal management has endeavored to include administrators from the taxi industry as accomplices in administrating the BRT as well as investors in the organization. Achievability considers demonstrated that inclusion in this manner would jeopardize their salaries and jobs through the removal of taxis on major roads (Gasennelwe, 2011). A few taxi affiliations went ahead board right off the bat, some were unaffected, asserting that the system would challenge their livings. Battling to the system prompted postponements in development yet pushed by the necessity set up an operational framework to help the 2009 Soccer Confederation Cup games, particularly the FIFA World Cup in June 2010, the district advanced with its designs (Hetherington, 2011). A few buses experienced attacks so involvement was essential by the former president Jacob Zuma to propel discussions (Hitge & Gqaji, 2011).

2.3 Discussion & Conclusions

This chapter has outlined various key aspects of public transportation and has provided an in-depth skeleton of the BRT system. Given the objective of the study, this discussion was largely cast in the context of BRT system.

There has been an ever-increasing urbanization and economic growth in urban areas which has brought challenges for transportation in many cities by accelerating the ownership of private cars. The quick increase of population has proven to be the result of unmet demands of transportation. Thus, the development of sustainable transportation has been a challenging reality for many cities. With an increasing number of challenges that the cities are facing, the quality of delivered transport service is also decreasing.

A huge step to making sustainable transport a reality is tackling the transport challenges and enhance regional, urban and rural mobility connections. South Africa has introduced a number of policy frameworks intended to effectively guide transport development such as NDP (2012), SPLUMA (2013) et cetera. The country needs to embrace lessons in terms of road-transport improvements and the implications thereof from other economies that have proven to be successful in this area.

South African transport policy is still fighting the increase of private car ownership, however even with the newly introduced mode of transport, it is still a battle that as per various transport specialist, it can be solved through the integration of transportation policy with development policies as well as integrating different modes of transport (Todes, 2012). The cities are however changing their mindset and the policies.

Apartheid planning affected the planning and delivery of the transportation. It is every cities goal to deliver public transport that is effective and cater for all citizens. BRT has been introduced as a high-quality bus-based transit system that will bring effectiveness in transportation through delivering transport that is affordable, fast, comfortable, safe, reliable, efficient service at metro level.

The introduction of the BRT worldwide has proven to be a solution to public transport challenges that the urban areas are experiencing. The framework brings various financial benefits, be that as it may, it as well brings various challenges for both public transport clients and non-users (Kishore, 2009). A portion of the challenges seen, are that indeed in spite of the fact that the framework plans to donate a capable transportation system whereas lessening traffic congestion within the city, thusly it has come about in higher levels of traffic blockage for private cars as well as taxis whom they share the same routes with. This is due to the introduction of dedicated lanes for BRT buses where other modes of transport are not permitted and thusly controlled road space available for distinctive users.

The nation needs to at this point be lauding the accomplishment of its venture on transportation. However, supporting the systems, especially the bus rapid transit

systems, is apparently being troublesome. Undoubtedly, high situating government specialists have communicated questions with respects to the way in which things are going.

Settling at that point must be concentrated on reducing costs and creating livelihoods. Operating costs have to be thus decreased as the system matures. In any case, to raise pay levels, BRT must turn out to be way better facilitated with housing and other transport benefits so that the subsystem has more amount and becomes sustainable. Particularly, the system must see into consolidating other modes of transport to extend the capacity. South African urban areas ought to receive sustainable planning as well as investments in order to urge this going.

CHAPTER 3 – DATA COLLECTION

3.1 Introduction

This section focuses on an outline of the methods utilized as part of the investigation. This section is organized around population sampling, research plan, information accumulation and information examination. Measures to give dependability and ethical considerations are likewise reflected.

As per Festinger and Katz, (1976) methodology alludes to methods for getting, organizing as well as analyzing information. Methodology adoptions depend on the impression of the study question. It can be supposed to be the philosophy of correct systematic choices (Karfman as referred to in Maxwell, 1961).

The fundamental focal point of this examination is the investigation and portrayal of the encounters of the *Rea Vaya* and *A Re Yeng* users as far as its effectiveness, in this way the research approach is qualitative.

This section portrays and explains the determination of the qualitative technique for information gathering as it is most fitting for this investigation. In this research, descriptive statements can be made about the subject based on observation, interviews or evaluation (Gopal, 1964). Also, Hillway (1964), highlights the fact that qualitative research focuses on real-life experiences (Festinger & Katz, 1976). The qualitative study comes with a benefit of supporting the way in which participants carry on in their normal situation by portraying the regular setting and what they feel and think about it (Good & Douglas, 1954). Qualitative data is not structured compared with quantitative data also the methods are utilized to pick up knowledge into the view of members (Maxwell, 1961).

The research comparatively assessed the effectiveness of BRT systems of Johannesburg and Tshwane metropolitan cities. The study specifically sought to identify the impacts, status quo, and benefits of this newly introduced fast-growing system, as well as its integration to other modes of transports. In view, thereof the study elaborated on the importance of integration in planning, transportation integration as well as integration in policy as an enhanced approach to the effectiveness of BRT in these cities. Detailed elaborations are provided on effectiveness and approaches in measuring effectiveness. The study further provided detailed benefits of transport effectiveness, specifically of BRT system.

3.2 Motivation for the Adoption of the Qualitative Research Design

The qualitative research design is regarded the most suitable for this research, as the researchers examine phenomena in their regular surroundings, in order to understand as well as translate societal marvels, for example, thoughts, insights, cooperation and behavior (Hillway, 1964). Most investigators who go for a qualitative research design do as such in view of the adaptability and advancing nature of qualitative research

(Festinger & Katz, 1976). Qualitative research additionally empowers investigators to dive underneath the surface and reveal the inward most encounters of members (Maxwell, 1961).

This investigation is undertaken using qualitative research strategies to accumulate data on the encounters, beliefs as well as the views of the BRT users and to reach conclusion with respect to how this has impacted the utilization of the bus rapid transit framework in both Johannesburg and Tshwane. Given that this investigation won't concentrate on estimation and quantifying numerical information, the qualitative research strategy is regarded most proper compared with quantitative research technique. Regardless of the way that the qualitative strategy is most suitable it has impediments (Maxwell, 1961). A few specialists contend that the qualitative researcher has a tendency to be one-sided and may lead the participants amid the research procedure (Festinger & Katz, 1976). To gather information, it is important to recognize inquiries about research site.

3.3 Gaining Access to Research Sites

BRT Johannesburg and Tshwane are regulated and overseen by the respective metropolitan municipalities (City of Tshwane Metropolitan Municipality in Tshwane, and City of Johannesburg Metropolitan Municipality in Johannesburg). The management department for *Rea Vaya* is arranged at the Johannesburg Roads Agency office block in the downtown area of Johannesburg. With a specific end goal to acquire consent to lead the investigation inside the stations, it was important to send through a formal letter from the respective department in University, where the researcher is enlisted to clarify the motivation behind the visits to the BRT stations.

In Tshwane, the management department of the Tshwane Rapid Transit are bus administrators and taxi administrators, on courses serviced by private transports (taxis and buses), recognized as Affected Operators, through shareholding proportional to their market share (Pourbaix, 2011). Tshwane Rapid Transit is operated as an autonomous business element. A corporate governance structure has been built up as an interim arrangement for the day by day activities of Tshwane Rapid Transit until assignment to the Affected Operators (McHugh, 2013). It has its own autonomous panel, administration group as well as a team. Its objective is to give people in general administrations that are agreeably productive and monetarily feasible for the advantage of the Affected Operators. The operation of the organization depends on a refreshment stand concurrence with the City of Tshwane, and it is represented by ordinary working methods composed by the City (Waldeck & Van Heerden, 2017). The City of Tshwane is in charge of expense gathering, the checking of administrations, and for following TRT's execution. The *A Re Yeng* buses are claimed and overseen by the organization.

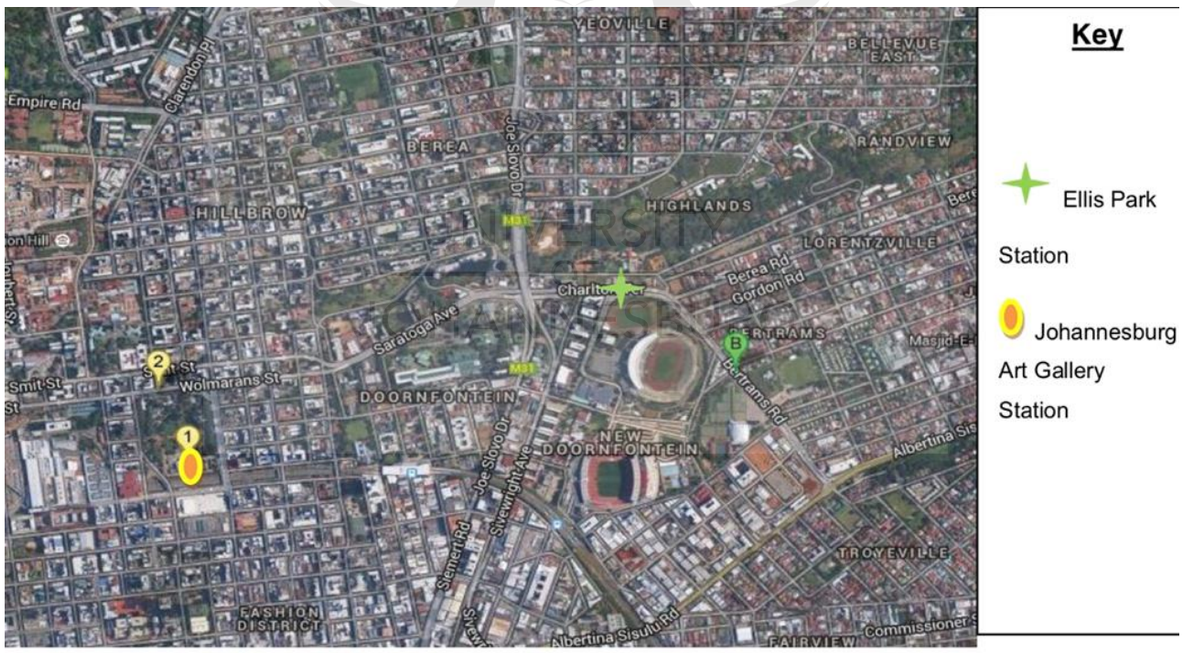
A research site is the setting where occasions or exercises happen and a socially characterized region with moving limitations (Hillway, 1964). It is important to interview

the members that use *Rea Vaya* and *A Re Yeng* at the respective stations to be able to get information about the encounters of the bus transit users.

Johannesburg Art Gallery Station to Fashion Square Northbound station and Ellis Park Station to Old Synagogue Station West are the chosen routes in Johannesburg for this study. Rationale on choosing these routes is that they are full of activity within the Doornfontein and Braamfontein ranges. These stations get a high volume of commuters' day by day. What's more is that Johannesburg Art Gallery station frames some portion of the C3 route, which is a complementary service(c). This is where travelers would exchange starting with one bus then onto the next that would take them to their desired destination. The information which is gathered from members at this station will give data on the encounters of travelers who utilize the system to travel around the city. Ellis Park Station is picked in light of the fact that it services the T1 (Trunk course), this route transports individuals from Thokoza Park to Ellis Park. The route is additionally situated in an area of student accommodations around the University of Johannesburg campus in Doornfontein. Consequently, members who were questioned, incorporated students.

The map of the research sites appears below:

Rea Vaya Stations

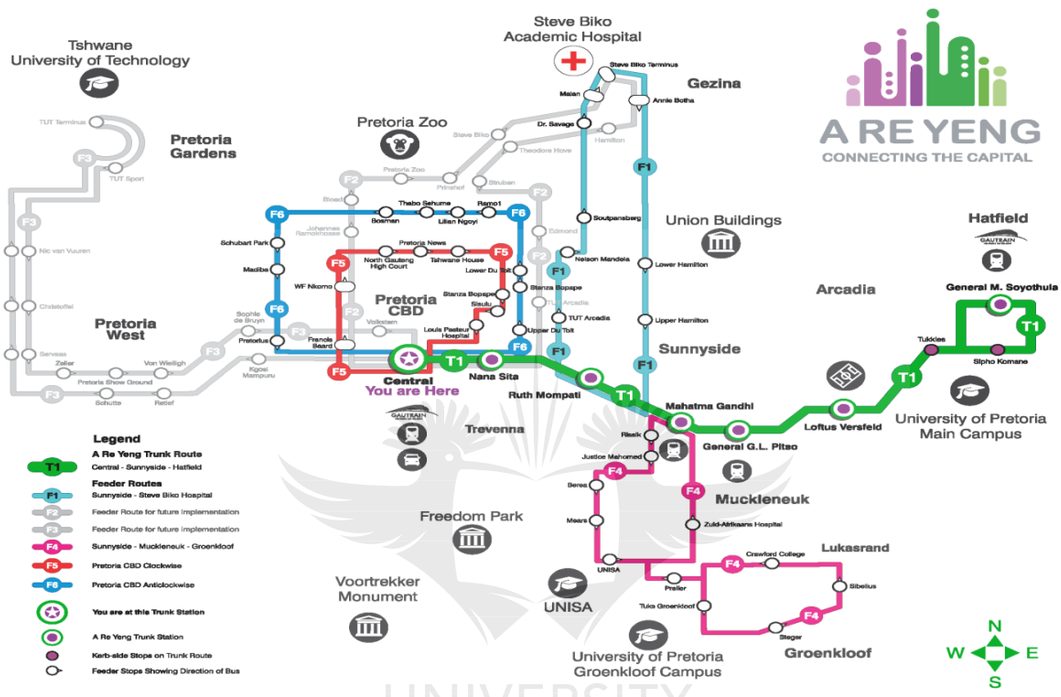


Map 11: Rea Vaya BRT Stations
Source: (City of Johannesburg 2018)

The above-mentioned research sites, Johannesburg Art Gallery and Ellis Park station are part of Phase 1 A of the *Rea Vaya* System, in 2009. In Tshwane, the chosen Tshwane Rapid Transit stations are Mahatma Gandhi Station to TUKS Groenkloof bus stop and Hector Pieterson station to Molefe Makinta Station. The rationale behind choosing this route as the study area is that Sunnyside consists mostly of high-density residential developments, which in the 21st century ranges from reasonably upmarket to run-down.

Hector Pieterson station (in Pretoria North) to Molefe Makinta Station (in Pretoria central) is one of the routes chosen for the purpose of this research. The rationale behind choosing this station is because of its good location. The Hector Pieterson station is adjacent to the Wonderboom Rail Station, therefore catering for bus, taxi and rail interchange. This route connects the Tshwane CDB to Pretoria North through Paul Kruger Street. This route is a trunk route and has been designed to cater for two *A Re Yeng* loading bays (standard or articulated buses) and 20 minibus taxi bays.

A Re Yeng bus routes, stations and bus stops



Map 12: A Re Yeng BRT
Source: (City of Tshwane, 2018)

3.4 Sampling design

A sample of 200 individuals was used in this study. The reason being that a huge sample measure is more representative of the populace, an adequately large sample size is likewise important to deliver outcomes among factors that are altogether unique. Participants were chosen from travelers to represent the diverse partners, taxi managers, BRT managers, and Town Planners. Simple random sampling was used where individuals were chosen entirely by chance and each member of the population had an equal chance to be chosen within these stations. Stratified sampling was used to divide participants into separate groups and ensure that subgroups of the participants are adequately represented within the whole sample population of the study. The reasons for the study was clearly explained to willing participants and only willing participants were interviewed.

As said before a sample of 200 individuals was asked to take part in the research with 100 members from each city. Although it can't be guaranteed that 200 members were

going to be representative of the considerable number of commuters who use and are affected by the *Rea Vaya* and *A Re Yeng*, this sample gave a sign of the encounters as well as opinions of the bus transit users. The main principles used for choosing individuals from the Taxi Managers is because they belong to Taxi Associations that work in Johannesburg and Tshwane as they are straightforwardly influenced by the Bus Rapid Transit framework. Town Planners are considered because they play a vital role in the transport planning department and the fact that developmental planning is moving toward integrating transport planning into development planning.

3.5 Data Collection Procedures and Processes

An advantage of utilizing primary data is that experts are collecting information for the specific motivations behind their examination. Fundamentally, the questions that the analysts ask are redone to bring out the data that will assist them with their examination Researchers assemble the data themselves, using surveys, interviews as well as observations.

Data was gathered utilizing as a part of profundity up close and personal meetings and a qualitative overview. Data was collected from the 26th of November 2018 to the 10th of December 2018 at the selected *A Re Yeng* and *Rea Vaya* stations.

The BRT users who took an interest in the survey, who later were alluded to as participants, were approached at the selected stations and asked to take part in the survey. The reason for this investigation and also the moral thought was disclosed to every member. A qualitative approach was used to gain an understanding of underlying reasons, opinions, and motivations from the participants.

This study uses a qualitative approach which enables the researchers to interview participants in a brief timeframe. Interviews were led with participants between the time where they hold up to exchange between transports or as they enter and leave the stations.

Closed-ended questions were used which works for the little interims that the buses have as these questions required a particular reaction, either yes or no (Bailey, 1938). Even though closed-ended questions allow for a speedy reaction and make it less demanding for the researcher to match the reactions of the different members, closed-ended can bring about vital information on the feelings and beliefs of members being interviewed (Good & Douglas, 1954). Along these lines, it was important to incorporate open-ended questions in this investigation. Favorable position of open-ended questions is that participants are given the chance to clarify their reactions, it likewise "grants innovativeness, self- expression, and extravagance of detail" (Gopal, 1964). Questions that were chosen for this review are founded on the primary research questions.

Secondary data refers to data accumulated by another person and not the researcher (Good & Douglas, 1954). Fundamental sources of secondary data for human science fuse censuses, data accumulated by government bodies, authoritative archives and

data which was originally collected for different research objectives. Primary data, by contrast, are collected by the agent driving the investigation.

Secondary data investigation saves time consumed collecting data and can provide excellent as well as good-quality records that would be impracticable for any person to accumulate on their own (Bailey, 1938). Additionally, investigators of monetary and social change contemplate secondary data basic, as it is hard to lead a new examination that can attractively get past changes as well as progressions.

