MYCITI BRT: A TOD APPROACH IN TRANSFORMING CAPE TOWN'S BUILT ENVIRONMENT

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ABSTRACT

The City of Cape Town (CoCT) is characterised by sprawling areas and suburbs that are represented by an overall lack of accessibility coupled with low mobility levels. The majority of the urban poor live in the urban periphery, approximately 30 kilometres away from the CBD where as much as 40% of monthly incomes are spent on transport to and from place of work. Therefore the CoCT has recently overhauled its approach for development, adopting a new Transit Oriented Development (TOD) approach in order to deal with these mounting issues. This research identifies how the CoCT aims to use the MyCiTi BRT as a catalyst in the implementation of TOD around the built environment. TOD has the potential to shape, change and drastically impact how future development will occur within Cape Town's built environment. Living near public transit saves both time and money and planning around TOD can enhance social inclusiveness by increasing accessibility to jobs, particularly for the urban poor.

Keywords and phrases: Public Transport, Transit Oriented Development (TOD), TOD Comprehensive (TOD-C), Bus Rapid Transit (BRT), Integrated Rapid Transit (IRT), Bus-based services, Nodes, Corridors, Sprawl, Compact City.

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ACRONYMS AND ABBREVIATIONS

BAU	Business as usual (land use model)
BEPP	Built Environment Performance Plan
BMT	Bus and Mini-taxi
BRT	Bus Rapid Transit
CBD	Central Business District
CoCT	City of Cape Town
DoT	Department of Transport
GABS	Golden Arrow Bus Service
GLA	Gross Leasable Area
IDP	Integrated Development Plan
IPTN	Integrated Public Transport Network
IRT	Integrated Rapid Transit
ITP	Integrated Transport Plan 2017-2022
MSE	Metro South-East Corridor
MSDF	Municipal Spatial Development Framework
MTIIF	Medium-Term Infrastructure Investment Framework
NMT	Non-Motorised Transport
PD	Pragmatic Densification
PT	Public Transport
PTNG	Public Transport Network Grant
PTIG	Public Transport Infrastructure Grant
PTOD	Pragmatic Transit Oriented Development (land use model)
TAP	Transit Accessible Precinct
TAZ	Transportation Analysis Zone
TCT	Transport for Cape Town
TDA	Transport and Urban Development Authority
TDI	Transport Development Index
TOD	Transit Oriented Development
TOD-C	Transit Oriented Development Comprehensive (land use model)
UGM	Urban Growth Model

1. INTRODUCTION

Throughout the world urbanisation has been occurring at a rapid rate, with more people now residing in urban areas compared to their rural counterparts (UN 2014). Often as cities grow, they lack the proper public infrastructure needed to support a burgeoning population which can cause several mobility and accessibility issues. However, according to Goldwyn (2013) an efficient and sustainable public transport network can revolutionise the way in which a city continues to grow and function. If implemented correctly, public transport has the potential to shape new neighbourhoods, and have positive socio-economic consequences for the city as a whole (Ugo 2014). Many cities such as London and Cape Town have therefore implemented and aligned their public transport systems with new infrastructural developments so as to move people, goods and services around as fast as possible. Therefore, it has become a significant force in becoming an effective urban regenerator of change.

1.1. PROBLEM STATEMENT

Many cities in the world are searching for ways to address their current urban transportation, accessibility and development challenges. Cape Town has a particularly complex urban layout due to both the injustices of apartheid spatial planning, and a somewhat complicated physical layout. Urban sprawl has pushed the boundary of the city farther outward, contributing to areas that are both physically and economically cut-off from the rest of the city. As a large proportion of the working class population reside in the urban periphery, employment opportunities are often located outside of these areas. This has led to transport networks becoming increasingly congested and overburdened, as these employment opportunities are situated within wealthier suburbs and nodal development cores.

Within South Africa, the amount of people living in urban areas surpassed that of their rural counterparts in 2009, with current figures now suggesting that the country is more than two-thirds urbanised (UN 2014). Presently South Africa has a higher urbanisation rate than the world average, with the country expected to be 71.3% urbanised by 2030 (South Africa 2016). This will further place increasing strain on South African cities

and their associated transport infrastructure. In recent years Cape Town has experienced a rapid population growth, establishing itself as South Africa's second largest city and supporting over 4 million individuals (CoCT 2017). Rapid urbanisation is said to have exacerbated the legacy of apartheid spatial planning, which has resulted in a disintegrated and fragmented urban form. As more than 40% of Cape Town's population reside approximately thirty kilometres away in the urban periphery, transport networks are often congested, more expensive and overburdened (CoCT 2016a). This has resulted in Cape Town becoming South Africa's most congested city, a title which it has held since 2013 (Savides 2016). This has caused peak travel times to extend from the original 07:00-09:00 in 2011, to the now longer period between 06:00-10:00 (CoCT 2015a). This has resulted in much as 40 percent of monthly incomes for the low income group being spent on transport to and from places of work (CoCT 2015a).

Seeing this trend develop, the CoCT decided to overhaul its public transport network and infrastructure system. The Integrated Public Transport Network (IPTN) plan was developed, which brings together all modes of transport including bus, rail, taxi and other forms of non-motorised transport under the care of the Transport and Urban Development Authority (TDA). The proposed plan aims to install a citywide, integrated transportation network by 2032, where various methods of public transportation will be joined together to form a seamless system. One of the major projects is the development of the multi-billion rand MyCiTi Bus Rapid Transit (BRT) system. Ultimately, the full scope of the system hopes to achieve a goal of placing 80% of residents within 500 metres of a transit station or stop within twenty years (MyCiTi 2015).

The MyCiTi BRT was first launched as a pilot project in May 2010 for the FIFA World Cup to provide services in and around key locations in central Cape Town for spectators and visitors. The System has since grown, with the first official route opening in early 2011 and successive smaller phases following. Seeing marginal success in the first few years of operation, MyCiTi now has an average number of around 66,000 daily commuters (BRT-Data 2017). In early 2017, the CoCT was successfully granted an application to start construction on phase two of the MyCiTi BRT project. With phase two of the project, MyCiTi aims to link many poorer neighbourhoods in the periphery with the rest of the city. Two trunk services and a network of 34 feeder routes will be

constructed over the course of five years, connecting 1.4 million inhabitants to the rest of the city (MyCiTi 2017). Mitchells Plain and Khayelitsha are earmarked as the two new trunk services, and will be linked along a new 35 kilometre dedicated busway. An estimated number of 25 new closed stations will have to be built, along with an additional 45 stops along these trunk routes (MyCiTi 2017). Within these neighbourhoods however, a further 320 stops will also have to be constructed. This amounts to a massive new capital outlay of infrastructure, and one in which the CoCT is hopeful will lead to improved access, easier mobility flows and development of these areas. With an estimated cost of ZAR4.7 billion and roughly four times the size of Phase 1, the second phase of this project needs to be properly evaluated in a broader planning context (MyCiTi 2017).

The CoCT has also recently adopted a Transit Oriented Development (TOD) approach to planning, with support for infrastructure and transport led economic growth and development being key. TOD has been touted as an approach that can re-energise and connect more areas of the city together, improving accessibility and increasing the socio-economic profile of various neighbourhoods and suburbs. New transport developments and investments are now actively supported around Integrated Rapid Transit (IRT) links, such as the MyCiTi BRT system. Although still relatively in its infancy, Phase 2 of the MyCiTi BRT project represents the perfect opportunity for the CoCT to apply the principles of TOD on a larger, more concrete scale. This brings the notion of whether TOD combined with BRT can change Cape Town's built environment for the better.

1.2. AIMS AND OBJECTIVES

The aim of this research is to identify how the CoCT aims to use the MyCiTi BRT as a catalyst in the implementation of their newly adopted Transit Oriented Development (TOD) Strategy. TOD has the potential to shape, change and drastically impact how future development will occur within Cape Town's built environment. In order to see the current and potential effects of TOD, an extensive coverage behind how and why it was adopted will be undertaken. Phase 1 and 2 of the MyCiTi BRT will extensively be looked at in order to determine how it can and has acted as a catalyst in this change.

This will be done by looking at the level of planning, implementation and roll out of these phases and what impacts MyCiTi has caused on the built environment so far. By looking at the use of land of areas adjacent to BRT infrastructure and what new changes have occurred will allow a broad understanding of the current status of TOD in Cape Town.

Phase 2 of the MyCiTi BRT is now being actively developed according to the newly adopted TOD Strategic Framework in mind, with emphasis on integration between different modes of transport. The Integrated Public Transport Network (IPTN) gives specific attention to how both TOD and IRT systems can aid in transforming the efficiencies of Cape Town's built environment.

In order to achieve this aim, the following research questions will be answered:

1. How did the concept of a BRT for the City of Cape Town originate?
2. How and where did the concept of TOD originate?
3. What forward land use/spatial planning went into planning for Phase 1 vs planning for Phase 2 of the BRT?
4. What are the socio-economic characteristics and average population density of the population living in close proximity to BRT stations in Phase 1 vs Phase 2?
5. What are the current land uses adjacent to BRT stations in Phase 1 and Phase 2?
6. What is the current status of TOD in Cape Town?
7. Has Phase 1 of MyCiTi spurred any growth in a TOD manner?
8. Were/are there any i) noticeable land use responses and developments and/or ii) impediments to land development surrounding BRT stations in Phase 1 and Phase 2 in Cape Town?

Therefore, this study aims to address the planning process behind both phases 1 and 2 of the MyCiTi BRT system in Cape Town. By using the MyCiTi BRT as a tool for the implementation of TOD, the CoCT hopes that this will lead to a more sustainable urban form and function. This ultimately highlights and demonstrates the importance of the planning processes for project outcomes as it can affect society as a whole.

2. Literature Review

As urban space has to serve a variety of functions, goods and services need to be effectively distributed in an efficient manner around the city. Transportation infrastructure is said to be a vital component to the economic growth and well-being of cities (Cervero 2013). This is especially prevalent in the Global South where urban populations and economies have dramatically increased in recent decades. Services, housing and places of employment are often disconnected from one another, leading to inefficient, and sprawling urban spaces. The lack of transportation links and systems, coupled with the increasing reliance on the private car has led to several mobility and accessibility issues within urban areas. In order to deal with these mounting issues, cities have begun to see the power that an integrated public transit system can have in shaping future growth. Goldwyn (2013) highlights this importance, adding that transport and land-use planning must run in parallel to ensure an optimal efficiency.

However, as with many cities in the Global South, there continues to lie a spatial mismatch between housing, employment and transportation links. This is evident in uncontained urban sprawl, where cities have grown without the correct planning and transport mechanisms in place (Cervero 2013). This has led to the clustering and concentration of services and other economic activities, exacerbating urban mobility and accessibility issues. This is often aggravated in cities that have no established transport links or public transit systems. Therefore it is paramount to reconnect people to the city, with land-use and transportation planning becoming more closely integrated to ensure optimal efficiency in and around the city. This has led to a renewed focus in achieving a compact city, whereby Transit Oriented Development (TOD) is said to actively achieve this form with the aid of new mixed-used land developments in and around transit hubs and stations.