Good documentation in the investigation of secondary qualitative information is good for scientists as it offers the basic foundation and setting and also allows duplication (Gopal, 1964). A sensible favored benefit of utilizing secondary data is that an awesome portion of the basics essential has quite been accomplished, such as contextual analyses or literature review. Secondary data, by and large, have a pre-established level of legality as well as reliability which needs not be rethought by the analyst re-using such information. Secondary data can give a baseline for primary research to compare the composed principal information outcomes to and it can similarly be advantageous in research design.

Desktop research involves studying previous documents, records, and articles on the subject topic. A number of previous documents on the subject topic were visited thoroughly to confirm and update on the development of BRT and the use of *Rea Vaya* and *A Re Yeng* by different commuters.

The research necessitated the conduct of the interviews with regards to the BRT framework and as a result, the chosen bus stations were visited to conduct interviews and observe the operation of the system so as to provide constructive description. The research also involved the use of GIS tool, specifically the ArcGIS tool in order to map the cities current transport routes, taxi routes within the cities, the BRT routes of the initial stages, the current status quo as well as the chosen case study routes. The ArcGIS tool also assisted in mapping the integration interchanges within the cities.

3.6 Data Analysis Procedures

Raw data gotten from the study through interviews with *A Re Yeng* and *Rea Vaya* users was organized and recorded in two groups, in particular members from Johannesburg and Tshwane. "Data analysis means a search for patterns in data" (Good & Douglas, 1954). The transcribed data were examined using content investigation strategy (Festinger & Katz, 1976). Content analysis is suitable for "describing and translating written products of general public or social group**"** (Maxwell, 1961). Raw data passes through three phases specifically open coding, axial coding and selective coding (Bailey, 1938). It’s critical to build up a particular kind of framework to characterize or examine the information. Gopal (1964) highlights that lacking order results in disorder. Collected data was dealt with and pro,cessed through these phases. Open coding was the primary phase and is talked about next.

Open Coding is a procedure of breaking down the literary substance. It incorporates classification ideas, characterizing as well as creating groups in light of their measures and properties. This method is utilized to break down qualitative data.

3.6.1 Open Coding

Open Coding is the main go through for raw information (Hillway, 1964). As per Johnson (1951) "Codes are labels or tags for assigning units of meaning to the descriptive or inferential information" (Maxwell, 1961). At this phase, labels are allocated to remarks and thoughts of participants. Initial labels are allocated to ideas that rise and some of them are improved at an advanced stage. "Open coding conveys subjects to the surface from somewhere inside the information" (Bailey, 1938). This method is done until the point when all the raw information is marked.

3.6.2 Axial Coding

The second phase of thematic analysis is Axial Coding. Preparatory labels are reconsidered at this phase and important rectifications made, from that point categories are grouped to form themes (Festinger & Katz, 1976). As themes rose just the most essential topics are recorded (Johnson, 1951). With a specific end goal to process the data, files are opened in IBM SPSS Statistics for each of the distinctive partners, as the arrangements of labels are accessed, they are exchanged to each file. Bunching of the labels distinguished themes that were presented in the literature. Association causes as well as results amongst distinctive classes are made at this phase. When the list of themes that are recognized in axial coding is finished the last go through the data which is selective coding is finished.

3.6.3 Selective Coding

Selective coding is the last go through the effectively arranged data where the most unmistakable classifications are chosen (Maxwell, 1961). This progression incorporates checking thoroughly the data again and making correlations and differences. When this is finished classes are consolidated and themes that are comparative are ordered under main themes (Bailey, 1938). Primary themes are featured in different colors in the IBM SPSS Statistics file that is made. Because of the capacity of data gathered, it is vital for the data to be manufactured and just the most suitable data is exhibited in the study (Festinger & Katz, 1976). Topics are summarized to form main themes, for example, Infrastructure, commuter satisfaction, and money related ramifications, are a portion of the significant topics that were recognized. Any qualitative study of this nature needs confirming.

The final stage is Transfer final concepts and categories into a data table.

3.7 Statistical methods used

Correlation works for measureable information where numbers have a meaning. Correlation is a numerical strategy that shows how sets of factors are connected. In this

study, for examples, distance and price are connected; long distance travels charge high fare price whereas local distance travels have low fare prices.

Rating scales are one of the methods used in this study. The numbers in rating scales have meaning, but that meaning isn't exceptionally exact. They are not like amounts. With an amount (for example money), the difference between R10 and R20 is precisely the same as between R20 and R30. However, this isn't truly the case with a rating scale. In this study, for example, rating scales of 1-Poor, 2-Moderate, 3-Good, and 4-Excellent are used.

Content analysis- this technique assisted in understanding the whole subjects that emerge in qualitative data, it allowed for analyzing of textual data to discovery the most common threads. Narrative analysis- the data collected involved different perceptions from various respondents. This analysis focused on how stories and ideas were communicated throughout the interviews. It involved interpreting how the respondents felt about the Bus Rapid Transit system, how they perceived this framework, and how they viewed its functioning processes. This was useful when considering the changes with the system from when it introduced to its current operating status.

3.8 Variables used for comparative analysis

Interval variables were used in this study for data collection. The interval variables are similar to an ordinal variable, but the intervals between the values are equally spaced. The units of measurement are equal throughout the full range of the scale. In this research the interval variable used was time e.g. 5-10minutes, 10-15 minutes, 15-20 minutes.

Categorical or nominal variables which are have no order. In this study data was classified into categories with no particular order. Examples of categorical variables in this study are gender, marital status, race, etc.

Ratio scales are comparable to interval scales, in that equal differences between scale values have equal quantitative meaning. Nonetheless, ratio scales have a true zero point, for example distance and money.

Data analysis

The analysis of data in this study was done through the use of the SPSS statistics software for statistical analysis. It is a "Statistical Package for the Social Sciences" launched in 1968 and it's formally known as IBM SPSS Statistics (Arkkelin, 2014). This software was used for editing and analyisng the structured data such as plain files and relational database which was ordered into file formats.

The data values were added on a data view sheet and the variables were reflected on the second sheet where the information about the meaning of the variables and the data values were shown. This software allowed for a compilation of descriptive statistics, parametric and non-parametric analyses and graphical representations of the results.

The software included the following statistics (Arkkelin, 2014):

- Descriptive statistics: Frequencies, Descriptives, Explore, Descriptive Ratio Statistics
- Bivariate statistics: Means, Correlation and Nonparametric tests, Bayesian
- Prediction for numerical outcomes: Linear regression
- Prediction for identifying groups: Factor analysis, cluster analysis (two-step, K-means, hierarchical), Discriminant
- Geo spatial analysis, simulation
- R extension (GUI), Python

3.9 Results and Findings

After analyzing and categorizing data, the results were then presented in statistics and frequency tables, and graphs with the use of IBM SPSS Statistics to analyze numbers on the research in order to finalize the graphs.

Data in this study was also presented in a Likert scale which is a scale that employs questionnaires, used to represent respondents' attitude towards the BRT system. The Likert scale used a statistical method of rating scales where the numbers have meaning, but that meaning isn't exceptionally exact. For example, 1-Not Important, 2-Somewhat Important, 3- Important, 4- Very Important.

Data was presented in graphs which include the presentation of data by utilizing graphical symbols, for example, bars, lines, spots, pie cuts and so forth. A diagram represents numerical information as a qualitative structure and gives imperative data.

CHAPTER 4: DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

In this chapter, findings are presented from the investigation concerning the experiences of the passenger and different associates with respect to the BRT in Johannesburg and Tshwane. The findings in this section range from interviews with commuters who use the BRT, Town and Regional planners from the respective municipalities, BRT managers, as well as the Taxi owners. The meetings were conducted in the morning during peak, during lunch hour and also in the evenings from the 26th of November 2018 to the 10th of December 2018. Participants were divided equally between the City of Johannesburg Metropolitan Municipality and the City of Tshwane Metropolitan Municipality. They were required to answer inquiries identified with the *Rea Vaya* and *A Re Yeng* (see Appendix A questionnaires). They were referred to as participants and the real expressions of the reactions are used as a part of reporting the findings.

Section 1: Demographic information

This section highlights on the demographic information of the participants who participated in the interviews that were held between the 26th of November 2018 and the 10th of December 2018. The breakdown of the demographics is as follows.

Table 2: Demographic Statistics

Demographic Statistics					
		Gender	Age group	Race	Education
N	Valid	192	192	192	192
	Missing	0	0	0	0

Source: Khumalo (2018)

Table 3: Demographic frequencies

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Gender	192	1	2	1.44	.498
Age group	192	1	3	1.66	.748
Education	192	1	5	4.01	1.123
Race	192	1	3	1.56	.770
Valid N (listwise)	192				

Source: Khumalo (2018)

Table 4: Age group statistics

Age group					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-35	97	50.5	50.5	50.5
	36-55	63	32.8	32.8	83.3
	>55	32	16.7	16.7	100.0
	Total	192	100.0	100.0	

Source: Khumalo (2018)

Table 5: Race statistics

Race					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	black	117	60.9	60.9	60.9
	coloured	42	21.9	21.9	82.8
	Indian/ Asian	33	17.2	17.2	100.0
	Total	192	100.0	100.0	

Source: Khumalo (2018)

Table 6: Gender statistics

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Females	107	55.7	55.7	55.7
	Males	85	44.3	44.3	100.0
	Total	192	100.0	100.0	

Source: Khumalo (2018)

The study was dominated by a female gender at 56% and the male gender at 44%.

Table 7: Education statistics

Education					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No schooling	7	3.6	3.6	3.6
	primary	13	6.8	6.8	10.4
	secondary	39	20.3	20.3	30.7
	grade 12	46	24.0	24.0	54.7
	graduation	87	45.3	45.3	100.0
	Total	192	100.0	100.0	

Source: Khumalo (2018)

The above tables give a clear demographic analysis of the participants. Dominating age group were participants aged between 18-35 years by 51%, and the race that dominated was the black race (61%) followed by Coloureds (22%) and Indian/Asians (17%). Majority of the participants were local residents in these cities, followed by residents from another locality, and only a few of them were visiting.

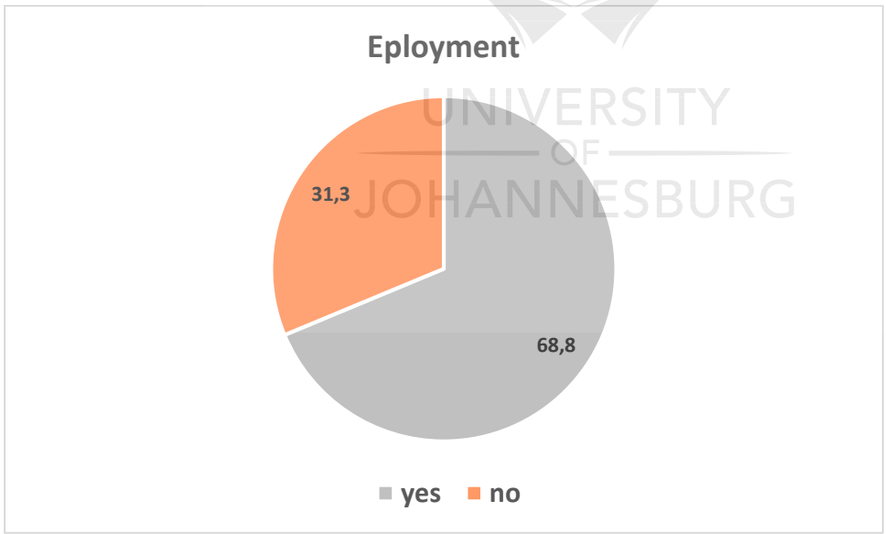


Figure 5: Employment
Source: Khumalo (2018)

In this study, only 69% of the participants were employed and the other 31% highlighted that they don't have employment. The following table shows the income distribution of the participants who are employed.

Table 8: Income statistics

Income in Rands					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<3000	24	12.5	18.2	18.2
	3000<5000	17	8.9	12.9	31.1
	5000<7000	26	13.5	19.7	50.8
	7000<10000	52	27.1	39.4	90.2
	>10000	13	6.8	9.8	100.0
	Total	132	68.8	100.0	
Missing	System	60	31.3		
Total		192	100.0		

Source: Khumalo (2018)

In this study, 69% of the participants were employed with only 18% earning less than R3000, 13% earning R3000<R5000, 20% earning R5000<R7000, 39% earning R7000<R10 000, and only 10% earning more than R10 000.

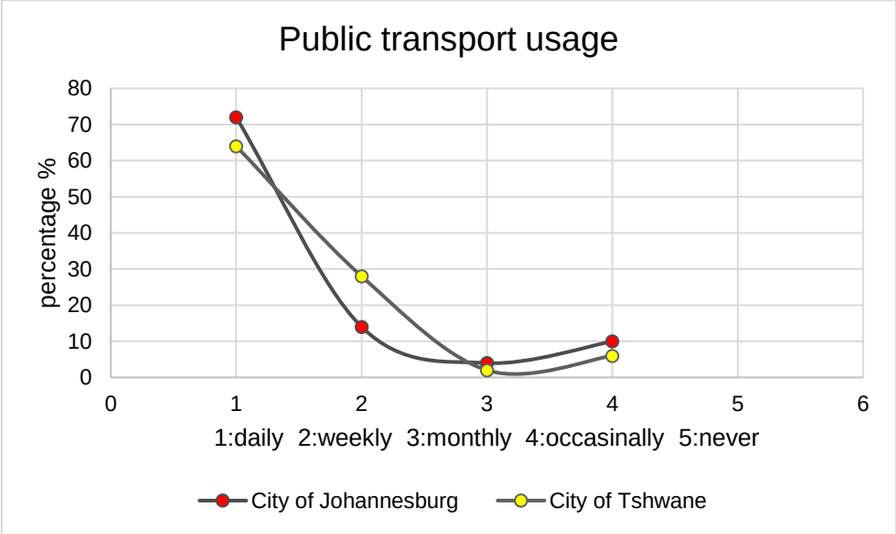
Section 2: BRT Status Quo in Johannesburg and Tshwane

The first group of participants who were interviewed are the commuters. This section focuses on the status quo of both the *Rea Vaya* and the *A Re Yeng* bus system. They were interviewed with respect to the BRT system and achieving its objective of addressing the needs of the communities. Participants were divided equally from both cities and the majority of them were living in the townships and surrounding suburbs. These participants commuted from their places in which they reside to access work, school and other personal activities.

Data was analysed and grouped into themes and the topics were then assembled to shape more extensive themes. Subjects that were most clear in the reactions of the participants are presented below.

On the inquiry, “how often do you use public transport on an average?” 72% of the participants from Johannesburg and 64% from Tshwane said they use public transport daily. COT had 28% and COJ had 14% of participants who use public transport weekly. Participants felt that public transport gives them different modes of transport to rely on. The below table and diagram show a clear distribution of participants in the usage of public transport from both cities.

Figure 6: Public transport usage



Source: Khumalo (2018)

Provided below are descriptive statistics of the use of public transport in both cities

Table 9: Public transport usage statistics

Public Transport Usage COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	daily	69	35.9	71.9	71.9
	weekly	13	6.8	13.5	85.4
	monthly	4	2.1	4.2	89.6
	occasionally	10	5.2	10.4	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		
Public Transport Usage COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	daily	61	31.6	63.5	63.5
	weekly	27	14.0	28.1	91.7
	monthly	2	1.0	2.1	93.8
	occasionally	6	3.1	6.3	100.0
	Total	96	49.7	100.0	
Missing	System	97	50.3		
Total		193	100.0		

Source: Khumalo (2018)

- **Type of transport available where you live**

There are numerous modes of transport available at disposal of humans to meet their ever-growing need for a specialized and most economic mode. It becomes important to choose the most suitable mode of transport looking at a number of factors (accessibility, cost, carbon emission, capacity, integration with other modes, reliability, comfort, safety, and frequency). All these factors are critical in making the final decision, some of them are not considered subject on personal preferences.

Previous research has proven that taxis are the most used mode of transport in general. Majority of the participants (69%) from both cities said that taxis are a mode of transport that is highly available and accessible where they live due to the fact that they don't have a specific stop and they are a well-known and used mode of transport in the townships. Other participants (24%) of the participants said that the BRT is easily accessible where they live, while (7%) had a train and metro bus as their highly used mode of transport. About 65% of these commuters' commute from home to their places of work and 30% commute to school and only 5% highlighted had personal business as their main purpose of the journey.

Table 10: Type of transport used statistics

Type Of Transport					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	taxi	132	68.8	68.8	68.8
	train	5	2.6	2.6	71.4
	metro bus	9	4.7	4.7	76.0
	BRT	46	24.0	24.0	100.0
	Total	192	100.0	100.0	

Source: Khumalo (2018)

- **The frequency of the BRT**

Freedom with public transport is about frequency. A mode with a higher frequency is desirable as the waiting time reduces thus saving time. Modes with good frequency help especially in cases of delays. 44.8% from COJ and 36.5% from COT felt that the BRT system is frequent in their area. The infrequency of the system seems to remain high in both cities, COT having 63.5% of participants who felt that the system was not frequent in their area, and COJ having 55.2%. Infrequency also has an impact on the time that commuters decide on to catch their transport. Increasing frequency and accessibility may be the best investment we can make to get people out of their cars. Descriptive statistics are provided below:

Table 11: Frequency of BRT

Descriptive Statistics			
	N	Mean	Std. Deviation
Frequency Of BRT COJ	96	1.55	.500
Frequency Of BRT COT	96	1.64	.484
Valid N (listwise)	96		

Source: Khumalo (2018)

Table 12: Frequency of BRT COT statistics

Frequency Of BRT COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	35	18.2	36.5	36.5
	no	61	31.8	63.5	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Table 13: Frequency of BRT COJ statistics

Frequency Of BRT COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	43	22.4	44.8	44.8
	no	53	27.6	55.2	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

The result show that majority of the participants catch the BRT between 8am-9am both in COJ (47,9%) and COT (40,6%). The least percentage is of the participants who use the BRT between 2pm-3pm. Presented below are descriptive statistics of the time of the day the participants catch the BRT together with illustrative diagram.