2.1. PUBLIC TRANSPORT AND THE RISE OF BRT

In today's largely urbanising world cities are growing at a tremendous rate, with 24 of the worlds 31 mega cities (10 million inhabitants or more) being located in the global South. This is further compounded by the fact that the 10 cities that are projected to

become megacities between 2016 and 2030 are all located in developing countries (UN 2016). This, coupled with growing levels of private car ownership, has meant that many cities are struggling to deal with the large influx of people, goods and services that traverse their road networks. This has placed significant strain on these networks and other transportation initiatives, often hindering further development of certain areas. According to Robert Cervero (2004), transportation and cities are co-dependent, mutually influencing each other in often complex and dynamic ways. He goes on to say that it is not the hardware characteristics of transport initiatives, but rather the resultant software characteristics (i.e. greater accessibility) that shape urban environments. A recent 2013 UN-Habitat study reveals that accessibility is at the core of urban mobility. It goes on to mention how mobility flows have become a key dynamic of the urbanisation process, with its associated infrastructure establishing and representing the backbone of urban form. As a vast majority of trips taken are to reach an end destination, accessibility and not mobility is considered to be more important (Dauby Et al 2014). Public transport links and routes can therefore play a pivotal role in providing all citizens and visitors with access to opportunities and facilities around the city, whether for economic, education, health, recreation or social purposes (Bulman, Greenwood & Kingma 2014).

Public transport initiatives have the power to transform and radically alter how a city functions. In 1974, the Brazilian city of Curitiba introduced a new form of public transport in order to deal with mounting traffic and mobility issues. The Bus Rapid Transit (BRT) system was developed, promising to deliver the same experience and results that a light rail system can offer, but with drastically lower input and operating costs (Rizvi 2014). In short, BRT can be considered to be an integrated system of facilities, services and amenities that collectively improve the speed, reliability, and identity of bus transit. Rizvi (2014) maintains that BRT systems are becoming increasingly more popular due its ability to be built quickly, incrementally, and economically.

According to Levinson Et al (2003), a BRT system is one that usually has dedicated bus lanes, raised stations and platforms, distinctive branded vehicles offering an off-board fare collection scheme and one that acts as a closed system offering both a constant scheduled and regular service interval. Maeso-González and Pérez-Cerón

(2014) on the other hand define BRT as "a rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses". A more detailed definition, which was developed as part of the Transit Cooperative Research Program (TCRP 2003) is as follows:

> "BRT is a flexible, rubber tired rapid transit mode that combined stations, vehicles, services, running ways, and intelligent transportation system elements into an integrated system with a strong positive image and identity. BRT applications are designed to be appropriate to the market they serve and their physical surroundings and can be incrementally implemented in a variety of environments".

Table 2.1: Characteristics of BRT

Characteristics	**Description**
Dedicated Right of Way and Bus Lanes	Bus only lanes - fully segregated from mixed traffic to allow faster travel times.
Route Structure	Dedicated routes with frequent service. Can be along dedicated trunk routes so as to move between areas faster
Stations	Stations are secured and provide platform level boarding which provides universal access
Reduced and Frequent Travel Times	Fewer stops and signal priority along most routes, with frequent service intervals
Off-Board Fare Collection Scheme	Allows for faster boarding, safety and proof of payment fare collection scheme. Can offer packages and discounts.
Branding	Unique and distinctive branding aimed at improving and establishing its presence

Source: Author (2017)

Curitiba saw that the BRT system was up to 99.8 percent cheaper to implement when weighing it up against building a full underground subway system (Goldwyn 2013). This meant that rather than paying upwards of US$90 million per kilometre for subway related infrastructure, local officials prioritized the new buses on existing streets for only US$200 000 per kilometre. While it is important that a BRT system becomes and remains cost-effective, it is noticed that higher densities are not required in order to

support the system. A study by Guerra and Cervero (2011) found that a BRT service required significantly lower densities than compared to light rail. They went on to uncover that a BRT system needed at least 45 jobs and residents per hectare within 800 metres of a station to be in the top 75 percent of cost-effective investments. A light rail system on the other hand required 125 jobs and residents per hectare to fall in the top quartile. Consequently, lower density thresholds are seen to act as an enabler in choosing BRT given the amount of urban sprawl that has occurred in the past. This means that BRT is well suited for cities that have lower densities and spread out spatial patterns.

Currently there are over 34 million people per day that use a BRT system, and this number is expected to grow substantially as cities are seeing the high latent potential that buses can offer (BRT-data 2017). According to Wright (2011), almost an equivalent amount of BRT systems are still in development, pointing towards their increasing popularity. This is especially prevalent in the Global South, where BRT has become known as one of the most effective solutions in providing transit services on a cost-effective basis in urban areas (Cervero 2013).

BRT systems need to also be differentiated from regular bus-based services and routes that only offer limited reach and support around a city. Public transport, and in particular buses, are still associated with a negative and undesirable perception. Vuchic (2007) argues that there lies a level of social stigma attached to transit dependent users (often lower income) who ultimately detract from a bus-based system's image. Cervero and Dai (2014) maintain that if there is an absence of key permanent infrastructure, it is thought to weaken and reduce BRTs overall development potential for a surrounding area. Due to BRTs ability to change and alter routes, many real estate developers do not have the assurance of the service features and of future bus operations. Currie (2006) however disagrees, maintaining that a BRT system offers the flexibility and versatility advantages that rail-based systems do not, by conferring benefits to areas that were previously unreachable. One of the main challenges therefore in the implementation phase is to challenge the public's perception of what a BRT service can provide. Only when a bus-based system begins to imitate the high quality, fixed guideway features of a rail system (dedicated and exclusive lanes) does it tend to shed

the negative stereotypes associated with older bus systems (Cervero 2004; Cervero & Dai 2014).

2.2. LAND USE AND TRANSPORTATION PLANNING

2.2.1. Transit Oriented Development (TOD)

It is said by Suzuki, Cervero & Iuchi (2013) that one of the most important strategic initiatives for developing more sustainable urban environments is the integration of transit and land use. Transit Oriented Development (TOD) can be considered to be a planning and design strategy for urban spatial development. It is a policy framework that aims to achieve a compact, mixed-use and pedestrian friendly urban environment that is closely integrated with nearby transit stations (Salat and Ollivier 2017). Transport infrastructure is considered to be the single most important determinant of land-use patterns which in turn directly shape mobility behaviour (LSE 2013). TOD therefore embraces the notion that locating services, amenities, jobs and housing around transit hubs promotes the use of transport systems and the use of non-motorised travel. TOD also hopes to see that by placing transit stations nearby residential areas, it hopes to facilitate and strengthen the emergence of compact urban communities and Non-Motorised Transport (NMT) initiatives. Urban areas that have increased access to transport links and well-designed urban spaces become highly attractive places for people to live, work and interact with the urban fabric (Suzuki, Cervero & Iuchi 2013). This is said to ultimately enhance a city's economic competitiveness, whilst at the same time promoting a more inclusive development.

Although TOD takes on many forms across the world, the Institute for Transportation and Development Policy (ITDP) has developed a TOD 'Standard'. This was developed to come to a common understanding of what constitutes urban development best practice. Ultimately, this includes reducing the use of private transportation and promoting the use of NMT (cycling, walking) and public transport. The TOD Standard identifies that by placing urban development projects within walking distance from an intermodal transit station presents an ideal opportunity to foster economic development. The ideologies of the TOD Standard is thus summarised in Table 2.2.

Table 2.2: TOD 'Standard' Principles

Principles	Description
Walk	Develop neighbourhoods that promote walking
Cycle	Prioritize non-motorized transport networks
Connect	Create dense networks of streets and paths
Transit	Locate development near high-quality public transport
Plan	Plan for mixed use
Densify	Match density and transit capacity
Compact	Create compact regions with short commutes
Shift	Increase mobility by regulating parking and road use

Source: CoCT 2016a

According to a recent report by the Salat and Ollivier (2017), cities that have undertaken a TOD approach to urban design have managed to spur economic growth, whilst at the same time becoming more globally competitive. This is as a result of agglomeration effects that TOD manages to deliver. Doubling job density of an area is said to increase economic productivity by as much 5–10 percent (Salat & Ollivier 2017). Businesses and firms will therefore locate where they can increase productivity. In other words, higher concentrations of economic activity should foster increased local economic development through economies of urbanization and localization (Rosenthal & Strange 2004). This according to Behrens et al (2014) would therefore attract more workers and residents whilst establishing and increasing economic links in to the area.

The City of London has adopted a TOD approach with new developments in and around underground tube stations. According to Smith Et al (2013), an increase in London's office prices (gross leasable area) are strongly correlated with the level of access that it provides to employment opportunities and people. Crossrail, London's new underground rail network and Europe's largest and most expensive transport construction project, has already had an impact on future investment decisions. Over 57 000 new homes and roughly 3.2 million square metres of commercial office space was identified for development – all within a one kilometre radius of stations along the route (Salat & Ollivier 2017). Although London is an established city with strong links and transit systems, the longer term benefits of TOD can best be seen here. In the next

decade, Crossrail will see an estimated increase in value for both commercial (10% above baseline) and residential (20-25% above baseline) properties located around new stations (Crossrail 2016). Here we begin to see that accessibility variables become an influential measure when considering TOD. Therefore, the most significant improvements can be expected to occur where large changes in connectivity coincide with major development opportunities.

As TOD aims to achieve a compact and mixed urban form, a dense urban form aligned with the transit network are key factors of competitiveness (Williams, Burton & Jenks 1996). TOD therefore recognises that urban development projects should not simply be aligned next to public transport routes, but should be pro-actively oriented toward public transport links (Cervero & Dai 2014). TOD has gained popular support in South African transport and urban planning policy circles in recent decades (CITE). The CoCT hopes to follow in the footsteps of other successful cities that have implemented a TOD approach in shaping their urban space and transport network. Johannesburg implemented a TOD approach with the development of the highly successful Gautrain Rapid Rail project. Developments in and around new rail stations have spurred growth, opening the city up further and improving accessibility in and around certain areas. According to an impact study done by Mushongahande et al (2014) on the areas around Gautrain stations, there is evidence that it does indeed attract new development in the vicinity around station precincts. They go on to mention how private property developers considered the presence of new Gautrain stations to be a major factor influencing their decision to develop in and around these areas.

Mushongahande et al (2014) argue that the Gautrain was an important revitalising instrument for the less developed and less attractive nodes of Midrand and Pretoria. The revitalisation and upgrading of brownfield sites along with the development of greenfield sites in these areas has indeed helped spur economic growth in these areas. Every major rail station constructed for the Gautrain generated some sort of development, upgrading and construction in and around the stations. This points to a strategy whereby a high quality public transport system coupled with the benefits of TOD can drastically alter the urban fabric in more ways than one. That being said, Suzuki, Cervero & Iuchi (2013) maintain that TOD can take years and even decades for a city to reap the full benefits that it creates. As a BRT service can provide the same

level of service that a light rail system can, it points to the high potential that BRT has in fostering higher levels of TOD.

According to Smith Et al (2013), the concentration of new transport capital investments in a one kilometre radius around transit stations offers an opportunity to change and shape cities into more efficient, inclusive and liveable areas. Nowadays, cities are taking supportive measures to prioritise development around transit hubs that are positioned in and along economic growth nodes and corridors. The CoCT has noted this trend, and has made TOD their key strategic framework for the foreseeable future. The CoCTs current vision is enshrined in their TOD Strategic Framework for the city, which establishes an implementation plan that will guide, direct and inform development in the city for the foreseeable future.

2.2.2. The (New) Compact City Model

Urbanisation has become one of the most transformative trends of the twenty-first century, fuelling the need for cities to expand and grow in relation to their burgeoning populations. This is especially apparent in the global south where cities are characterised by primacy and urban sprawl, contributing to the concentration of economic assets and employment opportunities (Cervero 2013). This spatial mismatch often seen between housing and employment opportunities has led to inefficient and ineffective cities, perpetuating a poor economic environment and decreasing overall quality of life (Cervero 2001; Ewing et al 2015).

In the global south, urban sprawl is taking place alongside rapid economic development and population growth, which places increased pressure on resources and the provision of goods and services. Urban sprawl is often characterised by the low-density, inefficient and rapid development around the periphery of cities, pushing the urban edge further outwards (Couch et al 2007; Chen et al 2014). This contributes to the loss of valuable land for the future growth potential of a city, which ultimately increases the cost of transport and service provisions. Habibi and Asadi (2011) go so far as to say that urban sprawl is one of the main problems that cities face today, with the effects from decades of sprawl now beginning to cause problems for urban areas. Chen et al (2014) maintain that urban sprawl has taken on a negative connotation, which has led

to the rise in popularity of the more densely aligned, compact city. Therefore many cities are actively trying to combat sprawl, with strategies such as TOD combined with a BRT system one of the main methods in doing so within the Global South. This provides a platform for cities to bolster and improve their economic output and productivity, acting as a meeting place where goods, services and people can meet.

In recent literature, scholars have noted the increasing trend of cities adopting a more compact city layout (Stead and Marshall 2001; Jenks & Jones 2010; Milder 2012; Bardhan, Kurisu & Hanaki 2015). A compact urban form is actively sought after as infrastructure and services can be distributed in a more cost effective manner. This offers people a greater access to a wider variety of facilities and amenities in their immediate surroundings (Breheny 1992). A study undertaken by Kenworthy and Laube (1999) reveal that sprawling urban areas are poorer economic performers, and that gross regional product per capita was generally higher in more compact cities. This is due to greater accessibility in and around the city, as distances become less and efficiencies are said to increase. Jenks and Jones (2010) agree, adding that a compact city offers higher rates of productivity due to a reduction in time wastage. This effect is compounded when urban areas offer an integrated transport network, allowing businesses and firms access to a larger pool of workers and vice versa. This can lead to urban agglomeration economies forming, contributing to increased performance (Williams, Burton & Jenks 1996).

Conversely, a study by Prud'homme and Lee (1999) revealed that there lies a strong relationship between the physical layout of a city and its related economic performance. They saw how city size, places of employment and commuting speeds across several countries influenced the urban fabric and general economic performance. Prud'homme and Lee (1999) ultimately conclude that spatial planning and good transport infrastructure should be aligned with one another which should increase the economic output and performance of a city. Both the containment of sprawl and the improvement of transportation links within a city increases the productivity output of a city. Cervero (2013) maintains that compact cities that provide good accessibility and an efficient transport network can be considered to be among the most productive of all urban settlement types. Therefore, it can be seen that the ideals surrounding a compact city

work well with the principles of TOD, and should always be actively encouraged to always work together.

By integrating transit with development and limiting the urban edge, a compact city should also reduce the need for travel by private motorized vehicles (Suzuki, Cervero & Iuchi 2013). A well integrated transit system and densified land development create urban forms and spaces that are more sustainable in the long run. Cervero (2001) builds on the work of Prud'homme and Lee, by suggesting that greater accessibility between jobs and housing, and a well-functioning transport system appears to positively contribute to the economic wellbeing of a city. TOD is said to achieve this feat by actively promoting the use of Non-Motorised Transport (NMT), hoping to see increasing levels of pedestrians both in and around integrated transit stations. Public transport systems are usually an integrated facet of compact cities, as initial infrastructure is cheaper to install and implement on a smaller scale (UN-Habitat 2013b) . This can lead to improved quality of life if the correct transport networks are in place to facilitate an individual's movement around the city.

2.2.3. Corridor and Nodal Development

In order to best instigate TOD with BRT, urban areas can leverage the powerful effects that nodes and corridors can create and foster. Dittmar and Ohland (2004) mention that TOD is never a stand-alone phenomenon, rather it is accompanied and strengthened by the development of economic nodes and transit corridors. Freilich (1998) maintains that a city's transportation system has a profound influence on its land-use patterns and rate of growth. He goes on to mention that transportation infrastructure is a shaper of urban form, and that the reliance on the private car in past decades has turned cities into inefficient and ineffective sprawling urban areas. Many cities that have experienced sprawl have resulted in the concentration of different types of land-use zones throughout the urban area. This ultimately leads to an inefficient and ineffective layout whereby employment opportunities and residential neighbourhoods have become increasingly separated and disconnected from one another. The growth of economic nodes and corridors throughout the city is therefore paramount in reconnecting the city, as well as to improve economic output and general quality of life (QOL), especially for residents in poorer areas. Development corridors along popular transport routes are said

to connect these nodes together, stimulating and creating a purposeful point of interaction between commercial and residential areas (Donaldson 2006). These development corridors are often characterised by a dynamic, mutually supporting relationship between land use and a supporting movement system.

Development corridors are commonly supported by a transport service that functions as an integrated system to facilitate ease of movement. Integrating various forms of transit linkages along the corridor allows for activity spines to develop, enhancing the economic potential of the area (Green et al 1995; Donaldson 2006). Ditmar and Ohland (2004) agree, maintaining that transit and TOD are often perfectly matched in these areas. While TOD may not be a new phenomenon, the challenge of adapting it according to an auto-oriented city is. The call for cities to develop in a more sustainable manner has meant that a push for a more compact city has led to the renewed interest in public transportation/mass transit. A move toward a more integrated and interconnected urban form allows a greater level of economic efficiency and productivity. This allows for areas of high-density, mixed-use urban development to occur, in which trip lengths and access to opportunities are greatly increased. This, according to Cervero and Dai (2014) allows for the convenient integration of urban communities with increased service provision, while also fulfilling a range of socio-economic needs. Robert Freilich (1998) maintains that by increasing densities in transit corridors and nodes, TOD principles encourage the development of a more concentrated, rather than dispersed, pattern of development. This, according to Donaldson (2006), can lead to the more efficient utilisation of infrastructure and resources, whilst at the same time increasing economic linkages and investment for the area.

Transport and housing are traditionally the largest expenditures for households, often accounting for more than half of one's income. By leveraging TOD within nodes and corridors, social and economic activity is said to increase (Cervero & Dai 2014). A study by Santos (2011) on the Curitiba BRT system revealed that it extensively relies on concentrated densities and mixed-use development along radial corridors in order to attract people to use the service. Cervero and Dai (2014) agree with this statement, maintaining that mixed land-uses along corridors in Curitiba have resulted in balanced, bidirectional flows. The concept of 'seat renewal' is important here as it determines

whether a BRT system becomes cost-effective or not. An activity corridor is said to strengthen this process by filling buses in both directions, thereby contributing to a more effective urban form. A recent analysis undertaken by Duarte and Ultramari (2012) stress the importance and relevance of activity corridors in the built environment. They maintain that up to 78% of trips that started in the terminus of Curitiba's north–south BRT corridor ended at a stop on the same corridor. This points to the increasing importance that corridors and nodes have for a city, which is seen to improve both accessibility and mobility levels.

Salat and Ollivier (2017) maintain that the layout of transit networks across the urban fabric plays a key role in shaping forces of agglomeration and the distribution of densities. They maintain that up to two-thirds of employment opportunities are typically located outside of the original core, which provides an ideal opportunity to create a mixed use development around transit corridors and nodes. Land-use and transport policies are increasingly becoming more intertwined, and are becoming central tools for local governments to change a city's built environment. Following a TOD perspective will enable agglomeration economies through better job matching, knowledge sharing, and networking opportunities (Cervero 2001; Fallah, Partridge, & Olfert 2011). There is also said to be higher growth potential where corridors can activate multimodal integration between different forms of transit, where the intensity of human interaction is greater (Salat & Ollivier 2017). The actions of a multiplicity of stakeholders and consistent policy frameworks across many geographical scales are needed to leave a long-term positive impact on city form and maximize economic efficiency.

2.3. BRT and TOD

Levinson et al (2002), maintain that BRT can indeed spawn TOD, guiding growth in a more compact, mixed-use urban form. Vincent and Jerram (2008) found that the type and level of investment occurring near BRT stations appears to be comparable to the experience with TOD near rail transit. They go on to say that planning agencies generally made no distinction between BRT and rail in terms of its ability to attract TOD. Cervero and Dai (2014) ultimately maintain that BRT is more than just a mobility investment. BRT has the ability to restructure and transform urban and regional growth

in new ways, leading to a more sustainable urban form. In a series of studies across three countries, Vincent and Jerram (2008) identified that developers were enthusiastic about the potential of BRT to attract TOD, mentioning that BRT impacts positively on property values surrounding stations. According to a recent World Bank review on urban transport lending, BRT was found to have great potential as a means to achieve modal split, environmental and poverty related objectives, whilst also facilitating and increasing economic development (Mitric 2013). When investigating the land value benefits associated with BRT, Estupinan and Rodriguez (2008) found that Bogatá's BRT system showed positive results in fostering an improved economic environment. Housing units that were located closer to the Trans-Milenio BRT rented for more per square meter than units located farther away. There is also increasing evidence that creating a pedestrian-friendly environment near BRT bus stops can further increase land-value benefits (Cerevo and Dai 2014)

However, recent failures of BRT systems in other cities has prompted the need for public officials to display a greater sensitivity to a city specific context, rather than simply copying a blueprint that worked well for another city or local area. Every city faces its own unique challenges that require input from a myriad of stakeholders that ultimately influence its success factor.

According to study by Kumar Et al (2011), transport projects that were implemented the fastest had consistently strong and dedicated support from the local governing body in charge. Therefore strong political commitments and obligations are required, as initial transport infrastructure provision can be an expensive undertaking in cities that lack formal public transport facilities and features (i.e. fixed fares, formal stops and schedules). Consequently, implementation of large transport projects necessitates the need for good planning from officials to address city specific challenges such as congestion, limited mobilities and social inequality. Cities and local governments alike can thus spawn development through supportive zoning, targeted infrastructural investments and other pro-growth incentives. There thus lies a strong link between land use and transportation planning, which have slowly become aligned with one another in recent years (Freilich 1998). A well-integrated transit and spatial development scheme can create urban forms and spaces that are said to contribute to a more

sustainable city. A BRT system can thus be used as an enabler to stimulate development and create a more accessible city.