Table 14: Time in catching the bus

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Time In Catching The Bus COJ	96	1	5	2.23	1.341
Time In Catching The Bus COT	96	1	5	2.23	1.201
Valid N (listwise)	96				

Source: Khumalo (2018)

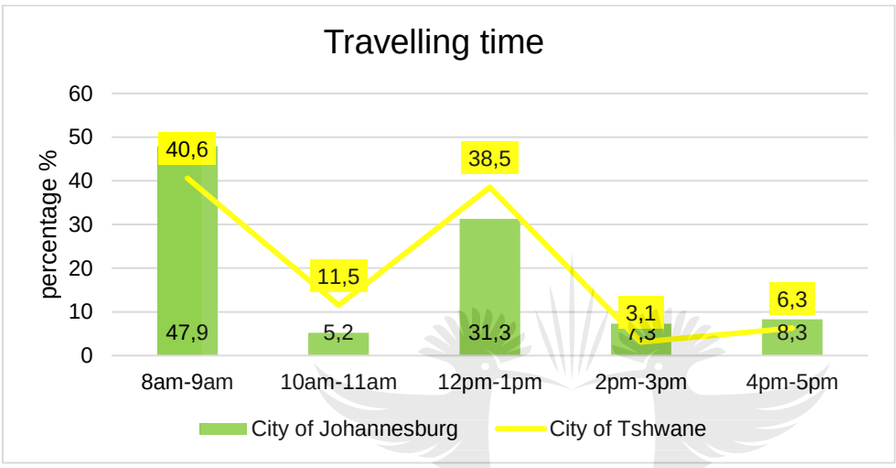


Figure 7: Travelling time
Source: Khumalo (2018)

Table 15: Travelling time- statistics

Travelling time- COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	8am-9am	46	24.0	47.9	47.9
	10am-11am	5	2.6	5.2	53.1
	12pm-1pm	30	15.6	31.3	84.4
	2pm-3pm	7	3.6	7.3	91.7
	4pm-5pm	8	4.2	8.3	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Travelling time- COT				
	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	8am-9am	39	20.3	40.6	40.6
	10am-11am	11	5.7	11.5	52.1
	12pm-1pm	37	19.3	38.5	90.6
	2pm-3pm	3	1.6	3.1	93.8
	4pm-5pm	6	3.1	6.3	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

- **The time it takes to catch BRT buses**

The BRT system aims to provide a transport system that is accessible within a 500m range. Accessibility of the buses can be affected by the time it takes commuters to reach the bus stations and bus stops. The longer it takes can result to bus commuters opting for a mode of transport that is accessible in less than 10 minutes.

Table 16: Time it takes to catch the bus

Time It Takes To Catch The Bus COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5-10minutes	25	13.0	26.0	26.0
	10-15 minutes	44	22.9	45.8	71.9
	16-20minutes	17	8.9	17.7	89.6
	20-30minutes	8	4.2	8.3	97.9
	30-45minutes	2	1.0	2.1	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Time It Takes To Catch The Bus COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5-10minutes	31	16.1	32.3	32.3

	10-15minutes	36	18.8	37.5	69.8
	16-20minutes	13	6.8	13.5	83.3
	20-30minutes	11	5.7	11.5	94.8
	30-45minutes	5	2.6	5.2	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

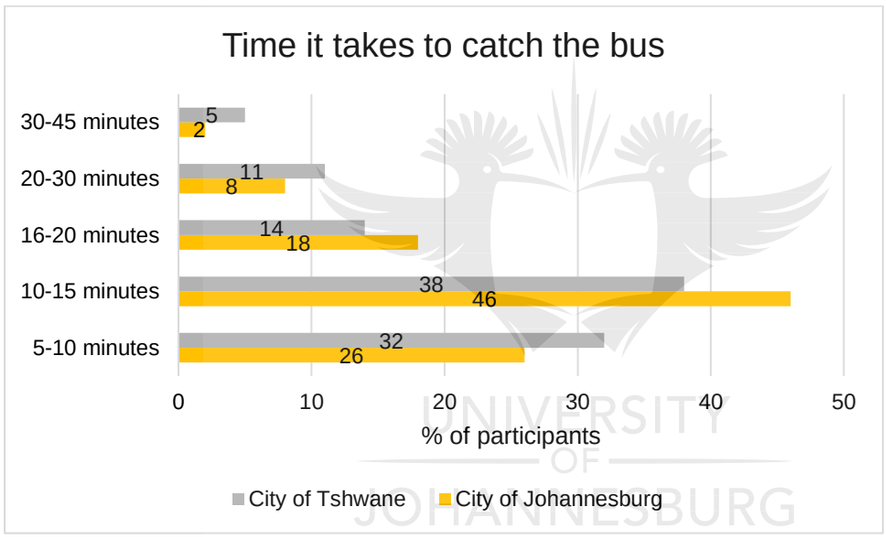


Figure 8: Time it takes to catch the bus
Source: Khumalo (2018)

City of Johannesburg has 46% of the commuters who catch the *Rea Vaya* system in 10-15 minutes, and a 38% of commuters from the City of Tshwane catch the A Re Yeng system in 10-15 minutes. A percentage of less than 10% from both cities said that they catch the bus in 30-45 minutes. Individual who catch the bus in 5-10 minutes are 26% from the City of Johannesburg and 32% from the City of Tshwane.

- **Important characteristics of BRT service**

Table 17: Important Characteristics of BRT service

(1-Not Important, 2- Somewhat Important, 3- Important, 4- Very Important)								
	COJ				**COT**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Service from home to work			**5**	**91**		**8**	**11**	**79**
Flexibility			**14**	**82**		**10**	**3**	**83**
Evening service	**14**	**27**	**23**	**32**	**11**	**3**	**46**	**36**
Late-night service	**43**	**23**	**12**	**18**	**61**		**23**	**12**
Weekend service	**2**	**8**	**39**	**47**		**7**	**21**	**68**
Wheelchair accessible			**9**	**87**			**17**	**79**
Very few stops	**23**	**18**	**14**	**41**	**9**	**49**	**15**	**23**
Clear fare structure			**8**	**88**			**5**	**91**

Source: Khumalo (2018)

The top 3 characteristics that were ranked very important by the COJ and COT commuters are service from home to work, flexibility, wheelchair accessible and clear fare structure.

- **Transport finance on BRT**

Table 18: Transport Finance on BRT

Transport finance on BRT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	increased	11	5.7	5.7	5.7
	remained the same	73	38.0	38.0	43.8
	decreased	108	56.3	56.3	100.0
	Total	192	100.0	100.0	

Source: Khumalo (2018)

Minibus taxis are by far the cheapest and most popular form of public transport in South Africa, used mainly by the urban and rural poor. A majority of commuters were using Taxis before the introduction of BRT while others used Trains which they found was cheaper. From responses received it was evident that participants found the BRT to be affordable as majority (56,3%) of them felt that their transport finances have deceased since the introduction of the BRT system; however, there were a few (5,7%) who were not satisfied with the increase in fare prices.

The following tables are a clear breakdown of the increase in BRT fare prices in both cities.

***Rea Vaya* fares from 1 July 2018 to 30 June 2019**

Table 19: Rea Vaya transport fare prices

Rea Vaya Journey	**2017/2018**	**2018/2019**	**Fares went up by**
0-5km	R7.00	R7.50	R 0.50
5.1-10km	R8.50	R9.00	R 0.50
10.1-15km	R10.50	R11.00	R 0.50
15.1-25km	R12.50	R13.00	R 0.50
25.1-35km	R13.50	R14.00	R 0.50
More than 35km	R14.50	R15.00	R 0.50
Single trip card	R15.00	R15.00	R 0.50
Penalty fee	R14.50	R15.00	R 0.50

Source: www.reavaya.org.za (accessed 9 December 2018)

***A Re Yeng* fares from 1 July 2018 to 30 June 2019**

Table 20: A Re Yeng transport fare prices

Distance range covered (KM)	**2017/2018**	**2018/2019**	**Fares went up by**
0 - 3	R7.00	R7.00	R1
3 - 8	R8.00	R8.00	R1
8 - 14	R10.00	R11.00	R1
14 - 21	R12.00	R13.00	R1
21 - 29	R14.00	R15.00	R1
29 - 38	R16.00	R17.00	R1

38 - 48	R18.00	R19.00	R1
48 - 59	R20.00	R21.00	R1
59 - 71	R22	R23.00	R1

Source: www.tshwane.gov.za (accessed 9 December 2018)

- **A major problem faced by BRT**

The most highlighted challenge that BRT is facing was traffic causing delays which could be avoided if taxis and private cars abstained from utilising the devoted BRT lanes. BRT has responded to the high fare complaints raised by the commuters by making the trips fare cheaper. The *Rea Vaya* fares have increased by R0.50 whereas the *A Re Yeng* fares increased by R1.00.

In both cities, the bus stations were found to be attractive. Upon observation, it has been found that there are daily cleaning and mopping of the stations with designated waste bins inside the stations. Participants pointed out that "There is more space, you are free". A member remarked that "This framework is superior to anything other transport; it goes ahead time, perfect and agreeable, pleasant stations". These stations have adequate resource and capacity and are also well equipped with modern technology and eco-friendly this was confirmed upon observation during the conduction of the interviews.

Section 3: Reliability

Reliability assumes a critical part in drawing in new consumers and in keeping the old purchasers (Bechstein, 2010). There are various factors with respect to reliability that should be viewed as, for example, climate, traffic, and equipment failure. These components could impact the dependability of a transport framework by upsetting the functionality of the framework, which thusly could impact the way that clients see the framework (Bickford, 2014). Opinions assume a noteworthy part in the decision's commuters make concerning the method of transport they use. Kane (2010) clarifies that if commuters have a tendency of picking a transport framework that is reliable, nonetheless if the transport frameworks neglect to address their issue, they would change to a substitute mode. Public transport is perceived as unreliable and unsafe; be that as it may, the BRT system intends to change this perception.

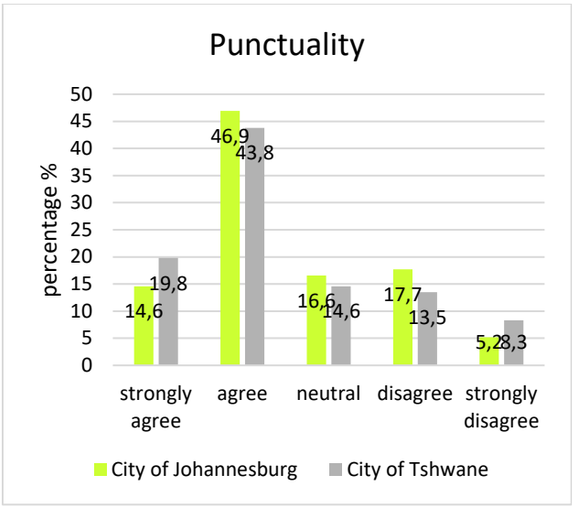


Figure 9: Bus punctuality
Source: Khumalo (2018)

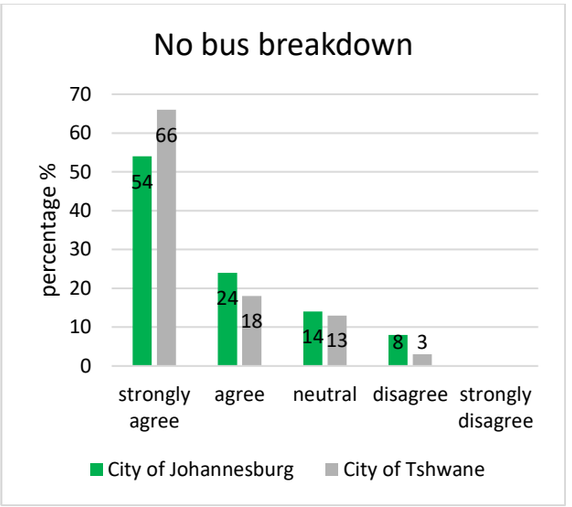


Figure 10: No bus breakdowns
Source: Khumalo (2018)

The following tables provide descriptive statistics of punctuality as per the participants.

Table 21: Bus punctuality

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Bus is punctual COJ	96	1	5	2.52	1.105
Bus is punctual COT	96	1	5	2.47	1.196
Valid N (listwise)	96				

Source: Khumalo (2018)

Table 22: Bus punctuality statistics

Bus is punctual COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	14	7.3	14.6	14.6
	agree	45	23.4	46.9	61.5
	neutral	15	7.8	15.6	77.1
	disagree	17	8.9	17.7	94.8
	strongly disagree	5	2.6	5.2	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Bus is punctual COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	19	9.9	19.8	19.8
	agree	42	21.9	43.8	63.5
	neutral	14	7.3	14.6	78.1
	disagree	13	6.8	13.5	91.7
	strongly disagree	8	4.2	8.3	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Participants found the bus system to be dependable and punctual, in any case, there were a couple of participants stated otherwise that the buses did not arrive on time as expressed on the screen, and this issue was affirmed while leading the interviews. The screen demonstrated a 3-minute postponement before the entry of the following bus; be that as it may, when the three minutes had slipped by the bus had still not arrived. The monitor naturally changed to the following entry time. This resulted in a delay for commuters.

A positive angle that adds to reliability is that the BRT buses don't "breakdown". The reason for this could be that the framework is still genuinely new and along these lines, buses are effectively maintained. Compared with different methods of transport, for example, the taxis, commuters trust that the BRT is more solid since there are no episodes to intrude on the smooth running of the system. From the above diagrams, 84% of the participants from Tshwane and 78% from Johannesburg agreed to the system having no breakdowns during working hours. Only 8% from Johannesburg and 3% from Tshwane felt that the system does have breakdowns at some point.

- **Access to tickets and timetables**

Access to tickets and timetables if crucial in ensuring that commuters are able to move from one place to another efficiently. Accessible timetables provide commuters with updated bus schedules and destinations which includes various bus stops and stations. Tickets allow commuters to travel more than one trip without reloading their transport fees on their tickets. As a result, this provides safety in transport costs for the commuters, thus easy access to tickets is crucial. The below diagram provides a clear comparison of access to tickets and timetables between *Rea Vay* and *A Re Yeng.*

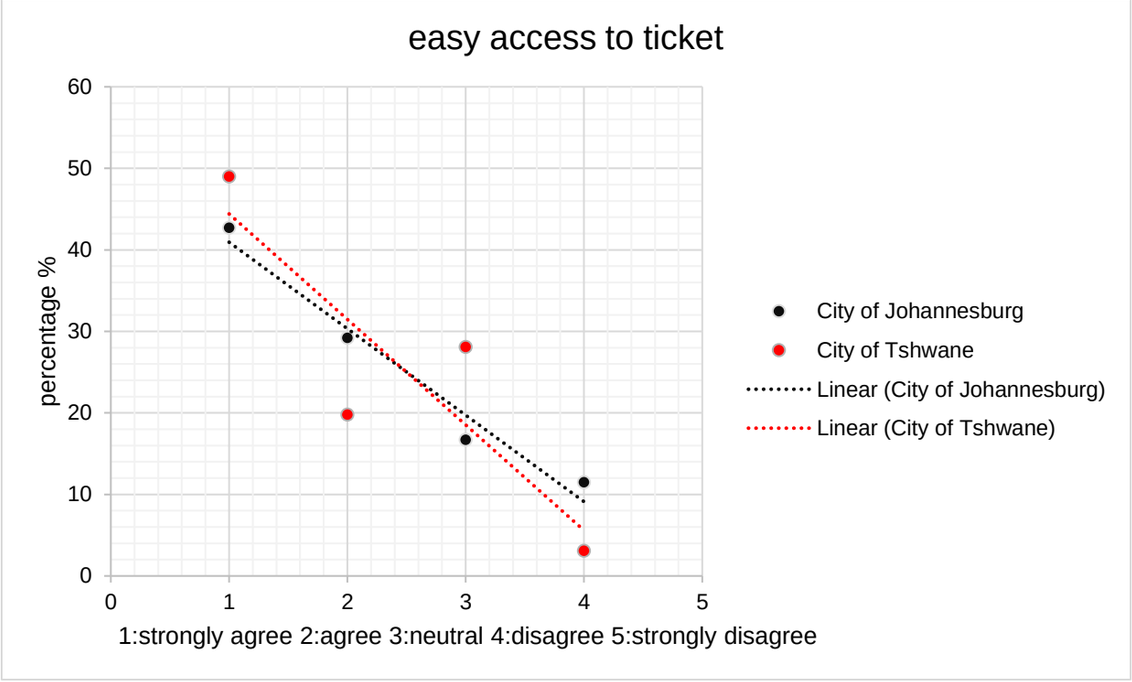


Figure 11: Easy access to tickets
Source: Khumalo (2018)

As per the above diagram, access to tickets and timetables in *Rea Vaya* overshadows access to tickets and timetables in *A Re Yeng*. A total of 71,9% participants from COJ agreed to having easy access and a total of 68,8% participants from COT agreed to having access as well.

Table 23: Easy access to tickets COJ

Easy access to tickets COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	41	21.4	42.7	42.7
	agree	28	14.6	29.2	71.9
	neutral	16	8.3	16.7	88.5
	disagree	11	5.7	11.5	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Table 24: Easy access to tickets COT

Easy access to tickets COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	47	24.5	49.0	49.0
	agree	19	9.9	19.8	68.8
	neutral	27	14.1	28.1	96.9
	disagree	3	1.6	3.1	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Another subject that rose up was the error-free timetables at the BRT stations. The below response proves that the presentation of the timetables in the stations is easy to read with updated information. Only 8% from the COJ and 3% from COT disagreed with the fact that the timetables are provided with no errors at the bus stations.

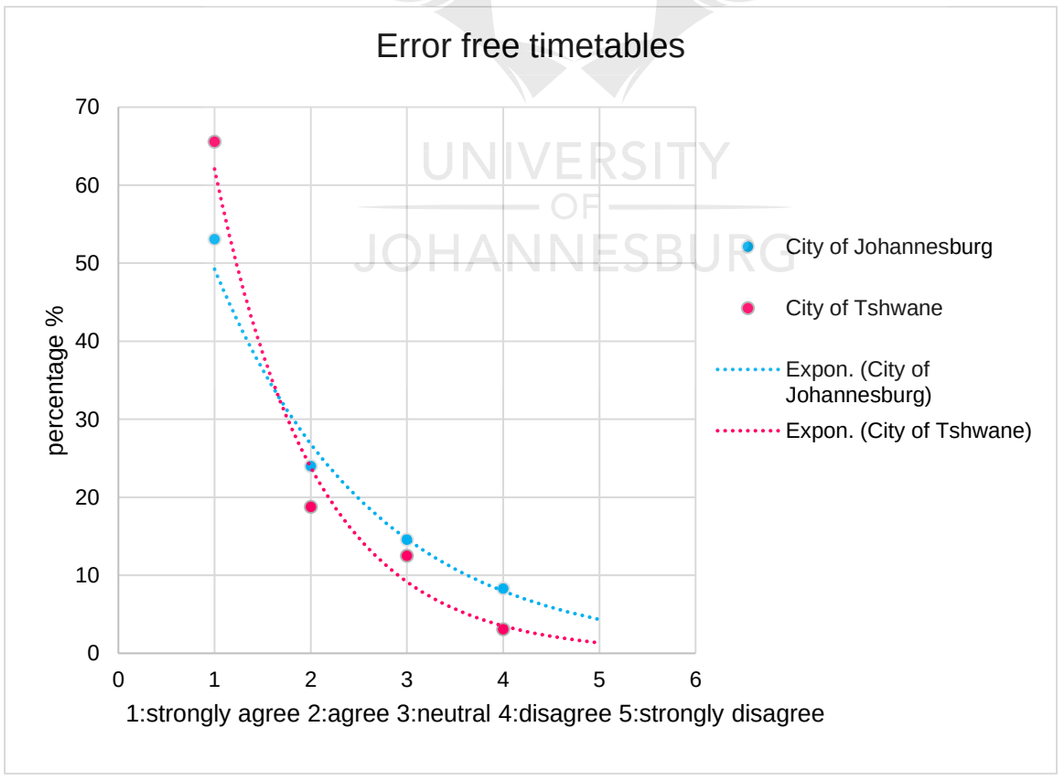


Figure 12: Error free timetables
Source: Khumalo (2018)

The following tables provide descriptive statistics from both cities on the issue of error free timetables.

Table 25: Error free timetables

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Error free timetables COJ	96	1	4	1.78	.986
Error free timetables COT	96	1	4	1.53	.833
Valid N (listwise)	96				

Source: Khumalo (2018)

Table 26: Error free timetables statistics

Error free timetables COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	51	26.6	53.1	53.1
	agree	23	12.0	24.0	77.1
	neutral	14	7.3	14.6	91.7
	disagree	8	4.2	8.3	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Error free timetables COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	63	32.8	65.6	65.6
	agree	18	9.4	18.8	84.4
	neutral	12	6.3	12.5	96.9
	disagree	3	1.6	3.1	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

- **Satisfactory of customer requests**

The relevant and meaningful messages shared with the customers shape the quality of experience that the customers receive. It is important that customers' requests are delivered in the right way and delivered on time. The quantity that the mode of transport attracts is also influenced by the level of customer experiences that the staff gives. The willingness and availability of a staff member to attend to customers request and provide meaningful information is key to successful customer engagement and can result to improved transport services. In conducting the interviews, participants felt that the staff satisfy customers' requests right the first time. Provided below are descriptive statistics on satisfactory of customer requests by staff member.

Table 27: Satisfactory of customer requests by staff

		Satisfactory of customer requests by staff COJ	**Satisfactory of customer requests by staff COT**
N	Valid	96	96
	Missing	96	96
Std. Deviation		.796	1.207
Minimum		1	1
Maximum		4	5

Satisfactory of customer requests by staff COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	16	8.3	16.7	16.7
	agree	39	20.3	40.6	57.3
	neutral	37	19.3	38.5	95.8
	disagree	4	2.1	4.2	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Table 28: Satisfactory of customer request by staff COT

Satisfactory of customer requests by staff COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	33	17.2	34.4	34.4

	agree	27	14.1	28.1	62.5
	neutral	19	9.9	19.8	82.3
	disagree	12	6.3	12.5	94.8
	strongly disagree	5	2.6	5.2	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Section 4- Responsiveness

The adapting of demand fluctuation is a critical challenge in dynamic transport planning. A reliable request satisfaction must be given even if the number of demands increases over the anticipated demand and asset scarceness appear.

Participants (70.3%) found the system responsive based on a fact that BRT always informs people of change of timetable and prices in advance and are accessible from their websites (www.reavaya.org.za, www.tshwane.gov.za). From the above sections, it has been confirmed that the system provides timely and efficient service to its commuters. The below diagram confirms a total percentage of 70.3 participants who agree to that the system is timely and efficient.

Effective communication is vital in making the success of any business. Majority of the participants (75%) from both cities acknowledged clear and helpful communication by staff when they are in need of help and clarity. All in all, BRT customer service was rated "good" by 83% of the participants. Presented below are descriptive statistics on the responsiveness of the system.

Table 29: Descriptive statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
BRT informs people of change in timetables and price	192	1	5	1.95	1.057
Timely and efficient service	192	1	4	1.97	.926
Clear and helpful communication by staff	192	1	5	1.89	1.089
BRT customer service	192	2	4	2.97	.415
Valid N (listwise)	192				

Source: Khumalo (2018)

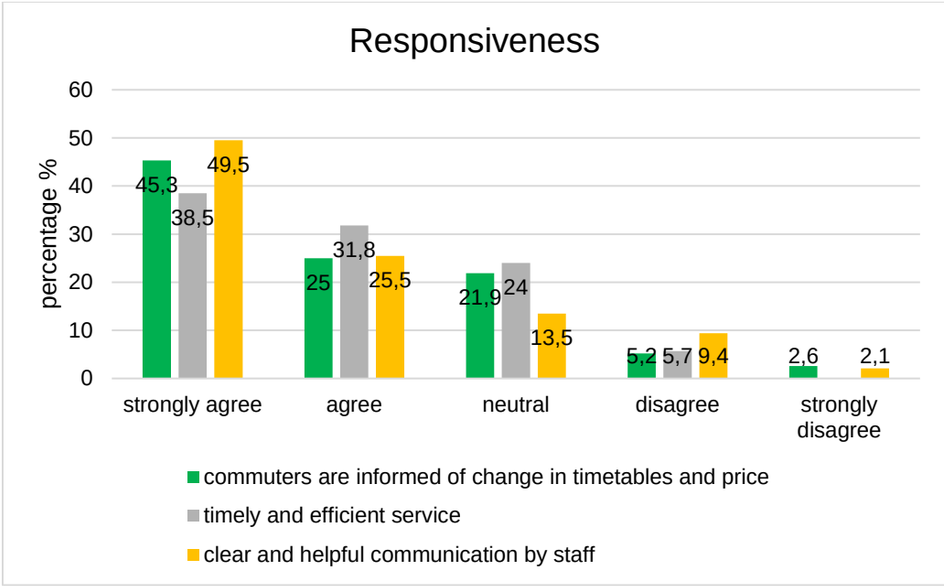


Figure 13: Responsiveness of the system
Source: Khumalo (2018)

Table 30: BRT customer service

BRT customer service					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	moderate	19	9.9	9.9	9.9
	good	159	82.8	82.8	92.7
	excellent	14	7.3	7.3	100.0
	Total	192	100.0	100.0	

Source: Khumalo (2018)

Section 5: BRT Safety and security

Safety and security are essential aspects of transportation concerned with the protection of life and property through regulation, management, and technology development of all forms of transportation. Participants believed that BRT staff members have good manners and they show respect for other people. However, a few participants stated otherwise which might be an experience on a personal level. The staff has accuracy in understanding information related to their job.

Table 31: Descriptive statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Polite staff COJ	96	1	5	2.64	1.400
Polite staff COT	96	1	5	2.44	1.304
Safety in transactions with staff COJ	96	1	5	1.55	1.065

Safety in transactions with staff COT	96	1	5	1.68	1.138
Valid N (listwise)	96				

Source: Khumalo (2018)

Table 32: Polite staff statistics COJ

Polite staff COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	29	15.1	30.2	30.2
	agree	18	9.4	18.8	49.0
	neutral	20	10.4	20.8	69.8
	disagree	17	8.9	17.7	87.5
	strongly disagree	12	6.3	12.5	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Table 33: Polite staff statistics COT

Polite staff COT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	33	17.2	34.4	34.4
	agree	21	10.9	21.9	56.3
	neutral	12	6.3	12.5	68.8
	disagree	27	14.1	28.1	96.9
	strongly disagree	3	1.6	3.1	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

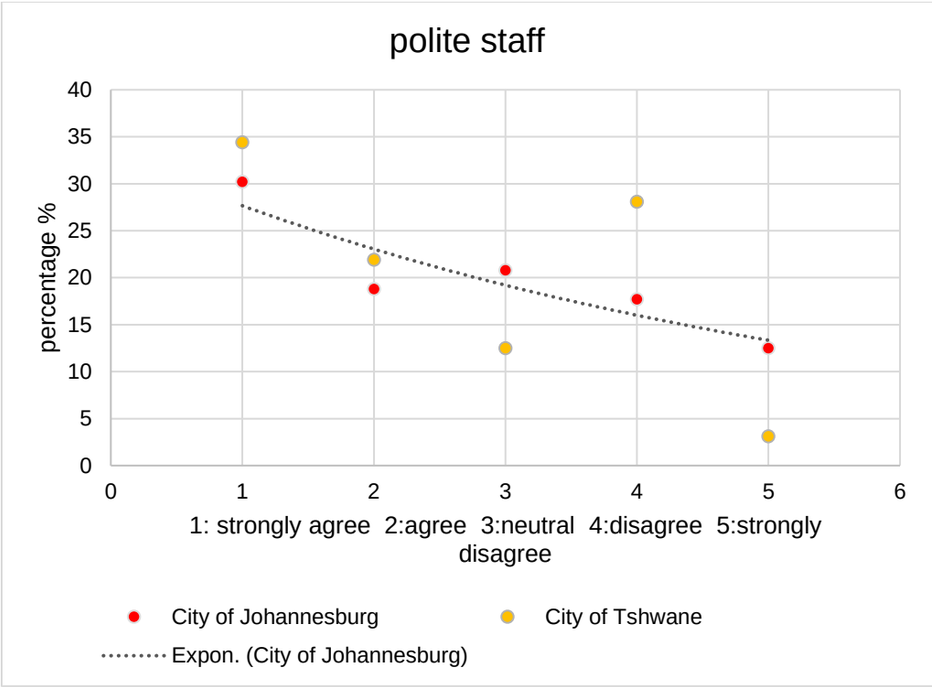


Figure 14: Polite staff members
Source: Khumalo (2018)

Majority of the participants (74% COJ and 66,7% COT) strongly agree that they are safe during their transactions with the staff members at the BRT stations. Below are diagrams and descriptive statistics on the safety of the commuters.

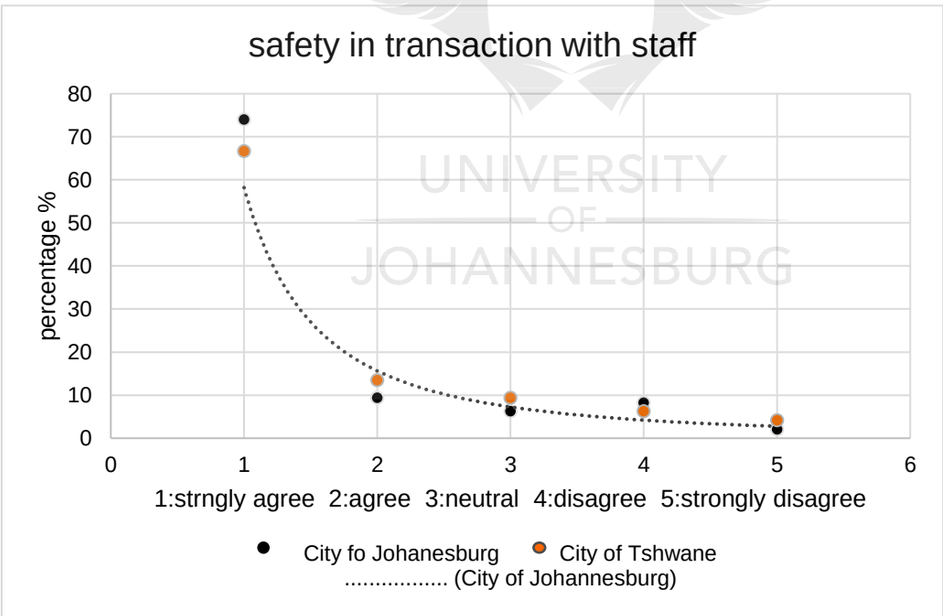


Figure 15: Safety in transaction with staff
Source: Khumalo (2018)

Table 34: Safety in transaction with staff statistics

Safety in transactions with staff COJ					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	71	37.0	74.0	74.0

	agree	9	4.7	9.4	83.3
	neutral	6	3.1	6.3	89.6
	disagree	8	4.2	8.3	97.9
	strongly disagree	2	1.0	2.1	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Safety in transactions with staff COT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	64	33.3	66.7	66.7
	agree	13	6.8	13.5	80.2
	neutral	9	4.7	9.4	89.6
	disagree	6	3.1	6.3	95.8
	strongly disagree	4	2.1	4.2	100.0
	Total	96	50.0	100.0	
Missing	System	96	50.0		
Total		192	100.0		

Source: Khumalo (2018)

Section 6: Integration

Modes of transport ought to operate as one 'seamless' entity - for the good of the paying client. Private transport more often than not gives 'door to door' transport and while usually not continuously a practical possibility for public transport the concept of 'transport integration' is to supply a 'seamless' journey that's as 'door to door' as conceivable.

The following diagrams are a response from the question “Does BRT have connections to other modes of transport?” and “Do you use more than one mode of transport when commuting from home to work/school?”.

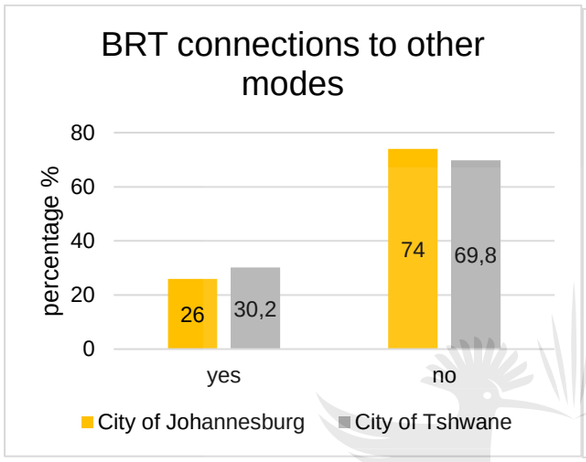
Table 35: Descriptive statistics integration

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
BRT connected to	96	1	2	1.74	.441

other modes COJ					
BRT connected to other modes COT	96	1	2	1.70	.462
Using more than one mode COJ	96	1	2	1.14	.344
Using more than one mode COT	96	1	2	1.05	.223
Valid N (listwise)	96				

Source: Khumalo (2018)



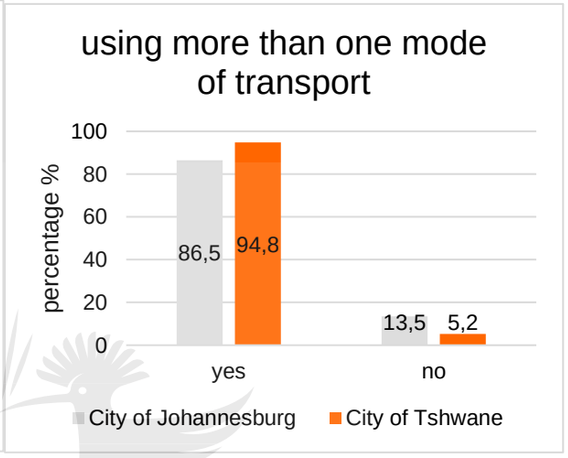


Figure 16: BRT connections with other modes

Figure 17: Using more than one mode of transport

Source: Khumalo (2018)

The BRT system implementation is not equally spread throughout the cities and as a result (confirmed upon observation), individuals also rely on other modes of transport to access the BRT and to also reach other places where the buses are not servicing. Participants believe that BRT does not have connections to other modes in a sense that there is no integration of fare prices, and that BRT is operating solely even though other modes act as feeders and vise verse, there is still no actual integration in paperwork. About 95% from COT and 86% from COJ are using more than one mode of transport. Places that are not serviced by BRT are serviced by taxis, metro bus, and trains. Taxis have been a backbone of transport for townships and they are accessible at anytime and anywhere.