When Kumar Et al (2011) studied various BRT related projects around the world, they highlighted the importance that the general public, informal sector and existing public transport providers play. After analysing the implementation process of the respective BRT systems for both Lagos and Johannesburg, it was revealed that communication and consultation between these different stakeholders was vital to ensure a quicker and less problematic implementation. Johannesburg had great difficulty in the implementation of its Rea Vaya BRT system due to a lack of consultation with both the informal sector and minibus-taxi industry. On the other hand, Lagos was able to get the informal sector on board relatively early on in the development of its BRT system. This much faster implementation has resulted in Lagos carrying over 200 000 passengers a day compared to Johannesburg's 42 000 passengers per day, even though they started operations at relatively the same time and are of similar size and scope. These differences between Johannesburg and Lagos are an indication of the importance that a two-way communication and consultation plays in stakeholder engagement and management. There thus lies a number of different interest groups, all of which have a different perception and stake within the public transport system.

The CoCT sees the MyCiTi project as the backbone of its 2032 public transport vision for Cape Town. If properly planned and executed, BRT systems have the potential to revolutionise the effectiveness and efficiency of transport operations within a city. According to Litman (2017), although not every BRT system is cost effective, transit improvements tend to provide significantly more value to society than simply measuring explicit costs. Litman (2017) goes on to say that current transportation evaluation practices tend to overlook and undervalue implicit costs associated with the development of large projects. These can be the overall benefits that it can provide, such as improved mobilities and socio-economic factors, and the potential for greater investment both in and around stations (i.e. TOD). Although the potential of BRT as a cost-effective mobility option is well-established, its ability to catalyse economic activity through TOD has not been well studied or investigated.

3. METHODOLOGY

3.1. RESEARCH DESIGN AND DATA ACQUISITION

The research study followed four stages as indicated in Figure 3.1. Stage one consisted of a broad literature review to provide a theoretical and conceptual base around the various concepts surrounding public transport, and in particular Bus Rapid Transit (BRT). This was followed by an in-depth analysis of land-use and transportation planning surrounding the concepts of TOD, the compact city and how nodal and corridor development can generate economic activity and contribute to a more effective urban form. This created a platform to see how BRT can be leveraged to foster TOD, and in particular to study the various effects associated with new transport related infrastructural development. This allowed for the development of the research questions for Stage 2, as well as for the aim and objectives to be finalised.

Table 3.1: Interviews Conducted

Name	Place of Employment	Position	Date of Interview
Vernon Moonsamy	The City of Cape Town, Transport and Urban Development Authority	Senior Spatial Planner	17/08/2017
Catherine Stone	The City of Cape Town	Formal Director of Spatial Planning and Urban Deisgn	03/10/2017
Robby Robertson	Aurecon	Civil Enginner / Transportation Planner	18/09/2017

Source: Author (2017)

In Stage two, data was collected by means of primary and secondary sources. For this investigation, a mixed-method approach was utilised employing both quantitative and qualitative data. In order to gain a better understanding of how the MyCiTi BRT operates and how TOD has been implemented in the city, three interviews were conducted with relevant planning officials. Table 3.1 displays a breakdown of the interviewees and their respective places of employment. Interviews were conducted

between July and September 2017, with ethical clearance being granted and approved as low risk (Appendix A).

In stage three, appropriate data was then identified, extracted and analysed from the City of Cape Town's Open Data Portal. This allowed for up-to-date information on various transport, spatial and socio-economic characteristics in and around BRT stations within the study area (see figure 3.2). Interviews that were conducted in Phase 2 were transcribed and the data obtained from the Open Data Portal was analysed using Microsoft Excel for quantitative and qualitative data analysis. This allowed for the study of surrounding land use over time for the MyCiTi development of phase 1, and for a socio-economic profile of an area to be drawn. Stage 4 allows for the report to be compiled and finalised.

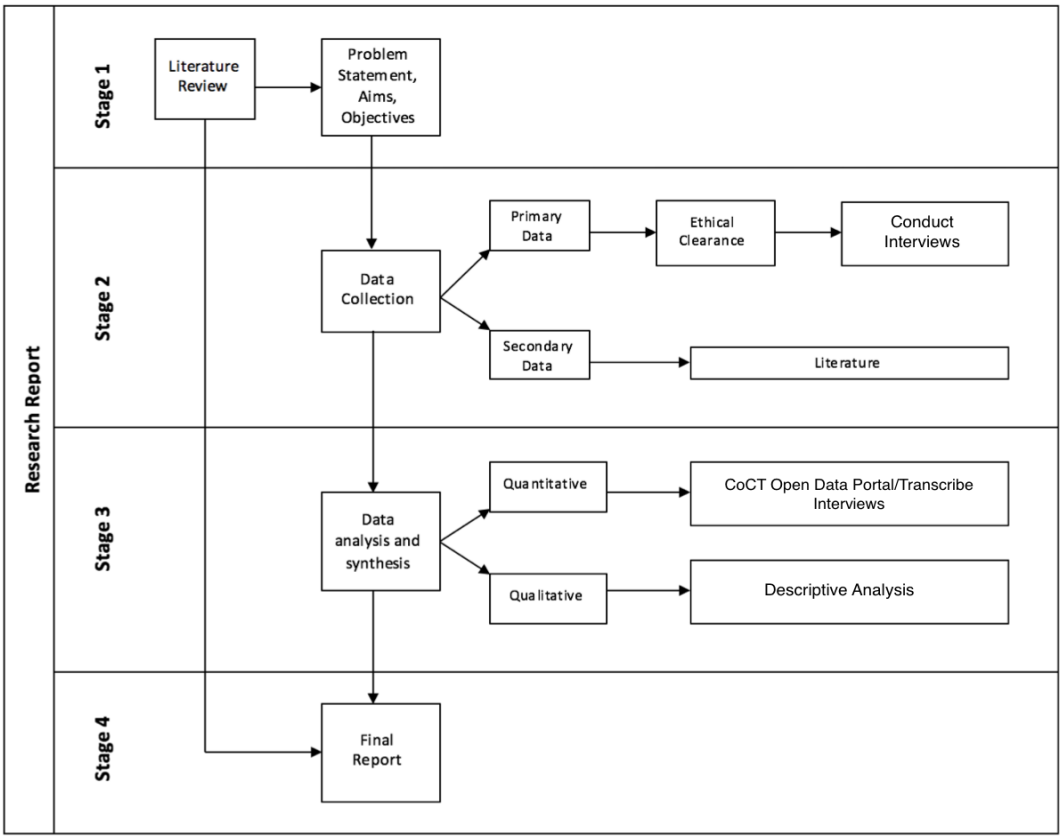


Figure 3.1: Research Process. Source: Author (2017)

3.2. STUDY AREA

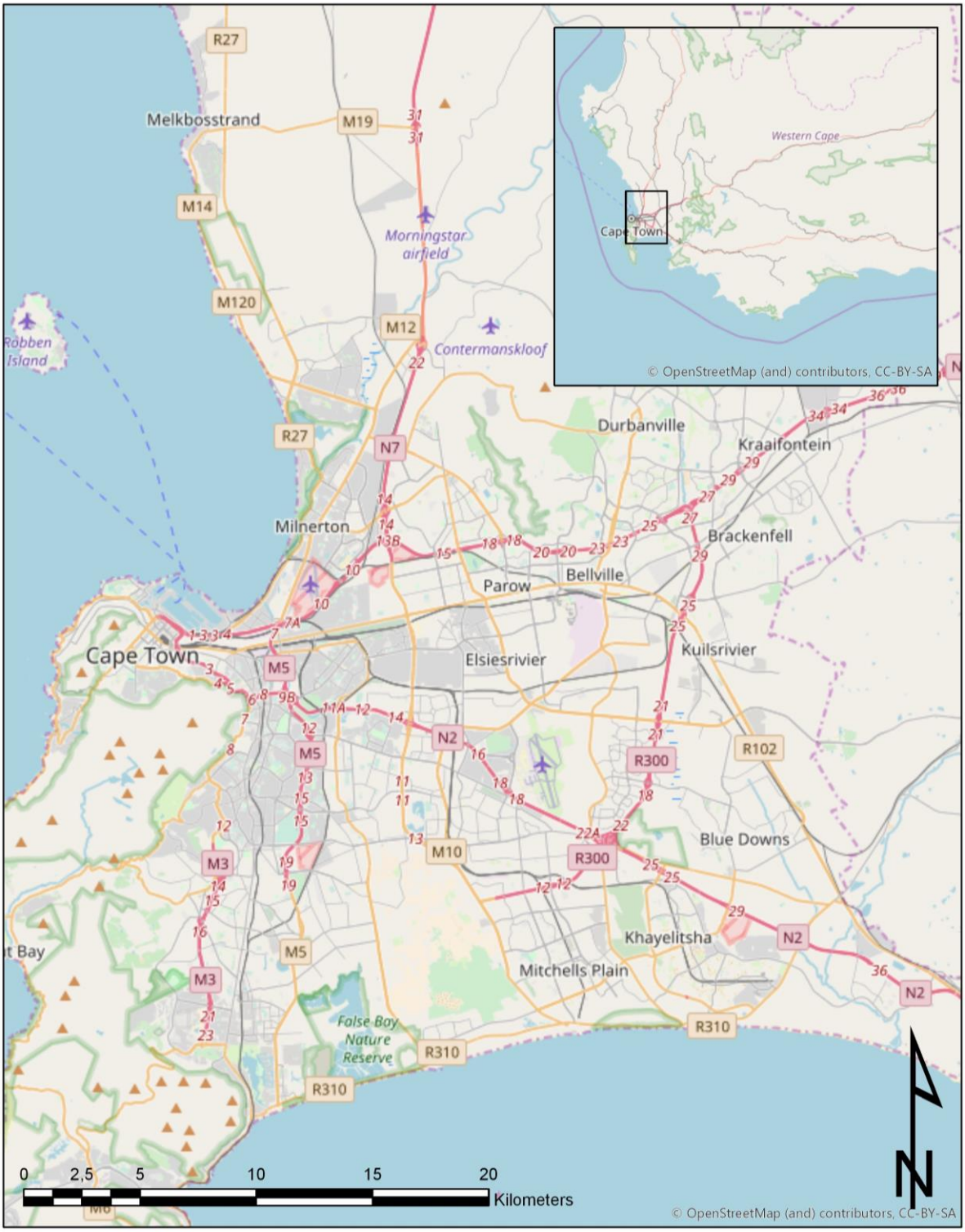


Figure 3.2: Study Area

4. RESULTS AND DISCUSSION

In this section, information gathered from the interviews and the results obtained from the Open Data Portal will be used to paint a picture of Cape Town's built environment and current transport picture. The two planning and development phases of the MyCiTi BRT will be discussed separately, as Phase 2 is still within the construction phase as of October 2017 and not yet operational. With the recent adoption of TOD as the main development focus for the city, it has re-shaped how phase 2 of the MyCiTi BRT was planned and how it will be further implemented, built and approved upon. This will be used to understand the current status of TOD in the city and what effect, if any, the BRT system has had on its further implementation and development.