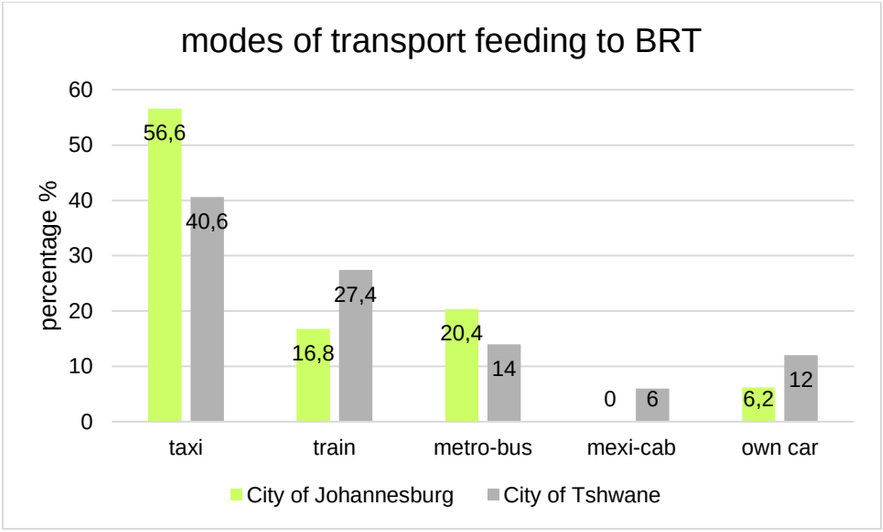
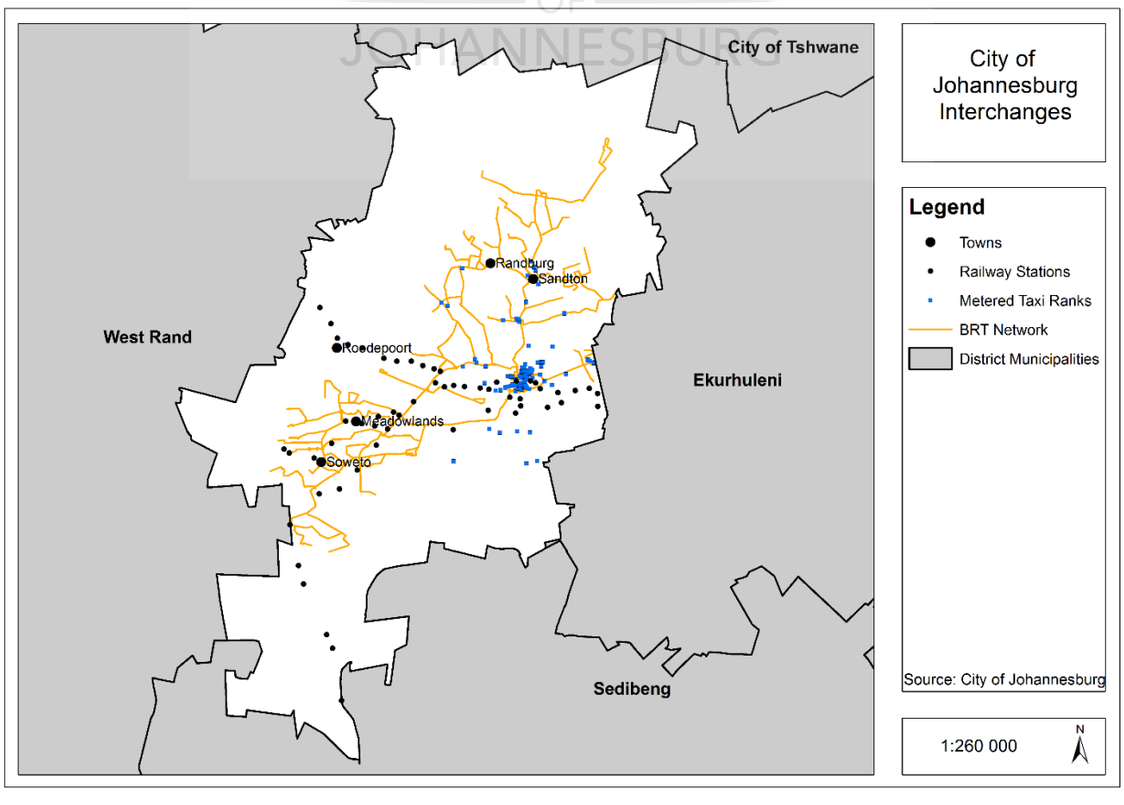


Figure 18: Modes of transport feeding to BRT
Source: Khumalo (2018)

The above presentation stresses the necessity of the integration and equal spread of the BRT system in the cities. The BRT system without feeders will not be as effective. This can be observed from the high percentage of commuters that the taxis and trains still hold even after the introduction of the system. Taxis and trains have remained the core transport system that is accessible and cheap to the townships. A participant said that trains also transport a large number of BRT users but due to the fact that it can only be accessible at the stations most people then prefer taxis to access BRT. Taxis feed the most to BRT. About 13% from COJ and 5% from COT of the participants using BRT are the participants who do not use more than one mode of transport as they reside within a 500m range from the BRT stations and therefore have BRT as their primary means of transport.



Map 13: Transport interchanges

- **Impact of using more than one mode**

Perpetually budgetary suggestions play a key part within the lives of a community. Therefore, the cost of commuting with the BRT buses comes beneath examination. The response received demonstrate that the BRT is affordable; however, a participant highlighted that having to take a taxi to get to work from the city and be able to access BRT is quite costing. BRT does not reach all the places around the city, commuters still have to use other modes to commute to their desired locations which they find costing at times.

Other participants stated that it is time-consuming for them and has affected their arrival time at work due to the fact that they have to wait longer in changing from one mode to another. Other participants highlighted that sometimes they leave their belongings when they change transport.

Section 7.1: Additional questions (Interviews)

Ten participants were selected for this section. Participants felt that the BRT system is looking after their best interest. The system has delivered a high quality, customer-oriented transport system, highlights made by one of the participants. Participants were pleased with the BRT operating hours and mentioned that it accommodates everyone, and it is safe to travel even during late hours. Bus intervals were a concern that arose during the interview where two of the participants felt that 15 minutes is a long time to wait for the next bus during off-peak hours.

Access to bus stations is a crucial issue and only three of the participants found that it was not easy for them to easily access the BRT bus stops or stations. This is because they rely on other modes of transport to access BRT and at times it becomes time-consuming. A participant mentioned that their bus stops have very clear and well-detailed bus timetables, provided with the BRT routes connecting to that specific bus stop. However, a few of them stated otherwise, that not all bus stops have timetables. The BRT marketing system is well updated. This was confirmed from their websites. As per the participants, bus schedules and ticket price information are accessible from the bus stations, internet and call centre.

What ranked the most excellent from the BRT bus service was the cleanliness followed by the frequency of the system which ranked good. Frequent transport is a transport that passengers can rely on and therefore reliability of the buses was also ranked excellent by the commuters. Few passengers felt the system has moderate fare prices and the majority felt it is an affordable mode of transport.

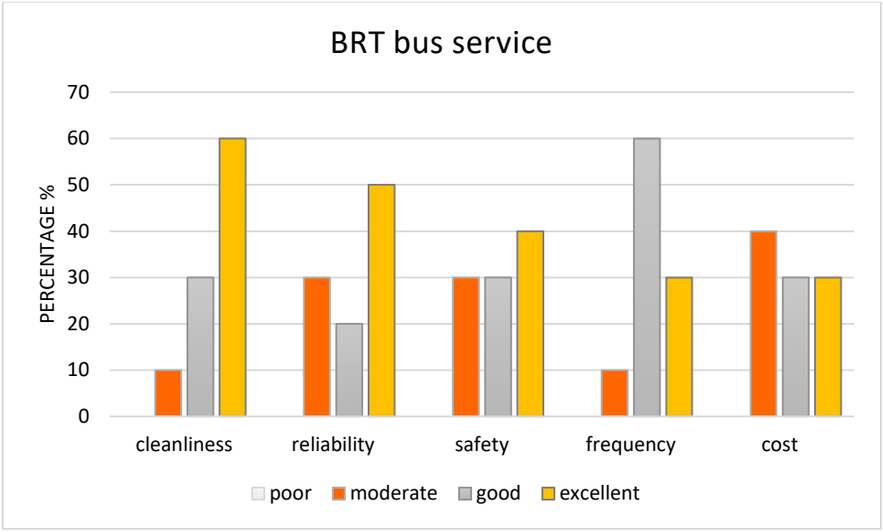


Figure 19: BRT bus service
Source: Khumalo (2018)

Participants also suggested changes for improving services in BRT. One participant highlighted that "they should find a way to lower their prices and provide more buses on a shorter time period". Another participant suggested on "lowered station platforms and pre-payment of tickets. Improvement of public space and sidewalks around the BRT and bus terminals". Reduction in BRT fare price was the most suggested improvement as another participant stated that "they should decrease their prices". There were participants who were happy with the system and had no improvement suggestions to provide.

Section 7.2: Stakeholders BRT Management

For the purpose of this study, BRT managers were interviewed being a part of the City of Johannesburg Region and the City of Tshwane Region Mr. Benny Makgoga, Director: Service Promotions from COJ and Mr. Piet Mahlangu, Deputy Chairman Tshwane Rapit Transit from COT were met to supply insight into the *Rea Vaya* and *A Re Yeng* projects in these cities. The discoveries radiating from the interviews are presented below.

Mr. Makgoga - City of Johannesburg Metropolitan Municipality

- **Access to BRT**

Access and change in the face of transport in the city are one of the main aims of the implementation of the *Rea Vaya*. In the initial development of *Rea Vaya*, the service was mainly meant for poor communities where the bus service is currently fully operating in the city. As per Mr. Makgoga, implemented in stages, the system's Phase 1A and 1B have been successfully completed, with *Rea Vaya* and the Department of Transport now working closely together to kick off Phase 1C. This phase is meant to connect Alexandra, Sandton, Randburg, Greenstone, Ivory Park, Rabie Ridge, Sandton, Randburg and Midrand with the inner city.

Figure 20: (Alexandra-on site picture: 01 December 2018)
Source: Khumalo (2018)

The city has moved towards the advancement of an integrated transport system which was reported by the Minister of Transport in June 2013. This system would connect the diverse modes of transport, making travelling more effective.

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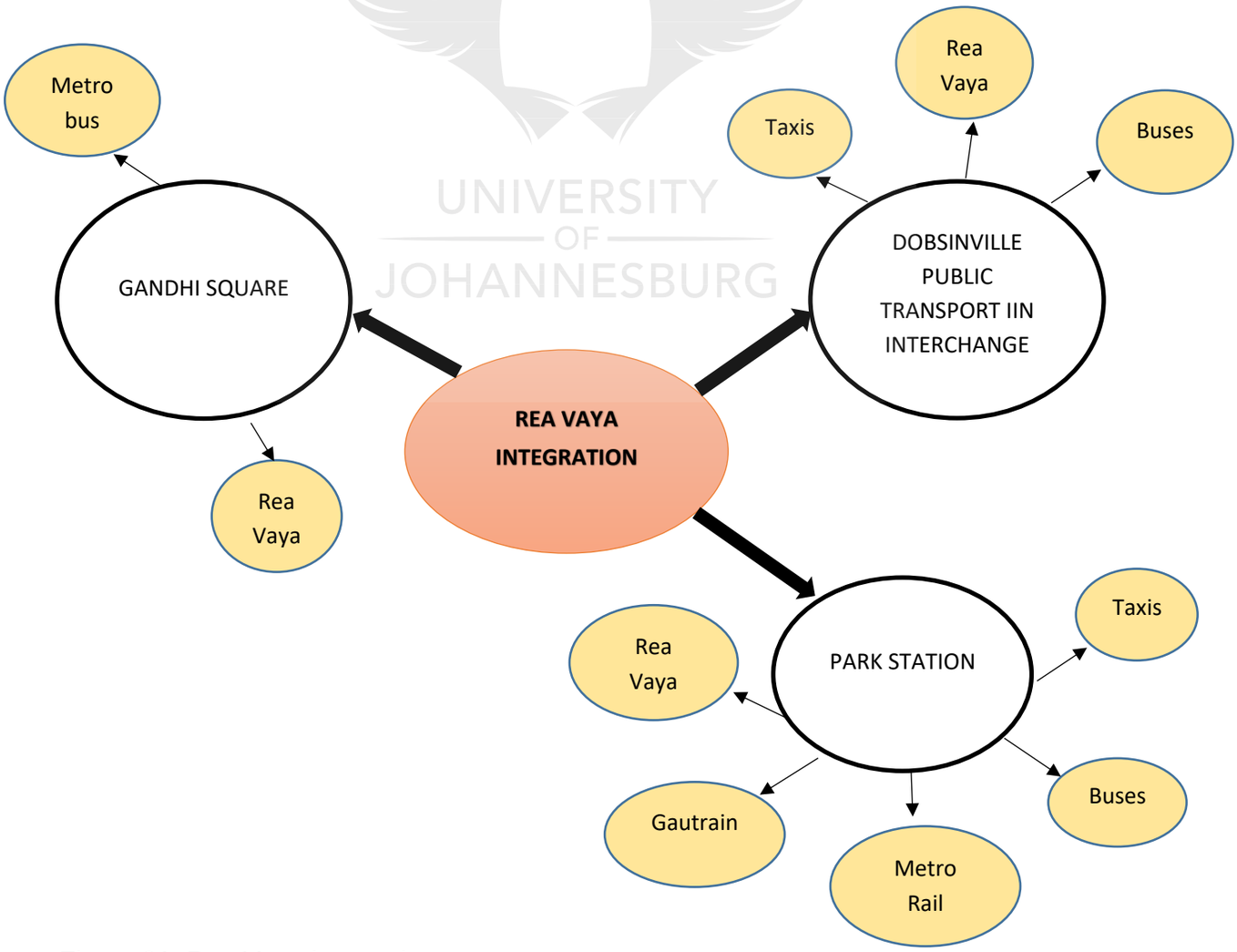


Figure 21: Rea Vaya integrations
Source: Khumalo (2018)

The *Rea Vaya* system has a Park Station West station where *Rea Vaya* is connecting to Gautrain as well as Metro Rail. The system is also connected to the taxis which includes both long-distance taxis in Wanderers and a short distance in Noord. There are also private buses which travel long distances such as Eastern Cape.

In Soweto, there's a public transport interchange where *Rea Vaya* connects with other modes of transports like taxis. In Gandhi Square where there's an interchange of metro buses and taxis, there's also a Library Gardens *Rea Vaya* stations where commuters from metro buses connect with the *Rea Vaya* from Gandhi Square. These interchanges are an important element for a sustainable transport system, which could have a major influence on attracting people to the BRT system. Different modes of transport are accessible at these interchanges and they provide a quick, secure and easy switch of modes without causing time delays.

- **Plans on integrating different modes**

Makgoga highlights that *Rea Vaya* and the Department of Transport is now working closely together to kick off Phase 1C in the eastern side of Johannesburg. *Rea Vaya* will be rolled out in the city's northeast quadrant – from the inner city to Alexandra, Sandton, Randburg, Greenstone, Ivory Park, Rabie Ridge, Sandton, Randburg and Midrand (Rea Vaya, 2014).

"The Marlboro *Rea Vaya* bus and pedestrian bridge are complete. It is for exclusive use by *Rea Vaya* buses and pedestrians. It launched in September-October 2017" said Makgoga.

Rea Vaya buses will have selected use of the bridge when the Rea Vaya Phase 1C(a) processes begin. The bridge allows for buses to move quickly from Johannesburg CBD by means of Wynberg and Alexandra over the M1 to Sandton CBD. The Rea Vaya Phase 1C framework will too include 30.5km of broad walking and cycling paths in Alexandra, progressed sidewalks along Louis Botha Road, and devoted cycle and walking ways from Alexandra to Sandton over a notorious bridge (Rea Vaya, 2014).

Furthermore, a modern integrated transport plan consolidating the *Rea Vaya* Bus Rapid Transit system, Metrobus, and the minibus taxis travel systems will make it simpler for commuters to access the public transport framework.

- **Provision of easy access to the city**

In terms of providing easy access to the city, the introduction of new *Rea Vaya* routes to the residents of the City of Johannesburg is a way of ensuring access to the city. Mr. Makgoga states that "The rollout of phase 1A and 1B has created accessibility to the city for the commuters who are living 500m along the routes. The introduction of phase 1C is also aiming at ensuring access to the city. In areas where *Rea Vaya* is not servicing, the city is also using Metro buses that act as a feeder to *Rea Vaya* as they

are more on the remote areas. The areas where *Rea Vaya* cannot introduce a new route, there is Metro bus."

- **Social and economic development**

The planning of *Rea Vaya* in terms of route system has been planned in such a way that it has been successful. Mr. Makgoga highlights that socially, looking at accessibility, the routing system has been planned to allow access to the health (Baragwanath hospital, Helen Joseph hospital, Rahima Moosa hospital and Hilpark Hospital), recreational (sport facilities Jobert park) and institutional (primary schools and high schools; University of Johannesburg and Wits, all campuses) facilities of the City of Johannesburg. Economically, Mr. Makgoga states that "the fact that more than 50 000 passengers are transported daily shows the economic growth of the city. The breakdown of daily transportation includes 46% workers, 41% of students/scholars, Pensioners, people with disabilities". The sports systems (Orlando stadium, FNB stadium, Ellis Park stadium), *Rea Vaya* provides access to these stadia and thus contributing to the economic growth of the city.

Access to tourist destination contributes to both social and economic development. Individuals go to a tourist destination for leisure, and thus contributing to job creation - Regina Mundi in Soweto, Vilakazi Street in Orlando, Johannesburg Apartheid Museum and Gold Reef in Ormonde, Johannesburg Zoo, and Constitutional Hill in Braamfontein etc.

The bus operating company which manages *Rea Vaya* has hired a number of 500 bus drivers. The operation of buses incorporates small and medium enterprises businesses that benefit, petrol supply, bus maintenance, cleaning etc.

- **Increased use of public transport**

"The *Rea Vaya* is currently transporting 50 000 passengers daily. Its connectivity is also contributing to other modes of public transport that feed the passengers to *Rea Vaya* and vice versa" said Mr. Makgoga. This statement shows the need for a well-integrated transport system in order to increase the number of commuters using the *Rea Vaya* in connection with other modes of public transport.

- **Reduced traffic congestion**

It is not easy to deal with traffic congestion, however, the introduction of the BRT system has resulted in the removal of a number of taxis within the routes that *Rea Vaya* is operational. Mr. Makgoga further mentioned that "Taxi owners whose taxis were removed became shareholders of *Rea Vaya* through a BEE transformation in which a bus operating company was formed. There are park and ride facilities where commuters park their cars. There's one in Thokoza Park Soweto where commuters park in the morning and use *Rea Vaya* to commute to the city". This system is contributing to reducing traffic congestion in the city and increasing the number of individuals using public transport instead of commuting with their private cars. The system has also

benefited businesses along the BRT corridors by providing easy and quick access to their workplaces, transported safely and on time.

Makgoga admitted that even though the intention of the system is to provide access to *Rea Vaya* in a walking distance, it is not always the case hence the ongoing development extensions of the system. He mentioned an integrated transport system which would link the different modes of transport, making commuting more efficient. Mr. Makgoga admits that the city still has a long way in achieving a successful effective BRT system and that integration should not just be of modes of transport but also include integration in fares and timetables.

- ***Rea Vaya* Status Quo**

The background and current situation of the BRT *Rea Vaya* system in the City of Johannesburg is provided as per the *Rea Vaya* Marketing and Communications Strategy and Implementation Plan for 2018/19. As per Mr. Makgoga, *Rea Vaya,* a prime transport infrastructure and a smart city project, has become a backbone of Johannesburg's economy and plays an important role as part of the broader public transport system. In light of this, the City aims to provide a reliable public transport networks, reduce congestion on public roads by a gradual shift or switch from private car users to the BRT system and for safe travel with shorter travel times.

- **Number of passenger trips**

Rea Vaya passengers continue to grow annually with the majority of passengers from some part of Soweto, Eldorado Park, Newlands, Florida Park, Westbury, Cresta, Yeoville, Parktown and the Inner-city of Johannesburg says Mr. Makgoga. He further highlighted it operates 277 buses, 48 stations with trunk and feeder routes. In 2017/18, Rea Vaya achieved a total of 48, 000 passenger trip per day.

Rea Vaya now aims for a new target of 53 000 passengers for 2018/2019 and this requires effective customer care services, operational efficiency, and integrated marketing and communication plan to attract new and retain existing passengers, states Mr. Makgoga.

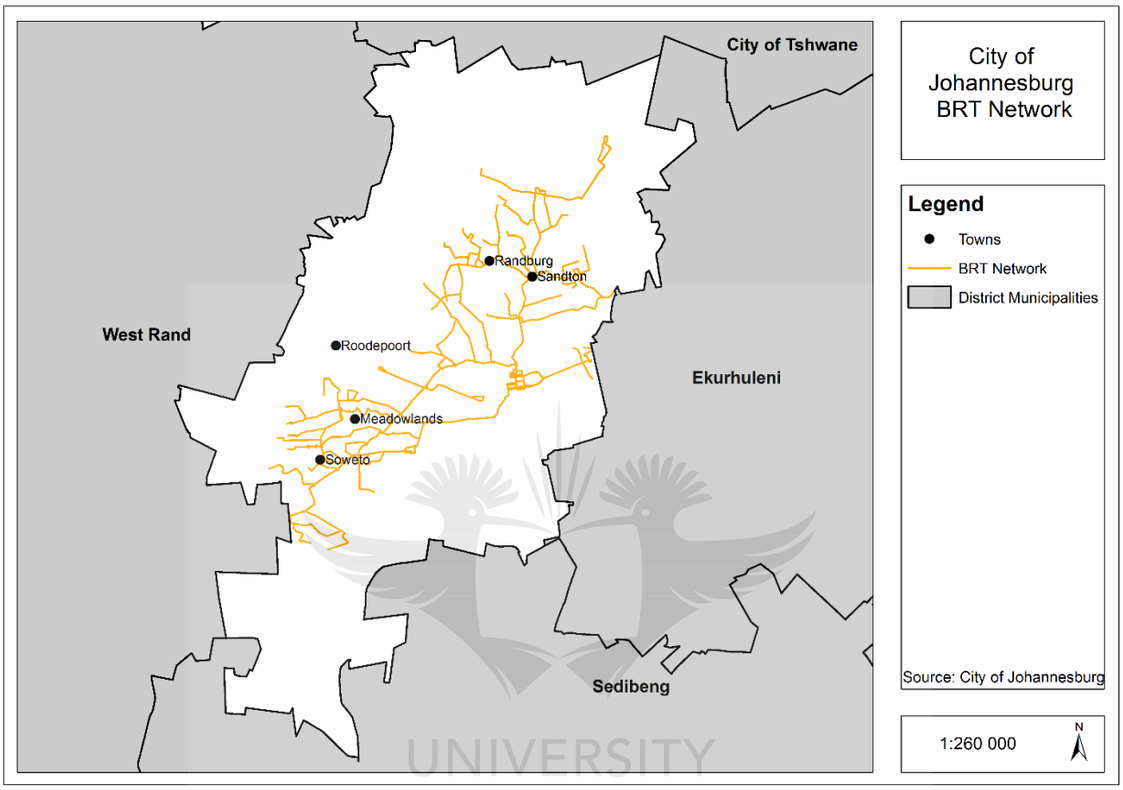
Table 36: Number of passenger trips- Rea Vaya

Name of Route	**Average Passenger Number for the routes for 2017/18**
F1	55 828
F2	127 411
F3	17 298
F4	39 011
F5	29 186
F6	27 236
F7	13 841
F8	9 636

F9	37 550
F10	21 493
F11	22 065
F12	18 952

Source: Rea Vaya Marketing and Communications Strategy and Implementation Plan for 2018/19

Rea Vaya routes



Map 14: Rea Vaya routes

In 2009, the Phase 1A of the *Rea Vaya* system was introduced. It consists of a trunk route functioning between Ellis Park in Doornfontein and Thokoza Park in Soweto, connecting with a number of feeder routes in Soweto. The Phase 1A route covers 325km inclusive of special lanes and intersections, and feeder and complementary buses (Rea Vaya, 2014).

Phase 1B incorporates a new trunk route running from Soweto through Noordgesig, Pennyville, Riverlea, Bosmont, Coronationville, Newclare, Westbury, Westdene, Melville, Auckland Park, Parktown and Braamfontein into the CBD (Rea Vaya, 2014). Phase 1B routes covers 93,22km, inclusive of trunk, feeder and complementary routes.

Mr. Mahlangu – City of Tshwane Metropolitan Municipality

- **Access to transport**

The *A Re Yeng* BRT system proved to be the only option for the urban poor. “The Gautrain is said to be serving the rich and the upper market class of the Tshwane community (which is in minority). Given the local context, the BRT system should take priority in terms of budgeting and implementation as it caters for the wider community and affordable by all” said Mr. Mahlangu.

- **Integration**

As per Mr. Mahlangu, there are places where *A Re Yeng* does not go directly and therefore necessitating commuters to use two or more modes of public transport. This, therefore, makes connector points between residential areas and major economic nodes including linkages to workplaces and residential areas a critical component for innovative urban public transport systems. In Mr. Mahlangu’s opinion, this will require cooperation and integration of different public transport providers, both public and private as it was successfully implemented and achieved in Rio de Janeiro. Mr. Mahlangu also highlighted the issue of one travel card to access different modes of transport. "This was through the introduction of one travel card, i.e. Bilhete Único Integrado (BUI) or Integrated Ticket Fare launched in 2010 for different modes of public transport in Rio de Janeiro (Brazil) which helped reduce travel time and cost (Babinard, 2012)". This depicts effective planning and integration in the urban public transport system where the poor and those living in the outskirts of the urban area benefited through the reduced travel costs and time.

The city has various public transport interchanges that could enhance the connectivity of the BRT with other modes of public transport.

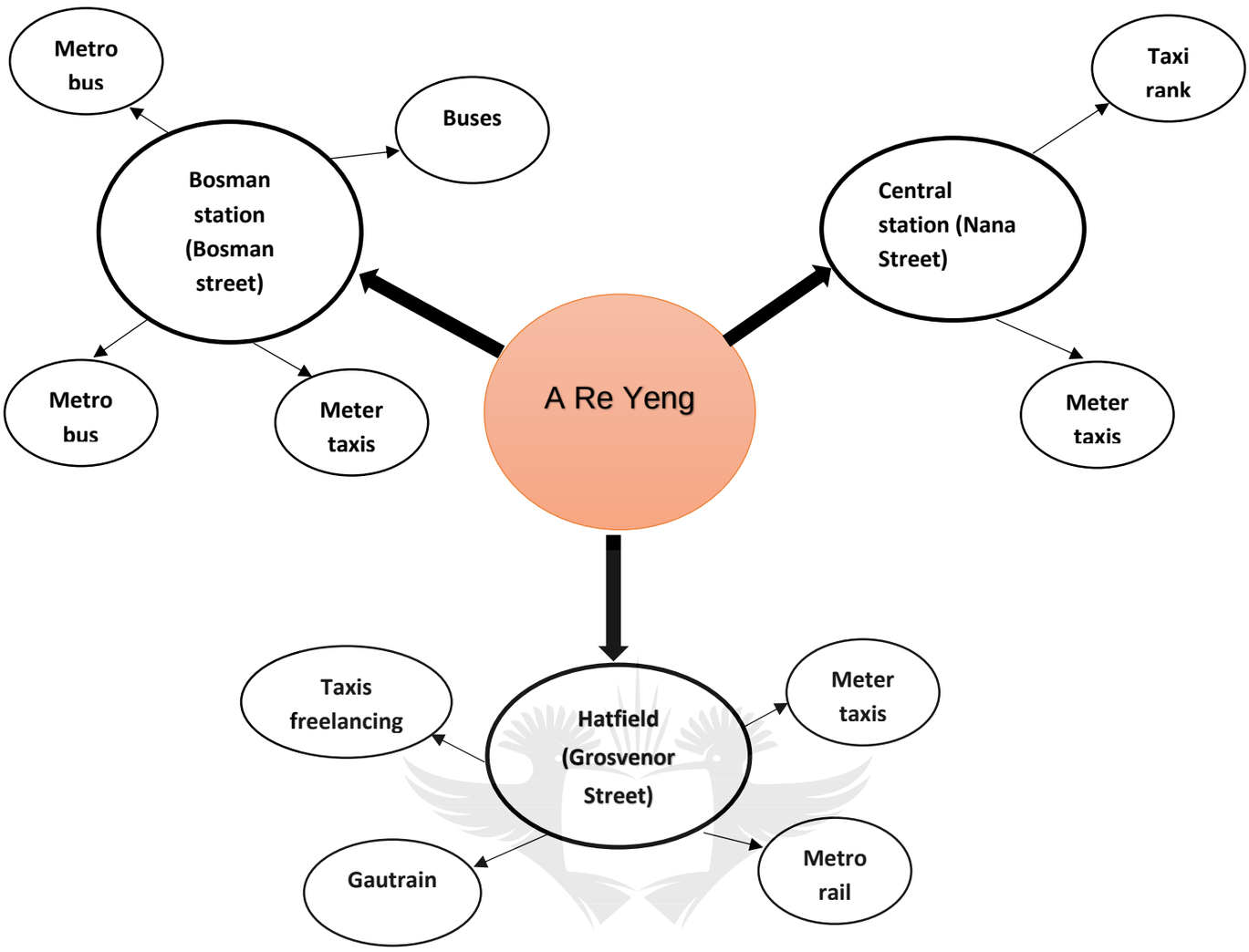


Figure 22: A Re Yeng integrations
Source: Khumalo (2018)

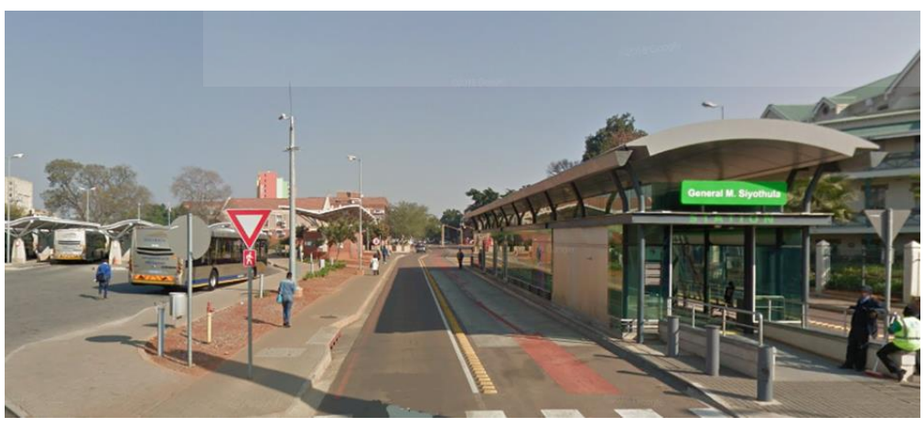


Figure 23: Hatfield interchange (onsite picture, 2018)
Source: Khumalo (2018)

Figure 24: Nana taxi rank (onsite picture, 2018)
Source: Khumalo (2018)

Figure 25: Bosman station (onsite picture, 2018)
Source: Khumalo (2018)

It is now evident that transport planning is evolving from a more traditional approach to transport planning towards a rational, comprehensive integrated approach that takes into account all modes of transport (Litman, 2013) while also fostering investments returns and positive spinoffs in economic growth and development (Mackie et al., 2012). Mahlangu's view is that in order to achieve these, innovative urban public transport system must be coordinated through an integrated approach to decision making and operations management to achieve economically viable and sustainable transport systems.

Mr Mahlangu emphasized that "Mechanisms must be developed to ensure that transport planning investments and the decision does not compromise the value of social, economic and environmental aspects of development focusing on realistic solutions to community problems". Through innovative urban public transport systems with a strong focus on integration, cities will become hotbeds for innovation where trade, tourism, commerce, services, and education will be improved and prosperous.

- **Providing easy access**

The City of Tshwane is developing regional spatial development frameworks which intend to ensure that people leave closer to the BRT corridors and therefore promoting easy access, Mr. Mahlangu highlighted “The initial Operational Plan for *A Re Yeng* was adopted by Council in 2009 (City of Tshwane, 2012b), followed by the completion of the preliminary design and environmental approval of Line 1 (City of Tshwane, 2012a). The BRT system was supposed to be running by the World Cup (*A Re Yeng* Consultant, personal interview, 2018). However, the national government raised concerns about the initial design towards the end of 2009 (City of Tshwane, 2012b) and later withdrew the PTISG funding in September 2010”.

The *A Re Yeng* IPTN was weighed down by planning woes from its inception. As the project unfolded over the eight-year period detailed in this study, it is seen that the concerns raised by the NDoT about the 2009 plan, delays the IPTN project by two years followed by a 2012 decision to change the Hatfield complementary loop into a Hatfield-CBD trunk route, again due to NDoT concerns. As per Mahlangu this decision increased the cost of construction, operations and industry transition, as well as reducing the overall system ridership.

With the above being said, providing easy access was jeopardized when the city had a lot of commitments, and yet nothing was happening. Treasury threatened to direct the funds to other cities, and this is why it was decided to just do something short just for operational purposes so that they can see that something is happening. "What affected access and number of passengers was also the decision to convert the Hatfield complementary loop, which would have run in mixed traffic, into a trunk route, which runs on dedicated lanes to the CBD, had far-reaching negative consequences and that is why we don’t have the passenger numbers because no one is traveling Hatfield – CBD" said Mr. Mahlangu

- **Social and economic development**

Mr. Mahlangu highlighted on the fact that the BRT system is changing the face of the city, be that as it may, the system was not developed fully as per the initial proposed plan and thus proposed objectives in line with the plan were not fully met. The intended developments were interrupted when funding was withdrawn for the following reasons: Line 1 directly competed with the Mabopane to Tshwane Priority Rail Corridor; inaccessible stations along the R80 highway; high project cost; and the absence of a full IPTN plan (City of Tshwane, 2012c). As a result of the National Government concerns, the CoT rerouted Line 1 and produced a new operational plan, with the intention to start Line 1 construction in 2012 (*A Re Yeng* Consultant, personal interview, 2018).

- **Increased use of public transport**

The introduction of the *A Re Yeng* system has partially increased the use of public transport in the city as it does allow efficiency in terms of providing mass transportation which as a result reduces the influx of private car ownership.

The number of commuters transported by the *A Re Yeng* buses was affected when the bus system received attacks in the Mamelodi. Thousands of commuters in Mamelodi were left in limbo after the Tshwane municipality withdrew its *A Re Yeng* rapid transit buses, allegedly after receiving threats from the local taxi associations (Sowetan, 13 Dec 2018). In terms of servicing the low-income communities, their needs were not met due to inaccessibility of the *A Re Yeng* system and buses are running empty.

- ***A Re Yeng* Status quo**

A Re Yeng network represent the rapid component of the Integrated Public Transport System (IPTN) and being developed in a number of phases over period up to 25 years (City of Tshwane, 2012c). The development of the A Re Yeng system in the City of Tshwane has been progressing well picking up on daily passenger trips and attracting passengers to use public transit mode.

A Re Yeng ridership by July 2016 have increased to 5200 passenger trips per average week day. Be that as it may, since the strike in August/September 2016 the passenger trips dropped to 3600 passenger trips (Parliament Portfolio Committee on Transport, 2017).

Number of passenger trips

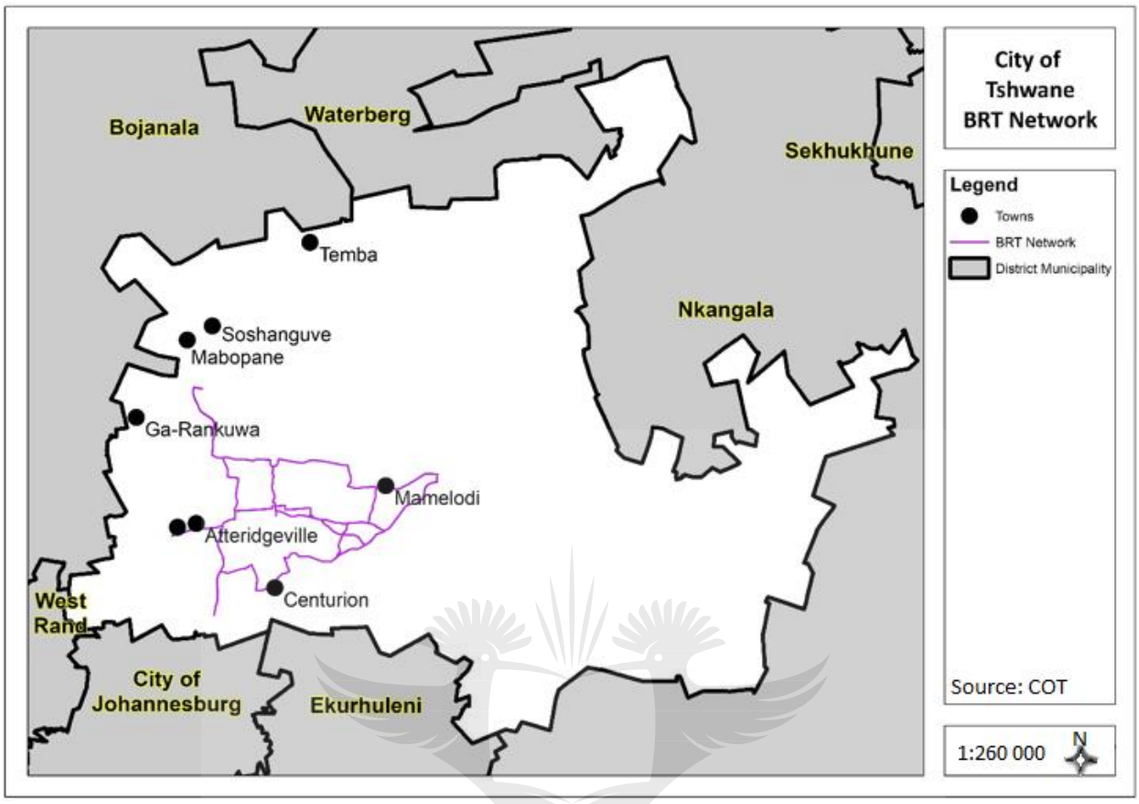
Table 37: Number of passenger trips A Re Yeng

Month	**Number of entries per month**			
	2014/2015	**2015/2016**	**2016/2017**	**2017/2018**
July		86 773	75 149	87 179
August		91 122	6 445	
September		81 329	23 298	
October		89 902	57 235	
November		90 366	59 104	
December	16 438	60 177	35 227	
January	44 068	74 269	51 693	
February	74 500	107 705	74 702	
March	86 405	97 315	77 007	
April	69 367	112 569	54 308	
May	88 185	104 982	87 779	
June	79 784	71 213	78 034	
Total	**458 747**	**1 067 722**	**678 981**	**87 179**

Source: (Parliament Portfolio Committee on Transport, 2017)

As per Mr. Mahlangu, the number of average weekday passenger trips on *A Re Yeng* (morning peaks) is 13,373, the daily demand is 26,745, fare revenue per day is 213,960, fare revenue per month (workdays) 4,707,120 and total fare revenue (including weekends) 5,177,832.