4.1. THE EVOLUTION OF TRANSPORT AND LAND-USE PLANNING IN CAPE TOWN

The City of Cape Town (CoCT) has realised that transport plays an integral role in the effective functioning of a city, seeing the need to reconnect the people with the city. Therefore the CoCT adopted a multi-modal approach to transport, seeing different modes coming together at key transit stations. This forms part of an integrated transport solution for Cape Town, which led to the approval of the Integrated Public Transport Network Plan (IPTN) in 2014. The purpose of the IPTN is to develop an integrated public transport system for the entire Cape Town metropolitan area, with the aim to improve mobility and accessibility for all residents. The IPTN plan encompasses all modes of public transport, including rail and road based technologies, as well as recognising the need to improve NMT accessibility. Three further IPTN documents have since been released and approved, namely the Operational, Implementation and Business Plans to give full effect to the newly adopted TOD Comprehensive (TOD-C) land use model (see table 4.1). This paved the way in establishing what mode of transport is needed in order to meet both current and future transport demand. These plans have ultimately determined future routes, station and stop locations, modal interchanges and where transport infrastructure needs to be positioned.

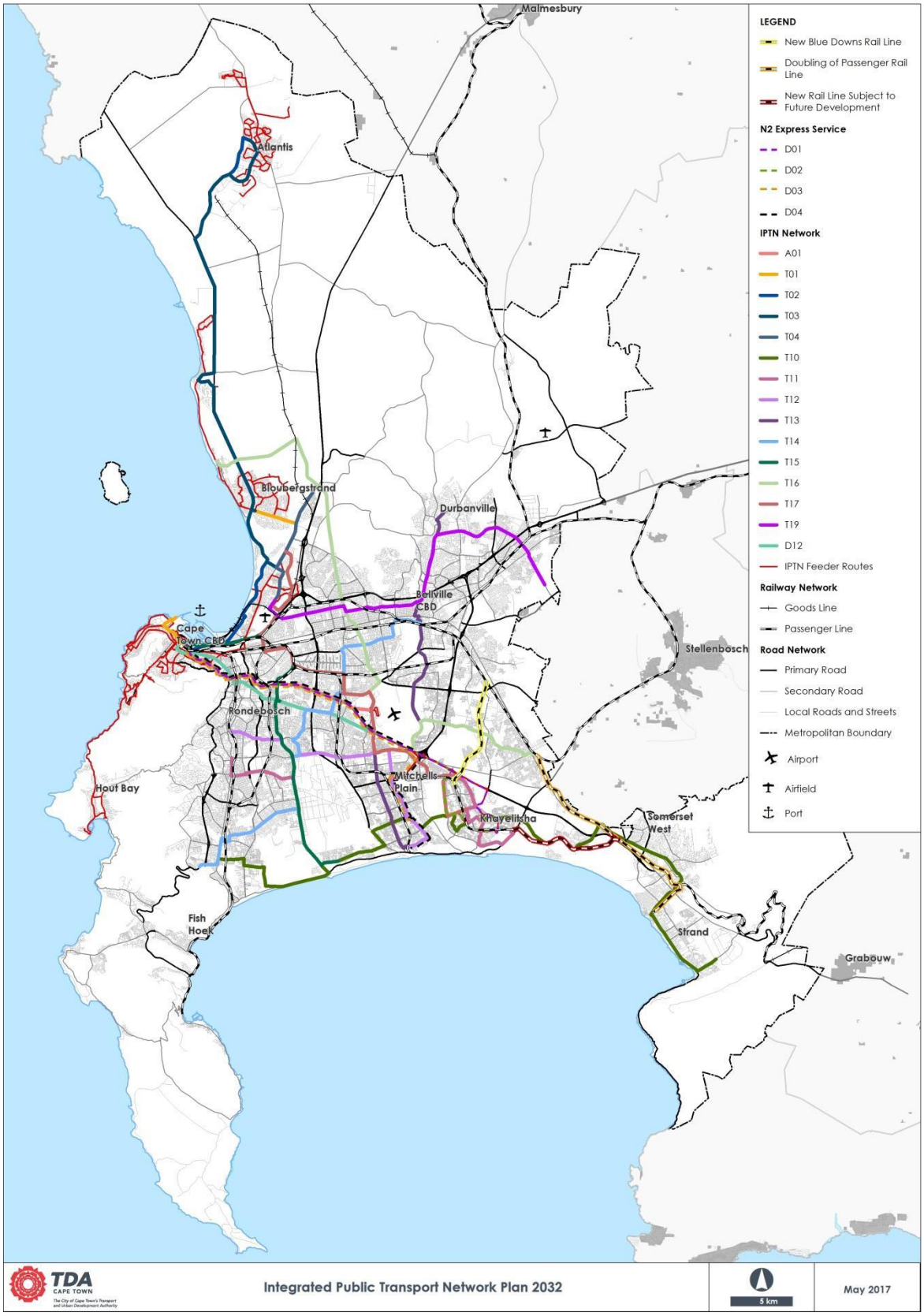


Figure 4.1: Integrated Public Transport Network Plan 2032 Vision. Source: CoCT 2016a

When the IPTN was in the development phase, the CoCT saw the opportunity to develop and explore options for a new land use scenario and model for the city. Due to Cape Town's urban area comprising of a network of disconnected and interdependent urban nodes, the City decided to move away from the Urban Growth Model (UGM) they had been following for many years. Table 4.1 displays the various land use scenarios that the CoCT investigated in order to predict the future potential spatial patterns and transport use around the city. The scenarios were combined with the current land use patterns and the anticipated new growth in areas across the urban fabric. The CoCT then created and developed a transport demand model to assess the different land use scenarios for the IPTN. The model took into account residential and employment distribution, travel times, commuter flows and land use and trip data obtained from census and household surveys. The number and time of trips for residents and their related modal choice were then also analysed in relation to trip purpose, travel distance and income. This was then reviewed to determine the trends and shortcomings of the current public transport system. The CoCT saw that the later scenarios (2013 onwards) could create a more efficient and balanced urban environment.

Year	Scenario	Spatial Allocation/Emphasis	Assumptions	Supporting Documents/Plans/Policies
Pre 2012	Urban Growth Model (UGM)	Citywide growth	Anticipated Development (best guess)	-
2012	Medium to Long-Term Cape Town Growth Options	NE & NW greenfield growth corridors	Greenfield Expansion	General Valuations Roll,
2013	Business as Usual (BAU) Land Use Scenario	Citywide growth	Development trends continue, not encumbered by urban edge. Based on financial and spatial principles in government subsidized housing policy, i.e. 1 land parcel 1 beneficiary	-
2013	Pragmatic Densification (PD) Land Use Scenario	Citywide growth	Development intensity and density more compact and more constrained within the urban edge, with intensified allocation to strategically located vacant parcels.	Medium Term Infrastructure Framework - MTIIF (initial assessment)
2013/2014	Pragmatic TOD (PTOD) Land Use Scenario	Citywide growth	Greater density and intensity in respect of new development located in relation to the public transportation network (IPTN) and access point, also included intensification on underutilised and vacant land parcels.	IPTN; Densification Policy; MTIIF (second assessment); Built Environment Performance Plan (BEPP); Making MyCiTi Sustainable
2015-	TOD Comprehensive (TOD-C) Land Use Scenario	Citywide growth – Public Transit nodes, Corridors, TAPs, PTZs	Land use allocated in a way that supports compact city development with a range of transportation related sustainability and efficiency outcomes.	IPTN Operational Plan; TOD Strategic Framework; Comprehensive Integrated Transport Plan 2017-2022; IDP 2017-2022; MSDF 2017-2022; BEPP; Travel Demand Management Strategy; IPTN Implementation Plan; IPTN Business Plan; Organisational Development and Transformation Plan (ODTP)

Table 4.1: Land use scenario change over time. Source: Adapted from CoCT 2017b

Using a twenty year planning period, the model was able to predict future travel demand based on various alternative transport networks for a proposed future land use scenario. The model was able to use a combination of public transport routes and modes which encompassed bus based services, BRT, rail and minibus taxis. Three future land use scenarios were initially proposed to be tested during the transport demand modelling process. These were Business as Usual (BAU), Pragmatic Densification (PD), and Pragmatic Transport Orientated Development (PTOD). The IPTN recognised however that a more thorough and in-depth approach to TOD should be carried out which would be in line with the city's new focus of increasing efficiency and integration levels throughout the built environment. According to Vernon Moonsamy (2017, Pers com), a senior spatial planner at the TDA, the high revenue to cost ratio and increasing overall operational costs associated with public transport, and in particular with the MyCiTi BRT, meant that a more inclusive TOD land use scenario was needed. He continued by saying that the current travel demand patterns resulted in low bidirectional flows and seat renewals which was financially unsustainable in the long run. In order to bring down future operational costs of the public transport system, TOD centred growth was seen as the best alternative. The concept of TOD focusses on the interdependent relationship between urban development and transport, creating more efficient cities that make use of the land value capture associated with main public transport networks, vacant land and built up areas. For this reason the PD scenario was no longer used for testing the IPTN transport model. This led to the development of the TOD Comprehensive (TOD-C) land use scenario, which set aggressive targets to densify and promote development in a compact manner around integrated transport interchanges.

4.1.1. TOD in the Context of Cape Town

As one can see in Table 4.1, the CoCT has actively changed the development future of Cape Town, introducing a host of new frameworks, policies and plans. These have culminated and come together to realise and unlock the potential of the TOD-C land use scenario in Cape Town. Krugman et al (2011) points out that a strong political drive, coupled with stakeholder engagement and a change in the public's perception is needed to effectively establish a public transport system. The CoCT has shown it has the political willpower to initiate such a system, which has culminated in a completely new

approach for development. Whilst interviewing Vernon Moonsamy (2017, Pers com) on these various institutional changes, he maintained that the City is "now following a more collaborative approach, rather than a regulatory approach to development." He went on to say that the new MSDF contains several changes that are premised on TOD. "There is no more urban edge and no designations that simply specify where development should occur. Rather the City is following an investment framework that actively promotes development in certain areas" (Moonsamy 2017, Pers com) By supplying infrastructural elements such as new links for public transport and construction of stations in certain areas, the City hopes to make development more attractive for private developers. Moonsamy (2017, Pers com) reiterated, saying that, "We (the CoCT) want to work with external parties to figure out what the right direction for us is. This could be interventions in areas of need, or infrastructure investments and public interventions. The city is willing to kick-start development in certain areas."

Therefore, one of the main considerations in the allocation of development in terms of TOD, was the creation of Transit Accessible Precincts (TAPs). These are spatially defined areas which are confined to a 500 metre radius from a higher order public transport station, and which are based on their overall level of access to the transit network. TAPs can be considered to incorporate important spatial restructuring elements, with aggressive density and diversity targets within these areas. TAPs can function either as a generator or attractor of people and trips, facilitating an optimised distribution of movement people, goods and services. By optimising land use intensity (density and diversity) in these areas, a movement pattern can potentially be encouraged that can systematically improve the sustainability of the public transport network. TAPs can be leveraged and constructed in certain areas to catalyse development, and by doing so creating new nodal developments. The CoCT hopes to therefore utilise TAPs around the city's current 98 rail stations and 42 BRT stations to spur development and intensify land use development. The TAPs are also used to measure the overall performance of the transport demand model on the TOD-C land use scenario, and can be coupled together with other overlay zones to incentivise further development in an area.