***A Re Yeng* routes**



Map 15: A Re Yeng routes

Mr. Mahlangu highlights that the *A Re Yeng* Phase 1 System includes three (3) trunk lines addition about 81km. This incorporates the Line 1 (Pretoria CBD to Kopanong/Soshanguve), Line 2 (Pretoria CBD to Mahube Valley/Mamelodi), and Line 3 (Pretoria CBD to Atteridgeville), with approximately 141 stations.

Section 7.3: Taxi Association

Head-on interviews were conducted with taxi owners in Johannesburg and Tshwane. For security reasons, pseudonyms were used for taxi owners. These owners were Mr. Lucky Nkabinde and Mr. Sibonelo Nkosi, both from the City of Johannesburg, as well as Mr. Themba Biyela and Mr. Alex Xulu from the City of Tshwane. Interviews were based on very strong themes which are financial implications, general perceptions, conflicts and division, the operating agreement and the effects of the introduction of this system.

Financial loss is a significant issue that emerged strongly from the interviews. All taxi owners mentioned on the loss of money for their businesses since the introduction of the BRT system.

- **General perception**

The general perception that the taxi owners had about the BRT system is that it has created unemployment and became a competition to them. Mr. Nkosi said that *Rea Vaya* is taking their routes. The system only operates on specific routes within the cities but even Mr. Biyela felt that the *A Re Yeng* has stolen his regular commuters. Mr. Xulu highlighted on the fact that they transport commuters from the townships where they can't access the *A Re Yeng* and as they get to the city they change to using *A Re Yeng* instead of taxis to further commute to their destinations. Mr. Nkabinde was concerned with how they've lost their connection amongst other taxis that they feed commuters to from the townships as they would change from one taxi to another once they enter the city. He stated that the introduction of BRT system broke the chain system and led to conflict between *Rea Vaya* Management and the Taxi Industry.

- **Employment of BRT status**

The introduction of the BRT systems infrastructure in the City of Johannesburg and City of Tshwane has created various work opportunities in local communities. The development and improvement of the *A Re Yeng* system is predicted to contribute about 0.29% to the City of Tshwane local economy and to further add growth of up to 0.035% over the long-run to the local economy (City of Tshwane, 2012).

The construction phase provides a number of about 1 989 jobs in a short run (City of Tshwane, 2012). The jobs accommodate both the skilled and semi-unskilled workers and more jobs are created in the development of ther additional lanes.

A number of 436 permanent jobs are estimated in the long run, catering for the majority of skilled workers in the wholesale and retail trade sector as well as in the business services sector (Rea Vaya, 2014). Between a number of 150-200 taxi drivers were employed in the introduction of new bus lanes and buses in the City of Tshwane.

Mr Nkosinathi Manzana the Senior Development Manager at the Johannesburg Development Agency highlighted that since July 2010 to June 2016, the Rea Vaya system has created work opportunities to approximately 3 300 individuals, including a considerable number of women (Rea Vaya, 2018).

- **Relationship between BRT and Taxi Industry**

The biggest problem that taxi owners are having with the BRT management is the assignment of routes within the city. Using the general traffic lanes is a challenge to taxi drivers as the volume of traffic causes delays. "The fact that taxis are not allowed to drive on the BRT designated lanes has resulted in a change of routes for some drivers", says Mr. Xulu. Mr. Nkabinde further added on the reason Taxi drivers and BRT don't see eye to eye. "The City of Johannesburg took their routes, now they share the busiest streets (Loveday, Rissik, Bree, Smith, Kotze, Jeppe, Harrison, Commissioner and Market Streets) with *Rea Vaya*". Another problem that Mr. Nkosi stated is that "If the traffic police find you in the dedicated lanes, they take the disc and you will be forced to stop working".

The Taxi Associations felt threatened by the presence of the *Rea Vaya* Bus Service. Mr. Biyela is of the opinion that "Buses were putting taxis off the road". It can be said that it is no longer profitable for taxis to operate together with the *Rea Vaya*. Mr. Xulu claims that “The *Rea Vaya* is threatening our income and the battle between them cannot be resolved”.

- **Affected serviced transport routes**

Mr. Xulu stated that even though the buses are operating on some of their routes, they still use the same route and that even if they are not allowed on the dedicated lane if the situation is demanding they use the lanes. Mr. Nkosi highlighted that they had to change some of the routes due to the fact that they receive fewer passengers and make no profit from them. Mr. Nkabinde also highlighted that it would take them a good agreement package for them to change routes from where *Rea Vaya* is operating, in the meantime competition is tough and they have to make a profit.

- **Operational agreement**

The City of Tshwane has entered into an agreement with the Taxi Associations after having protested against not being allowed to enter the CBD from the Hammanskraal, Rainbow Junction public facility. Mr. Biyela explained that “The reached agreement is that they transport commuters from Hammanskraal and drop them off at Rainbow Junction where they will board *A Re Yeng* Bus Transit system to the CBD”. However, Mr. Xulu explained that the agreement was not working in their favor and therefore some operators are not adhering to it.

The City of Johannesburg has also entered into an agreement with the Taxi Association, which would enable the representatives to become major shareholders in the *Rea Vaya* system. Mr. Nkosi explained that “The agreement was not in favor of taxi owners”, and he would have to “Give up two permits for one bus”. Mr. Nkabinde explained that he would have to surrender three taxis for one *Rea Vaya* bus to operate and that would mean the loss of income for him.

Both cities have reached an operational agreement between BRT and Taxi Associations, however, taxi drivers are not operating as per the agreement because they believe it is not in favor for them.

Section 7.4: Development planning and urban management

Transport frameworks have continuously had a pivotal impact on urban improvement designs. In the last 50 years, transport frameworks have been characterised by a huge increment within the use of the private car and the parallel advancement of street framework and space for parking (Tiawoun, 2000). The car dependence has played a major part in organizing urban and rural improvement along highway corridors, regularly taking the frame of scattered low-density, confined, isolated employments with small regard for public transport. The purpose of this study necessitated the participation of the Town Planning officials in order to eradicate the pattern of isolated development

based on high use of private cars and to integrate the transport planning into the town and urban planning frameworks.

Therefore, this section highlights the perceptions of the Town and Regional planners regarding the development of the newly introduced mass transit system. Interviews were conducted between Mr. T. Ratone, the City of Johannesburg Town Planner and Mr. I. Nkoane the City of Tshwane Town Planner.

Mr. Ratone - COJ

Mastering urban transport multimodal future in sustainable cities. Mr. Ratone presented a number of ideas which he believes can help achieve transport multimodal future for the city**.**

- The fundamental process of creating a working/functioning transport system is to first study and understand mobility (how people move – to work, vehicular movement, road classification etc.). “This can be done through various mechanism employed in the research industries, for instance, Space Syntax”. By understanding movement, you can then plan around which routes are to be dedicated to public transport; which routes can be limited to pedestrian-friendly movement.
- Mr. Ratone further mentioned the need to understand movement in order to know where to concentrate certain land uses which will feed into public transportation. When dealing with Policy Frameworks, it is important to include relevant stakeholders that will give input in transport planning. (Steering committee that includes traffic/transport engineers).
- Combat urban sprawl. Urban sprawl as a phenomenon does not only focus on "leapfrog" developments but also scattered land uses within urban areas. Thus, taking away from an ideal "compact city". Polycentric modeling has been a key feature in realizing sustainable cities, linkages and transport planning becomes easier.

Urbanites appreciate their city's ordinary change and assortment. However, expanding urbanization moreover makes living in cities a smothering issue. Creative urban spaces can contribute to eliminating one of the biggest transport issues which are an increase in private car usage. Mr. Ratone believes that this can be done by replacing tar roads with paving, which will automatically reduce speeds and creates a perception of non-motorized movement; urban greening and landscaping; Urban Design as a concept: promotion of street café, open-air theatres and cultural precincts (Maboneng Precinct).
The benefits that the BRT networks could provide in the cities is to see the promotion of higher densities, promotion of mixed land uses, less CO2 emissions as well as the linkages of different economic sectors (Polycentric modeling).

Mr. Ratone concluded that planning cannot happen in silos, therefore, Policy frameworks have to take Transit Policies into consideration in order to tie BRT to urban planning and development in connection with its long-term sustainability. Steering

committees for policy development that include transport and traffic engineers is another way to achieve this.

Mr. Nkoane - COT

People migrate to cities to seek and take advantage of opportunities, all for survival. In order to master urban transport policy, Mr. Nkoane stated that cities need to consider mass transit systems along areas of economic opportunity. Densifying nodes and corridors where public transport is available/developable. This, cities can achieve by mastering the concept of "Live, Work, and Play", where multiple users are considered and made available within proximity to each other.

“Within the Gauteng region, Metros still operate and plan according to their administrative boundaries. An integrated planning approach is necessary in order to ensure alignment of transport master plans within the metros”.

In transport planning, it is important to consider why the use of private cars is preferable. Many citizens would consider using public transport if it was reliable. Users of public transport do not only use it to get from one point to another. They also use it to access a variety of amenities which are not necessarily situated in a linear manner. “To contribute to the reduction of usage of private cars, creative urban spaces can be used to ensure the provision of amenities within walking distances from each other. This includes reduction of distances within and between districts”

As per Mr. Nkane, the BRT framework that the city has adopted on has a number of benefits such as mass transportation of citizens thus providing access to opportunities within the city; contribution to the reduction of carbon emissions, increased densities along strategic routes and the realisation of a viable city through the provision of mixed uses.

BRTs are inherently a by-product of planning. In order to ensure sustainability, BRTs require high densities. Scholarly research has proved that the future of cities is through the mass-transit-system. Municipal guide documents (SDF, Growth-and-development-strategies, etc.) should inevitably be inclusive of planning around mass transit. Cities could then drive major developments, through various incentives to be situated along the BRT routes.

4.2 Summary

To comparatively assess the effectiveness of the BRT system in both cities, the study objectives looked at the determinants of effectiveness in BRT and the results were presented as per the objectives. The findings presented above highlight the different status quo, perceptions, experiences, and challenges from the different sources of data collected.

Accessibility

The BRT system has been seen in a positive light by a number of stakeholders from both the City of Johannesburg and City of Tshwane. Accessibility to the stations is an essential element in transport planning. Both the City of Johannesburg and the City of Tshwane have provided a maintainable transport framework giving access to fundamental administrations, for example, medicinal services and training. However, the objective of providing accessibility to the system has not been a success for the majority of commuters residing far from the stations and bus stops and as a result, it has restrained access to economic opportunities.

A few percentages of population resides within one kilometer of a BRT station, routes, and bust stops. There is an increase in the use of other modes of transport by the BRT users to access nearest bus stops and stations. It is of concern that the spread of the BRT system is not evenly spread in these cities, thus affecting the number of riderships.

Reliability

The respondents remarked on the dependability and timeliness of the *Rea Vaya* and *A Re Yeng.* However, it is evident that buses don't hold fast to the timetable at some point which postures issues for travelers who need to travel to their work places and arrive on time. Commuters are pleased with the introduction of the BRT bus designated lane as it decreases their travel time and reduces traffic delays. On the other hand, the Taxi Industry is threatened by the introduction of this system and its designated lanes.

Dependability was measured by the certainty of bus timetables, by the number of punctuality of buses/trips compared to the number of trips that are interrupted and by how much they’ve been postponed. Both the *Rea Vaya* and *A Re Yeng* have a strong communication of bus schedules and timetable to the commuters, for example even a 2-minute bus delay was demonstrated on the time screens inside the bus station when the bus was delayed. Majority vowed for the reliability of the system in both cities.

In both cities the issue of congestion with regards to the system is not a problem. The system is not affected during rush hour travel time compared to free flow travel time, and it has reduced travel time. The frequency of the buses affects the reliability of a system. The respondents found the system to be frequent and providing a number of accessible buses per one hour in their bus time schedules provided in the stations, bus stops and internet.

Affordability

The respondents are comfortable that *Rea Vaya* and *A Re Yeng* has provided affordability by allowing the commuters to load a reasonable amount and enable them to have several rides with the loaded amount. The card system has allowed for access

to various economic nodes with one card in order to benefit from the basic goods and services without compromising the ability to maintain healthcare, shopping, school, work and social activities. The respondents also highlighted that the card system has improved their ability to save money, ability to respond to financial costs such as increased transport costs.

Assigned Bus Lanes and Time Spent Commuting

Designated paths isolate BRT buses from the movement congestion, giving them the selective right of way, which empowers the buses to achieve more noteworthy speeds. Respondents from both the City of Johannesburg and the City of Tshwane confirmed that their travel time has indeed been decreased by the use of the designated lanes for the BRT buses resulting in speed and decreased travel times. Be that as it may, the Taxi Industry remains threatened by the introduction of bus only lanes. A respondent felt that these lanes are a result that their customers chose BRT because the buses are never stuck in traffic. The respondents felt that it is not fair that they are not allowed to use the lanes and if the Metro cops find them in these lanes, they are issued tickets.

Improved service

The ability of the system to provide reliability, affordability, decreased travel times and congestion, and enhancing accessibility, is a sign that the BRT system is providing improved transport service to its commuters. The respondents are pleased with the charges of BRT enabling it to give a more a prominent system scope.

The BRT manager has highlighted that the City of Johannesburg continues to increase the number of buses and stations that are wheelchair-accessible. The development of the new Phase 1C will introduce more buses to improve the BRT system. Within the City of Tshwane, there has been an increase of buses since the introduction of the system.

The respondents believe that the system offers reasonable operating hours per week with easy to access travel cards. For the commuters from both cities, it is remarkable that the system is never involved in accidents and hardly experiences breakdown. This as a result provides improved BRT service to the commuters.

Integration of BRT with other modes of transport

The public transport interchanges for both cities have been major transport integration points where *Rea Vaya* and *A Re Yeng* integrates with taxis, metro buses, and trains. These modes of transports all feed commuters to each other in order to successfully transport the commuters to different places within the cities. It is, however highlighted by the managers that the formal integration of these modes is still a process.

CHAPTER 5: Discussion and conclusion

5.1 Introduction

Comparative Assessment of Effectiveness of BRT Systems in the City of Johannesburg and City of Tshwane was investigated in this study. Qualitative survey and in-depth interviews were led in order to gather information on the opinions and the encounters of diverse participants in Johannesburg and Tshwane with respects to the *A Re Yeng* and *Rea Vaya* BRT system. Findings of the study are presented in Chapter 4, while in Chapter 5 these findings are evaluated. Conclusions offered in this chapter are based on the main theme presented within the analysis of the study.

5.1.1 BRT Status Quo

In order to get an idea of the status quo in these cities, the research looked at the spread of the BRT framework in the city, and its determinants. The objectives of the 2007 Public Transport Strategy and Action Plan have not been achieved in full in both cities. In the City of Tshwane transportation, the minibus-taxi industry had been partially transformed, while none of the Integrated Public Transport Network systems were implemented within their initial timelines. Neither, did the initial development of the *A Re Yeng* achieve all its initial plan of the development. Be that as it may, *A Re Yeng* has delivered a high-quality bus-based transit system that delivers fast, comfortable, and cost-effective services at metro-level capacities. The spread of the system in the both cities, connects the disadvantaged areas with the city center to provide for accessibility, however the system is not evenly spread throughout the city. The City of Johannesburg has transformed the lives of the urban poor with its initial development of the *Rea Vaya* bus system. Even though in its initial proposal, the system was not introduced to all the disadvantaged communities, its introduction however has brought change to the communities and the Municipality has moved ahead with the introduction of Phase 1C in other parts of the city. This increases the spread of the system to the areas that were not previously served by the BRT system. The economic transformation plan still ought to intentionally encourage the consideration of the disadvantaged in line with the enormous transport investment ventures that have been made

Moreover, the urban poor and previously disadvantaged citizens are yet to meaningfully benefit from innovative urban public transport systems investments. Their economic constraints need to be at the forefront in order to access employment opportunities and enhanced business opportunities that come with innovative urban transport systems.

5.1.2 The Social and Economic Effect of the *Rea Vaya* and *A Re Yeng* BRT System

The research intended to study the social and economic effect of the Rea Vaya and A Re Yeng BRT system within the Johannesburg and Tshwane Metropolitan Municipalities, by investigating to what extent does the *Rea Vaya* and *A Re Yeng* meet the socio-economic needs of the commuters, if the system improved travel conditions, and the challenges and opportunities for an inclusive and comprehensive mobility system.

To what extent is *Rea Vaya* and *A Re Yeng* meeting the socio-economic needs of the commuters?

The *Rea Vaya* and *A Re Yeng* BRT systems are experienced and viewed differently by various stakeholders. The result from the commuters suggest that the system is improving the travel conditions for the commuters and is meeting the socio-economic needs of the commuters, however not for everyone who uses the system. It has provided an affordable mode of transport and reduced travel time due to the designated lanes for the buses. The consistency of the system has provided reliability of the system to the commuters, and the effective communication in bus timetables, change of bus schedule, and change in transport fare has assured the commuters on its reliability. Commuters also found the system to be reliable, safe and clean. However, for the Taxi Industry, the introduction of the system has resulted in loss of profit as the results have demonstrated. The sharing of the routes and the fact that some of their customers have chosen to use BRT system has left the taxi industry with a decreasing number of commuters and a change in their transport routes in order to increase their number of taxi commuters.