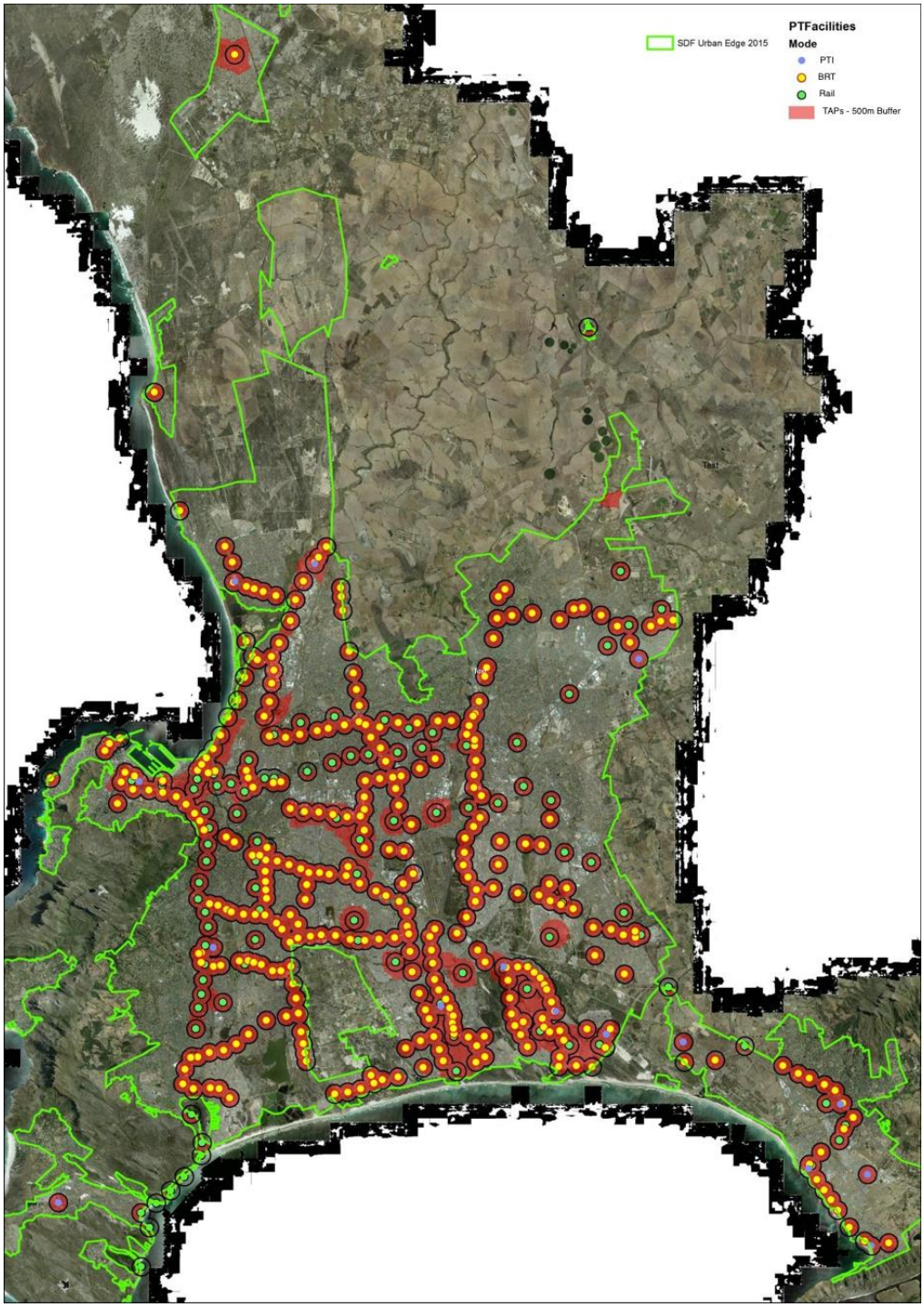


Figure 4.2: Transit Accessible Precincts. Source: CoCT Open Data Portal 2017

Many TAPs are also designated Public Transport (PT) Zones. These are areas in which different modes of public transport are more actively encouraged and promoted. This is due to their favourable location along corridors and public transit networks. Both

TAPs and PT zones are therefore suitably positioned as focus areas for a more densified and mixed use land development. Figure 4.2 displays where the CoCT has designated various TAPs and PT zones. As one can see, these overlay the built environment along future and current development corridors and key economic nodes. The CoCT hopes to leverage both the MyCiTi BRT system and Metrorail network as anchors in creating major intermodal hubs, which acts as an interchange between two or more forms of transportation. Here, the CoCT will invest in new BRT related infrastructure, hoping to leverage BRT and rail in fostering higher levels of TOD.

Iin line with the new development focus, PT zones are granted special privileges with regard to land use zoning rights and requirements. Table 4.2 displays how PT Zones have reduced requirements for on-site parking, thus promoting densification in areas where there are strong public transport links. Table 4.2 also shows how the CoCT has established both a PT1 and PT2 zone classification. According to chapter 15 of the Municipal Planning By-Law (CoCT 2015b), PT1 zones refer to areas where “the use of public transport is promoted, but where the City considers the provision of public transport inadequate or where the use of motor vehicles is limited.” PT2 zones on the other hand refers to areas where “the use of public transport is promoted and the City considers the provision of public transport good, or where the use of motor vehicles is very limited.” This shows the city’s move toward adopting a more compact and sustainable urban form whereby public transport should flow seamlessly between economic nodes, bringing life to the IPTN.

Table 4.2: Examples of requirements for PT1 and PT2 Zones

Land Use	Standard Areas	PT1 Zone	PT2 Zone
Main Dwelling House (SR1 Zoned)	2 bays per dwelling unit (1 bay per dwelling for erven <350 m^2)	1 bay per dwelling unit	-
Main Dwelling House (SR2 Zoned)	1 bay per dwelling unit (Nil per dwelling for erven < 100m^2)	-	-
Shops (excluding supermarket)	4 bays per 100 m^2 GLA	2 bays per 100 m^2 GLA	1 bay per 100 m^2 GLA
Supermarket, Shopping Centre	6 bays per 100 m^2 GLA	4 bays per 100 m^2 GLA	2 bays per 100 m^2 GLA
Offices	4 bays per 100 m^2 GLA	2.5 bays per 100 m^2 GLA	1 bay per 100 m^2 GLA
Conference Centre	6 bays per 10 seats GLA	4 bays per 10 seats	2 bays per 10 seats

Source: Adapted from CoCT 2015b

Figure 4.3: Public Transport Zones Source: CoCT 2017b

According to the recent 2016 State of Cape Town Report (CoCT 2016b), there is a growing indication that the property market is responding well to the city's strategic shift toward TOD. The report maintains that there has been an increase in residential densities along development corridors and within TAPs, with high density residential and mixed used land intensification. Moonsamy from the TDA maintained that the City had recognised the potential of TOD not only for economic and transport purposes, but also to bring about spatial transformation to build sustainable communities. Since the adoption of the TOD-C land use scenario, the CoCT has identified and prioritised public transport corridors and economic nodes so as to support TAPs, PT zones and land use intensification. Urban nodes are normally characterised by concentrations of higher intensity, mixed use land development and the grouping of activities or land uses at points of maximum accessibility, exposure, convenience and urban opportunity. This gives effect to the TOD Strategic Framework, showing that the CoCT has strong political will and leadership in the adoption of TOD.

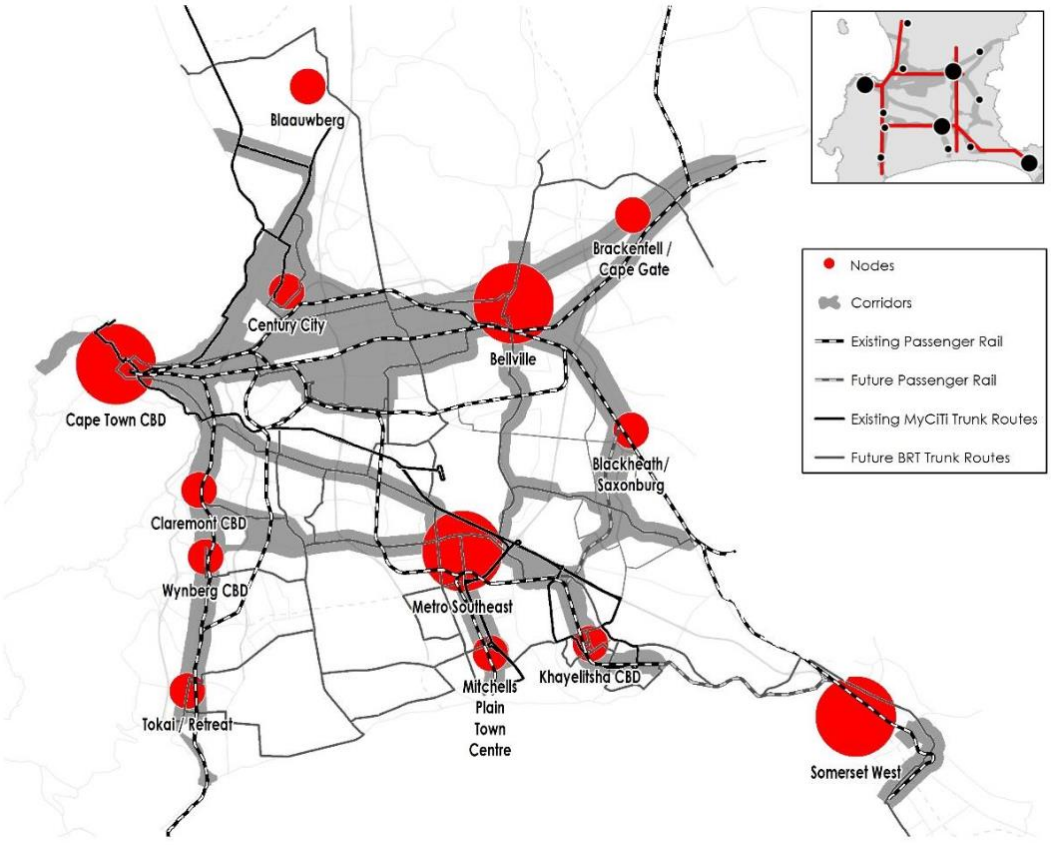


Figure 4.4: Nodes and Corridors Source CoCT 2016

The TOD-C land use scenario is useful in that it depicts the optimised location of future growth in Cape Town (projected new development) until 2032 to support the City's current IPTN and principles of TOD. but the intent of the scenario remains constant i.e. to illustrate the ideal locations of future residential and non-residential growth towards the year 2032. Ultimately the TOD-C Strategy must trigger a paradigm shift through direct public and private sustainable investment into the built form.