The challenges and opportunities for an inclusive and comprehensive mobility system.

The BRT system in both cities has offered various opportunities to its commuters, these include reasonable transport prices, less travel times, reduced traffic through the designated lanes, safety, reliability of the system and providing access to places of economic opportunities. It is important to also note that the development of the BRT system has provided employment opportunities to a number of both skilled and semi-skilled individuals. While providing the communities with a safe, reliable, affordable, and accessible mode of transport, the cities are simultaneously providing solution to the issue of an increase in unemployment within these cities. Nonetheless, what remains a challenge for commuters is accessing the BRT system. It was also highlighted that the system at times faces issue of delays and that the designated BRT lanes are sometimes crowded by taxis and private cars which results in delays for the commuters. The BRT system has also provided opportunities for the Taxi Industry. This has been done through the transport feeder system with the BRT. As much as the taxis feed commuters to the BRT buses who do not reside closer to the BRT routes, bus stops and stations, the BRT buses also feed commuters to the taxis.

The introduction of this system has also provided employment opportunity for some of the taxi driver who formally went onboard with the *Rea Vaya* and *A Re Yeng* BRT. Be that as it may, the system has created challenges for the Taxi Industry. Designated paths have created pressure amongst the BRT management and Taxi industry. As the results have demonstrated, members from the Taxi industry felt that the *Rea Vaya* and *A Re Yeng* has its assigned paths “is not fair” and in their view increased the volume of traffic within the city. The Taxi industry is of the opinion that the City of Johannesburg

and City of Tshwane “is trying to get rid" of them. They have highlighted that since the introduction of this system, they are not making a profit. There’s an increase in a number of commuters who are choosing *Rea Vaya* and *A Re Yeng* BRT system over Taxis, which affects the taxi operation and a loss of income with a decrease in the number of commuters who use taxi. The cities had incorporated the Taxi industry in the negotiations process, however, the Taxi Association refused to take part and there’s presently still strains between these parties. TOD has not however been accomplished within the City of Johannesburg. In any case, the cities plan encompassing the advancement of corridors of freedom gives chances for TOD and blended land use.

5.1.3 Integration of BRT to other mode of transport

In analyzing BRT integration, the study aimed at investigating the integration of the BRT system to other informal public modes of transport, and the possible measures required for integrating other modes of transport with the BRT system.

BRT integration to other informal modes of transport.

The results demonstrate the use of two or more modes of public transport utilized by the commuters. This, therefore, makes connector points between residential areas and major economic nodes including linkages to workplaces and residential areas a critical component for innovative urban public transport systems. The cities have various public transport interchanges that were highlighted by the BRT managers (Bosman station, Central station, and Hatfield in the City of Tshwane; and Gandhi Square, Dobsinville public transport interchange and Park station in the City of Johannesburg). Be that as it may, there is no formal integration of these modes of transport at current, it is integration on normal public transport interchanges. With that being said, both the BRT representatives have highlighted that the cities are adopting on new Integrated Transport Plans which will provide the commuters with a Sustainable Integrated Public Transport.

Possible measures for integrating BRT with other modes of transport.

Considering that there has been integration of BRT with other informal modes of transport through public transport interchanges. Improving possible measures to formally integrate these modes of transport can begin within the interchanges itself. This was highlighted by the respondents that it necessitates the one travel card option to access different modes of transport. Mr. Mahlangu also mentioned the need to adopt on Integrate Ticket Fare in order to reduce travel time and cost. Furthermore, an integrated transport plan consolidating the *Rea Vaya* Bus Rapid Transit system, Metrobus, and the minibus taxis travel systems will make it less demanding for commuters to get to the public transport framework, this was highlighted by Mr. Makgoga. It is now evident that transport planning is evolving from a more traditional approach to transport planning towards a rational, comprehensive integrated approach that takes into account all modes of transport.

5.1.4 Accessibility of the BRT system

The BRT system aims to provide a safe, accessible and reliable form of public transport for commuters (Rea Vaya, 2012). The research objective of accessibility was analysed by investigating if the BRT system serves the disadvantaged zones, the level of accessibility of the BRT compared to other modes, and if it has achieved its goal of meeting the needs of commuters in the city.

BRT system serving the disadvantaged areas

The study has found that the BRT system does not effectively cater to the needs of the urban poor as it is by far not accessible to the majority of the disadvantaged zones. The BRT system (which has proven to cost less compared to other modes) has remained the appropriate option for the socio-economic needs of the urban poor. However, evidence on the ground suggests that places, where the urban poor resides, are most likely going to be the last to receive the BRT system services since the project already started by prioritising major economic nodes and not necessarily places where the urban poor reside.

Level of accessibility of the BRT system compared to other modes

Accessibility of the system compared to other informal modes of transport is picking up at a slow pace. It cannot be disputed that the system provides remarkable access to the commuters residing within a 500m range of the bus stops, route, and stations, however the results have demonstrated that majority of the commuters still rely on other modes such as taxis, metro buses and trains which provide them with access to the BRT. Inaccessibility to the *Rea Vaya* and *A Re Yeng* Stations is one of the major reasons why many commuters still use taxis, metro bus, trains, and private cars to commute and access the city. Of importance if that the City of Johannesburg is introducing Phase 1C connecting Sandton, Alexandra, Greenstone, Randburg, Rabie Ridge, Midrand and Ivory Park to the city centre. The City of Tshwane is developing regional spatial development frameworks which intend to ensure that people live closer to the BRT corridors and therefore promoting easy access.

BRT achieving its goal of meeting the needs of the commuters

The system has provided an affordable, safe, efficient and reliable mode of transport to the majority of the commuters who reside within a 500m range of the BRT system (bus stops and stations). Be that as it may, the objective of the system to meeting the needs of commuters in both the City of Johannesburg and the City of Tshwane has not been met and thus the system is not fully meeting the needs of the poor. The system in both cities at current is not attracting the intended number of commuters as highlighted from the above sections, majority of them are still using taxis. The development of the BRT system was initial meant for poor communities, however, the spatial spread of the BRT routes is not evenly spread to and within the poor communities.

5.2 Conclusion

It can be concluded that the *Rea Vaya* system in Johannesburg is working towards being an effective mode of transport, regardless of the challenges experienced. The system has provided improved service to its commuters through lessening travel times, traffic congestion, affordability and a reliable mode of transport. In recognizing the inaccessibility of the system, the city took step to introduce Phase 1C of the system in other urban poor communities, however, the issue of inaccessibility of the existing system in other areas still remains. There are no plans on introducing new lanes to the existing ones within the city or reconsidering the routing of the system. Integration with other modes of transport is not yet at an official process. Both the *Rea Vaya* and *A Re Yeng* are dependent on the transport interchanges within the cities where they can access and transport individuals who do not reside within a 500m range of the *Rea Vaya* and *A Re Yeng* bus terminals. The interchange system has been effective for both the cities. The park and ride system is also one of the few steps towards achieving integration of all modes of transport.

Upon extensive study of the *A Re Yeng* system in Tshwane, the City of Tshwane is also working towards providing an effective mode of transport. Regardless of the delay in the introduction of the system in the city, the *A Re Yeng* performance and service provided has been notable for the commuters. The system has been faced with conflicts from the Taxi Industry, however it is still operational in the city and intends on further improving travel conditions for public transport users and attracting new public transport users. It is noteworthy that the City of Tshwane is improving the integration of BRT with other modes of transport through integrated public transport and development planning.

5.3 Recommendations of the Study

The study has found that the BRT system in both cities is not accessible to the majority of commuters within the City of Johannesburg and the City of Tshwane. Although future and current plans indicate an expansion of the network to zones encompassing the cities, the framework isn't as accessible as taxis. As a result, in order to address these challenges, there ought to be integration between the distinctive modes of transport and the BRT framework. Feeder buses need to operate inside residential areas so that the *Rea Vaya* and *A Re Yeng* may be more available to commuters. The municipalities need to formally integrate the BRT with other modes of transport as these alternative modes are already feeding to the system.

Therefore, in order for the *Rea Vaya* and *A Re Yeng* BRT system to be more affordable, the City of Johannesburg and City of Tshwane need to adjust the cost of the loading fee. This will result in the *Rea Vaya* and *A Re Yeng* being more affordable and thus the needs of the poor would be met. The system also needs to look at integrating the price fare with other modes of transport which can allow for single use of card on different modes of transport. These cities need to learn from the success and failures of the BRT

systems in other countries where there have been developments of the BRT system, especially because they are located within metropolitan regions.

Perhaps the BRT Management could learn and adopt from the best practice of other transport frameworks within the City of Johannesburg and City of Tshwane such as the Metro buses. The BRT could begin by adding its operational routes and increase its route coverage within these cities, thus giving BRT access to a larger population. The management could also plan an onboard fare payment comparable to that used by Metro buses. This was seen as a productive installment strategy by participants as commuters would swipe their cards on the bus as opposed to at the station, as within the case when using a BRT transport. Putco and Metro Transport have been operational for a long time now, the BRT can learn from the victory and disappointments of these two public transport suppliers and utilize this to progress the *Rea Vaya* and *A Re Yeng* framework. The BRT management ought to moreover observe best practices from worldwide case studies, where the BRT framework has created and connected those practices.

The study advocates for an integrated approach to economic transformation and innovative urban transport system. To foster transportation transformation in South Africa, attention must not only be given to development planning but also integrating transport planning into development planning in order to deliver sustainable integrated transport to the citizens and the previously disadvantaged to access the BRT system effectively and benefit from the integration of various modes.

Recommendations from the planning department were that the fundamental process of creating a functional transport system is to study and understand mobility. Planning cannot happen in solo, therefore, Policy frameworks have to take Transit Policies into consideration in order to tie BRT to urban planning and development in connection with its long term sustainability.

To ensure sustainability, BRTs require high densities. Scholarly research has proved that the future of cities is through the mass-transit-system. Municipal guide documents (SDF, Growth-and-development-strategies, etc.) should inevitably be inclusive of planning around mass transit. Cities could then drive major developments, through various incentives to be situated along the BRT routes.

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Appendix A: Questionnaire

Masters in Sustainable Urban Planning and Development

Department of Town and Regional Planning, Faculty of Engineering and the Built Environment, University of Johannesburg

Research Student: Ms. TN Khumalo (Student Number: 201313724)

Research Project Title:

COMPARATIVE ASSESSMENT OF EFFECTIVENESS OF BRT SYSTEMS OF JOHANNESBURG AND TSHWANE

Research objectives:

1. To determine the status quo of BRT in Johannesburg and Tshwane.
2. To determine the cross-sector benefits of accessible transport planning/development.
3. To determine its integration (BRT) to other public transport.
4. To investigate the perception, social and economic effect of the *Rea Vaya* and *ARe Yeng* on commuters who use the system.

Dear Respondent

This questionnaire forms part of the important requirements for fulfilling the University of Johannesburg Masters in Sustainable Urban Planning and Development qualification. The aim of the study is to comparatively assess the effectiveness of BRT systems of Johannesburg and Tshwane. Please note that all the results acquired from the study will be used for research purposes only. Information gathered will be anonymous and confidentiality will be maintained. The approximate time required for completing the answers is 20 minutes. Please answer all questions honestly and accurately.

Please note that participating in this research is voluntary. You have the right to participate or withdraw your consent. If there is any further information required with regards to the study, you can contact the supervisor Mr. A. Ogra from University of Johannesburg on 011 559 6131 or aogra@uj.ac.za. Thank you for providing your time to participate in this research.

I have read and understood the details of this consent form, hence I am willing to participate in this study.

Respondent's signature: Date:

Kind Regards

Thandekile N Khumalo

Research Student

Department of Town and Regional Planning

Faculty of Engineering and the Built Environment

University of Johannesburg

Section-1: Demographic Information (mark with an X on the relevant item)

1.1 Gender : Male / Female

1.2 Age : 18-35 ; 36-55; > 55

1.3 Nationality :South African; Non South African_____

1.4 Race : Black African; Coloured; Indian/Asian; White

1.5 Marital Status : Single; Married; Divorced; Widowed; Separated

1.6 Education (Graduation) : No Schooling; Primary; Secondary; Grade 12/Std10; Higher

1.7 Employment : Yes / No

1.8 Monthly Income : < 3000 | 3000 < 5000 | 5000 < 7000 | 7000 < 10000 | > 10000

1.9 Physical Disability : Yes / No

Section-2: Status Quo

2.1 What city or area of the city do you live in?

_____

2.2 What city or area of the city do you commute to for work/school or other regular activities? _____

2.3 What is your primary means of transportation?

Taxi	Train	BRT	Metro-Bus	Maxi-cab	Own car

2.4 How often do you use public transportation on an average?

Daily	Weekly	Monthly	Occasionally	Never

2.5 What kind of public transportation is available where you live?

Taxi	Train	Metro-bus	Maxi-cab	BRT

2.6 What is the main purpose of the journeys you usually make?

Work	Education	Shopping	Personal business

2.7 What times of day do you typically catch the bus (BRT)?

8 am – 9 am	10 am- 11 am	12 pm – 1 pm	2 pm – 3 pm	4 pm – 5 pm

2.8 Is the BRT service in your area frequent?

Yes	No

2.9 How long does or would it take you to get to the nearest BRT station or stop from your home?

5-10	10-15 minutes	16-20	20-30	30-45 minutes

minutes		minutes	minutes	

2.10 How important is each of the following characteristics in using a BRT service?

(**1**-Not Important, **2**- Somewhat Important, **3**- Important, **4**- Very Important)

Service from home to work	1	2	3	4
Flexibility	1	2	3	4
Evening service	1	2	3	4
Late-night service	1	2	3	4
Weekend service	1	2	3	4
Wheelchair accessible	1	2	3	4
Very few stops	1	2	3	4
Clear fare structure	1	2	3	4

2.11 How is your transport finance on BRT compared to the previous mode of transport?

Increased	Remained the same	Decreased

2.12 What do you feel is the major problem that BRT transportation is facing today?

Traffic	Bus schedules	Safety	Cost	Other _____

2.13 The bus stations are attractive

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

2.14 The bus station is equipped with modern technology and is eco-friendly

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

2.15 The bus station has adequate resource and capacity

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

Section-3: Reliability

3.1 The bus always arrives at the destination on time

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

3.2 The bus never breaks down on the road

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

3.3 Customers can easily get a ticket for their journey with BRT

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

3.4 Staff satisfy customers' requests right the first time

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

3.5 The timetable in the bus station and stand is error-free

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

Section-4: Responsiveness

4.1 BRT always inform people of change of timetable and prices in advance.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

4.2 BRT provides timely and efficient service

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

4.3 Communication of BRT staff with customers is clear and helpful

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

4.4 BRT staff provides complete answers when they attend to customers' requests.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

4.5 How would you rate the BRT customer service? 1-Poor 2-Moderate 3-Good 4-Excellent

1	2	3	4

Section-5: Assurance

5.1 Customers feel safe in their transactions with staff in the bus stations.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

5.2 Staff off bored are always polite

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

5.3 Staff has in-depth occupational knowledge of their jobs.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree

Section-6: integration

6.1 Does BRT have connections to other modes of transport?

Yes	No

6.2 Do you use more than one mode of transport when commuting from home to work /school?

Yes	No

6.3 If yes, which other mode of transport do you use to access BRT?

Taxi	Train	Metro-Bus	Maxi-cab	Own car

6.4 How are your finances affected in using more than one mode of transport?

Increased	Remained the same	Decreased

6.5 How is the integration of BRT with other modes affecting you other than finances?

_____

_____

Section-7: Additional Questions (Interviews)

<u>7.1 Commuters</u>

7.1.1 Does BRT always look after the best interests of their customers?

Yes	No

7.1.2 Are the BRT operating hours convenient for you?

Yes	No

7.1.3 It is easy to find and access the BRT bus station and stands?

Yes	No

7.1.4 At the bus stop do you find that there are timetables available and readable should you need them?

Yes	No

7.1.5 From where do you get the bus schedules and ticket price information?

Newspapers	Internet	At bus stations	Call Centre	Don't know

7.1.6 How would you rate the following services of BRT buses?

Services	**Poor**	**Moderate**	**Good**	**Excellent**
cleanliness	1	2	3	4
Reliability	1	2	3	4
Safety	1	2	3	4
Frequency	1	2	3	4
Cost	1	2	3	4

7.1.7 What changes would you like to suggest for improving services in BRT?

_____

Stakeholders

7.2 BRT management (2 Rea Vaya - 2 AreYeng managers)

7.2.1 Is BRT providing access to transport in different communities?

7.2.2 Is the spread of the BRT in the city promoting integration with other modes?

7.2.3 Is BRT planning to integrate with other modes of transport?

7.2.4 Is BRT achieving its intended goal of providing easy access to the city?

7.2.5 Has the introduction of BRT changed the face of the city and other social and economic development?

7.2.6 Has the introduction of BRT increased the use of public transport in the city?

7.2.7 Is BRT reducing traffic congestion in the city?

7.2.8 How has the introduction of BRT affected the businesses located along the corridors?

7.3 Taxi Association (2 Managers in COJ – 2 managers in City of Tshwane)

7.3.1 How has the introduction of the Rea-Vaya impacted on your business?

Loss of money	Lesser commuters	Taking over the routes

7.3.2 What is your general perception of the Rea-Vaya Bus rapid transit system?

_____

_____

_____

7.3.3 What is your view on Rea-Vaya management and taxi association (Division

in the Taxi industry)?

_____

_____

_____

7.3.4 Is there a reached operational agreement with BRT management? If any what is it?

_____

_____

7.3.5 How are your serviced transport routes affected by the operation of the BRT in the city?

_____

_____

7.4 <u>Development planning and urban management</u>

(1 Planner from COJ – 1 Planner from City of Tshwane)

7.3.1 How can the municipality master urban transport multimodal future in sustainable cities?

_____

_____

_____

7.3.2 How can creative urban spaces reduce the usage of private cars?

_____

_____

_____

7.3.3 What potential benefits could BRT networks provide in the cities to develop a framework incorporating these benefits into the planning process?

_____

_____

_____

7.3.4 What are the ways through which the municipality can tie BRT to urban planning and development in connection with its long term sustainability?

_____

_____

_____