4.2. CAPE TOWN'S TRANSPORT PICTURE: AN OVERVIEW

The CoCT has developed its own Transport Development Index (TDI), which quantifies data in ascertaining the baseline of the state of transport in Cape Town. The city can then assess the effectiveness of its service delivery to the various transport user groups across all income brackets and the built environment. Transport trends can then be identified, seeing where interventions and other initiatives must be planned and implemented. The TDI is therefore able to quantify the costs according to key user groups' Access Priorities. These Access Priorities are the main concerns of the different user groups broken down in to direct costs and indirect costs. Moonsamy (2017, Pers com) maintains that a "key challenge for the TDA is how it can increasingly lower these costs across all transport user groups."

The TDI quantifies the costs of key user groups' Access Priorities. These Access Priorities are the priorities of different user groups broken down into direct costs (such as the price of a ticket) or indirect costs (such as flexibility, safety, reliability, crime or congestion). The TDI discovered the following key Access Priorities:

- flexibility and safety
- travel times and distance
- direct costs relating to ticket fares, particularly among PT users in the low income group
- congestion, particularly for high income private transport users

The TDI highlights the high direct and indirect transport costs for many of Cape Town's citizens, and most notably for the low income groups that live well outside the city centre. Reconnecting people to economic opportunities and forging sustainable

connections across communities are integral to the efficiency and sustainability of Cape Town. The transport system is said to be vital in this process.

Currently, the key modes of transport in Cape Town are by private car, passenger rail, BRT, bus-based services and minibus-taxi's. Several forms of transport should therefore culminate at a modal interchange station, helping to improve the efficiencies of the currently overburdened transport network. The IPTN saw that TOD could be utilised and harnessed the most in creating a more compact and sustainable city. The integration objective of the IPTN is to provide a seamless journey for a passenger who has to make one or more transfers using different PT modes to get from trip origin to destination.

Table 4.3: Modal Split per Income Group.

		Low Income	Low-Medium Income	Medium Income	High Income
Amount (ZAR/month)[1]		R0 - R4000	R4001 – R31 600	R31 601 - R63 200	R63 201 +
Percentage of Total Commuters		25%	57%	12%	6%
Modal Split per Income Group[2] (%)	Public Transport	71	55	21	11
	Private Transport	17	35	76	88
	NMT	12	9	3	2

Source: CoCT 2017c

1 - Source: 2013 Cape Town Household Survey Report
2- source: ITP

Table 4.3 displays the modal split between the different income groups throughout the city. The majority of people within the 'Low' and 'Low-Medium' income group rely on public transport the most to get to and from places of work, with 71 percent and 55 percent of these users respectively. This is further compounded by the fact that the 'Low' and 'Low-Medium' income brackets make up 82 percent of commuter trips into Cape Town every day. This points to the relatively high level of importance that public transport has for many residents, especially for lower income residents living in the urban periphery. However when the total working population is taken in to account, the

private car has become the dominant form of transport for commuters (Table 4.4). According to data obtained from Cape Town's Transport Development Index (TDI), private transport accounts for 53 percent of commuter trips while only 38 percent of all workers make use of public transport (CoCT 2017c). This creates a modal split ratio of 58:42 (Private Transport:Public Transport), contributing to increased congestion on road networks and reducing overall mobilities. The National Department of Transport however has a goal of achieving a 20:80 (private transport: PT) ratio split, which suggests that Cape Town still has a long way to go in achieving this goal.

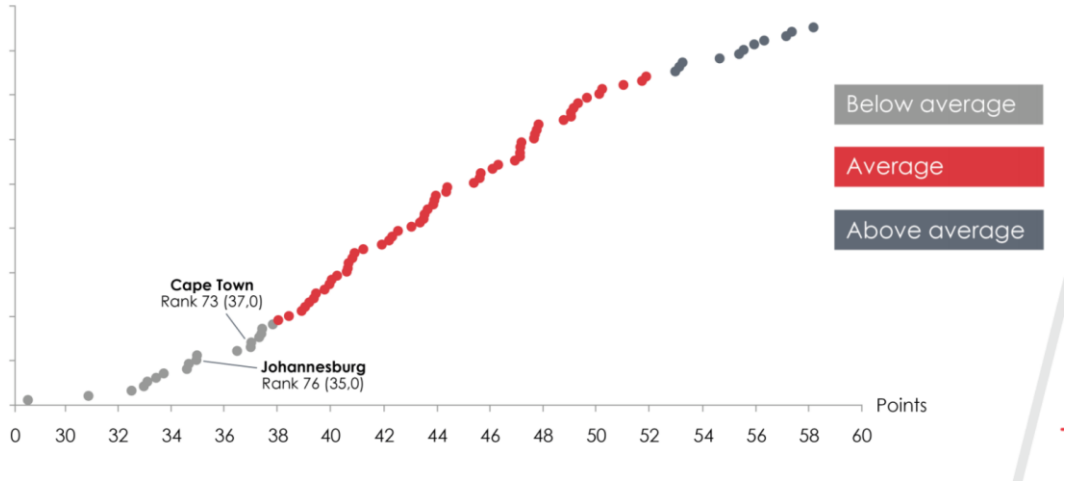
Table 4.4: Detailed Modal Split and Expenditure on Transport

		Public Transport				**Private Transport**	**Non-Motorised Transport**
		Rail	*Contracted Bus*	*BRT (MyCiTi)*	*Minibus-Taxi*		
Modal Split (%)		18	6	2	12	-	-
Total Modal Split (%)		38				53	9
Average Travel Times to Work (min)		59	63	45	53	58	-
Expenditure on Transport per Income Group (% per Month)	*Low*	43				56	-
	Low-Medium	6				23	-
	Medium	2				17	-
	High	1				6	-

Source: CoCT 2017c

The TDI has further established that 94 percent of the entire public transport user group is in the 'Low' to 'Low-Medium' income groups (CoCT 2017b). The "Low" and "Low-Medium" income group who live in these economically devoid areas of the city, have both a limited mobility and accessibility in and around the built environment. The 'Low' income group, who is seen to use and rely on public transport the most, bear the most cost for transport relative to their monthly income. The average direct transport cost for the "Low" income public transport user group is 43.1 percent of their monthly household income, with the international norm at 5-10 percent (ITP 2017). This points to how uncontained urban sprawl in Cape Town has contributed to high transport costs and services, turning it into a disconnected, inefficient and inaccessible urban environment.

Figure 4.5: Cape Town's Urban Mobility Index



Source: CoCT 2017c

This is further compounded when measuring and comparing Cape Town's Urban Mobility Index with other cities. The Urban Mobility Index was developed by A.D. Little, which measures the mobility challenges that cities face. It assesses the mobility performance and maturity of a transport network in a city across a particular set of criteria, with the mobility score per city ranging between 0 (worst) and 100 (best). Figure 4.5 shows that Cape Town scored a value of 37.0 points, ranking 73rd out of 85 cities worldwide which shows a 'below average' rating. Within an African perspective, Cape Town is ranked fourth out of six cities analysed on the continent, scoring two points better than Johannesburg (35.0). The A.D. Little model reveals that urban mobility infrastructure is paramount for cities in attracting new developments and investors. Dauby et al (2014) maintain that at the same time, the highest need for investment in cities between 2007-2017 was in the mobility sector (Dauby et al, 2014). Cities are therefore investing a large proportion of their budgets within the mobility sector as a means to improve urban efficiencies. This is evident when looking at the 2017/2018 total budget breakdown for the CoCT (see Figure 4.6). The TDA received the second highest portion of the budget, accounting for 26.8 percent of the total amount. This represents the second largest expenditure after Informal Settlements, Water & Waste Services (34.4%) which points to the importance of mobility investment.

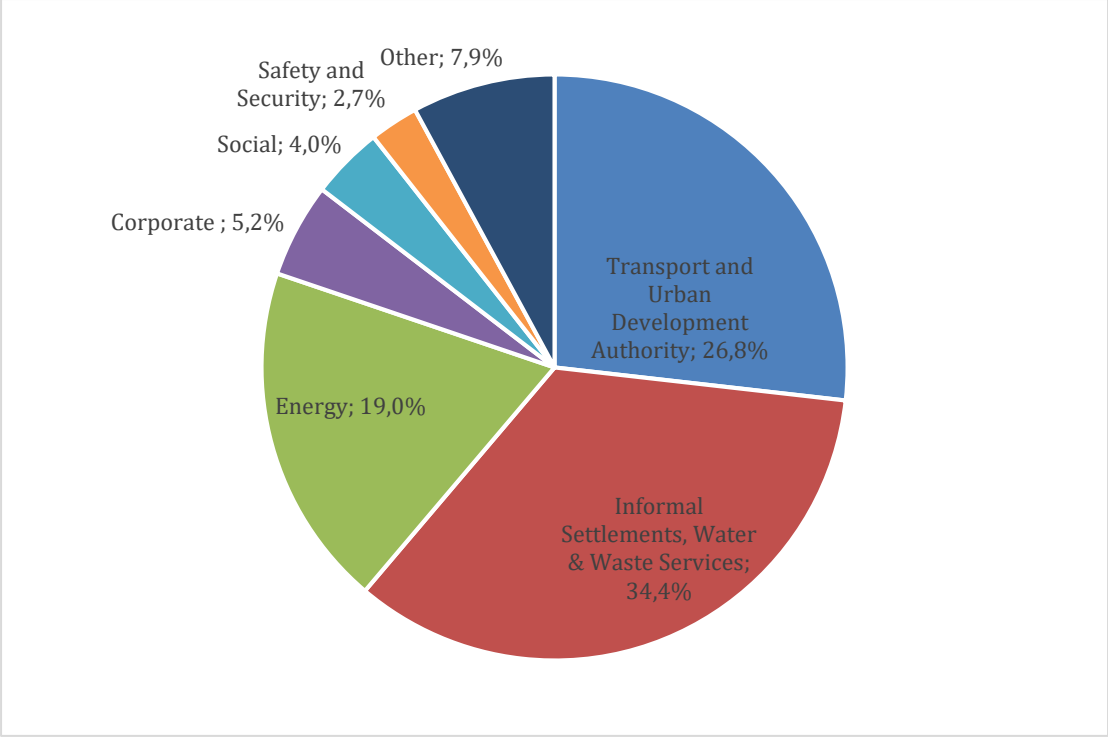


Figure 4.6: Total 2017/2018 Budget for the CoCT. Source: CTBP 2017

Over the years, there has been a rapid growth of the private car and subsequent loss of rail (Metrorail) commuters. The Metrorail system has long been considered the backbone of Cape Town's public transport system, containing 1014 kilometres of rail network and 118 stations (CITP 2017; IPTN 2014). However due to recent failures and vandalism on the Metrorail network, the number of operational passenger train sets in the city has decreased from 94 in 2000, to 68 in 2017 with an average age of over forty years old (Evans 2017). These factors have affected the punctuality and efficiency of the service which is further compromised by arson and theft. This has resulted in the number of daily trips (passenger boardings) between 2013 and 2017 showing a rapid and accelerated decline of people using the rail network. A comparison of these daily rail trips reveals that Metrorail saw a decline of 43 percent over this period, falling from 636 000 in 2013 to 360 000 passenger boarding's in 2017. This is directly contrasted with the rise and use of private transportation, which has grown steadily at a rate of 4 percent per year from 2013 to 2017 (CoCT 2017c). The decrease in passenger numbers and subsequent modal shift towards road-based public and private transportation can be directly attributed to the decline of rail. The minibus-taxi industry and contracted bus services (GABS and Sibanye) have been the main beneficiaries due to their larger spatial coverage, while MyCiTi has benefited in localised areas which overlap with the

rail system directly. This has ultimately contributed to Cape Town's congestion issues, which also points to the large polarity that lies between employment opportunities and residential areas.

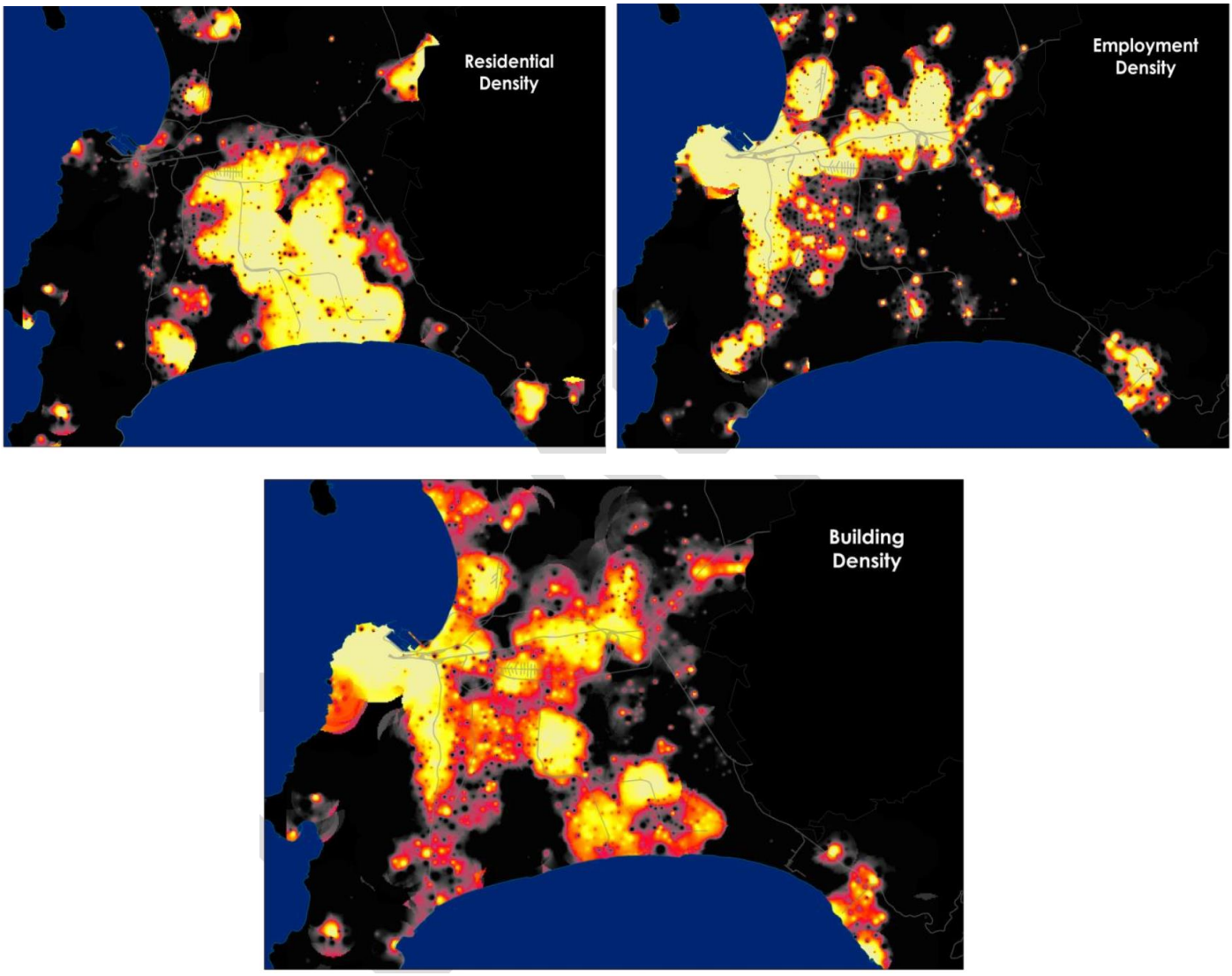


Figure 4.7: Residential, Employment and Building Densities. Source: CoCT 2017b

Cape Town has a particularly complex urban layout due to both the injustices of apartheid spatial planning, and a somewhat complicated physical layout. This has resulted in a fragmented and disconnected urban form, leading to the concentration of economic nodes and activities. This has resulted in residential areas and places of

employment being often spread out and detached from one another, requiring longer travel and commuting distances. Figure 4.7 displays how residential and employment densities have become separated and alienated from another. Employment densities are primarily situated within the CBD and to the North along the Voortrekker Road corridor, while the majority of the city's residential density is located in the South-East of the city. This is further aggravated by low formal and high informal building densities in the South-East and peripheries, where the urban poor are often located. This results in an unsustainable environment in which people are forced to travel from highly dense, underserved, informal areas to sparsely populated, well-serviced areas of the city where employment opportunities are located. This is a major issue for the CoCT and one which has been exacerbated by years of uncontained urban sprawl. Tackling this disjunction is central to the rationale for the City's establishment of the TDA with its wider mandate and the adoption of the TOD strategy.

4.3. MYCITI BRT: PHASE 1

4.3.1. Background and History

The idea of a BRT system originated in 2007 when the Department of Transport (DoT) prepared a Public Transport Strategy and Action Plan, with the intention to develop a Phase 1 (2007-2010) package of catalytic integrated rapid rail and road corridors. The strategy acted as a process to fast track the implementation process in developing a high quality, Integrated Rapid Public Transport Network (IRPTN) in 12 cities across South Africa. One of the key focus areas of the Action Plan was to integrate Rapid Rail and BRT along development corridors. The long term vision was to have at least 85 percent of a city's population within one kilometre of a IRPTN trunk route, followed by a feeder system consisting of smaller buses, taxi's and park and ride facilities.

Public transport, walking and cycling will be prioritised over private car travel and road space will be demarcated accordingly. The overarching strategic approach is to create a mass rapid public transport system, which integrates routes of various modes and maximises accessibility, particularly to those with special needs (Pillay & Seedat, 2007).

In response to the Public Transport Strategy and in order to deal with Cape Town's mounting spatial issues, the MyCiTi BRT was first launched as a pilot project in May 2010 for the FIFA World Cup. Operating around key locations in central Cape Town for spectators and visitors, operation officially commenced in May 2011 the following year. The MyCiTi BRT followed the guidelines in the IRPTN, and developed a network of BRT trunk and feeder services. The main aim of a trunk service is to move people as fast as possible between an origin and a destination point, usually along the most straightforward and direct path. A trunk route usually offers a dedicated lane so as to move between stations relatively more quickly. However, there are usually a less number of stations along a trunk route in order to achieve faster travel between two areas or suburbs. Commuters are able to then get to and from a trunk station by means of a feeder bus service. These act as a catchment area for people and residents within suburbs, using smaller buses that travel on the normal road reserve.

The first phase of development encompassed routes both within and the immediate surroundings of the inner city and up along the West Coast corridor toward Table View and Blouberg (Phase 1A). This was then followed by expanding the network up towards Atlantis, fifty kilometres from the Central Business District (CBD), as well as along the Atlantic Seaboard (Phase 1B). Additional routes include a service from the CBD to Cape Town International Airport, as well as an N2 Express Route out towards Khayelitsha and Mitchell's Plain in the Metro South-East (Appendix B). BRT routes were chosen in these areas, as they served as a regions of high growth that were not serviced by rail. Therefore Phase 1 allowed for a more direct route in to the CBD along trunk routes and dedicated bus lanes, with the full service being completed by November 2014.

Table 4.5: Phase 1 BRT user group characteristics (n=929)

Category	Sub-category	Total Percentage %
Age Group	30 years or less	48.6
	30–39 years	28.6
	40–49 years	11.3
	50 years and older	11.5
Gender	Male	42.8
	Female	57.2
Employment Status	Employed	78.6
	Unemployed	21.4
Economic Level*	High	70.9
	Middle	10.8
	Low	18.3
Education Level	Higher	79.8
	Middle	10.5
	Low	9.7
Euclidian distance from home to the BRT	500m or less	68.4
	501m - 1km	11.9
	1-3km	10.5
	3km and greater	9.2

Source: Adapted from Bartles et al (2016)

*Categories 1–2 (very good and good) were combined to represent higher economic level (HE) participants and categories 3–5 (average to very needy) were combined to represent low-middle economic level (LME) participants.

Currently consisting of 42 stations, phase 1 was not actively built with TOD elements in mind as the CoCT had not yet adopted this land use scenario for the city. When interviewing Catherine Stone (2017, Pers com), the former Director of Spatial Planning and Urban Design for the CoCT, she maintained that there "was no spatial planning and land use integration behind phase 1 for MyCiTi." She maintains that the "west coast and central CBD areas were chosen as a tactical decision partly due to growing congestion issues, but also due to the fact that the route had less overall risk and had a more inherently suitable land use that was conducive in supporting a BRT system" (Stone 2017, Pers com). When observing table 4.5, data abstracted from 929 BRT users in a recent study by Bartles et al (2016) seems to confirm this. It reveals that the MyCiTi phase 1 development was more manageable to implement as it was operating in areas with overall higher employment and income levels. This is important in that it acted as

a safe space to get the system going in order to establish and guarantee stable ridership levels. Although other areas (i.e. Metro South–East) were more in need of an accessible and efficient public transport system, it "needed to be tested first in order to refine further roll outs of the system" said Robby Robertson (2017, Pers com), a Transportation Planner and Traffic Engineer.

Once routes had been established, station locations were appointed based on the surrounding land use, with a spacing of about 900 metres to 1000 metres between them and allowing for a sufficient boarding and alighting opportunities and coverage (based on an assumed 500 metre walking distance). It should be noted, however, that Hitge and Vanderschuren (2015) found that MyCiTi commuters were walking an average distance of 1.3 kilometres. This is more than double the assumed average walking distance applied in the MyCiTi BRT planning and implementation. The decision on the location of stations was done manually and was not informed by a modelling procedure.

Stone (2017, Pers com) mentions that she thinks that the overall design of the system was overridden by an engineering perspective, which ignored certain aspects of spatial planning. Stations and stops were placed according to engineering guidelines and principles, which Catherine says overlooked the surrounding land use to some extent, and hence were not as efficiently placed as they could have been. Ultimately she said that, "the CoCT has learnt a lot from Phase 1 in the planning, implementation and operational stages, which has completely changed the development perspective for the city" (Stone 2017, Pers com). Seeing lower than expected ridership levels in the first few years of operation caused overall expenditures for the system to balloon, relying on various grants and subsidies (i.e. PTIG/PTNG) in order to maintain the service. This was a "main decision factor to go all out TOD for the City", said Moonsamy (2017, Pers com), as travel demand patterns resulted in low bidirectional flows and seat renewals which was financially unsustainable in the long run. TOD centred growth was thus seen as the best way forward due to its ability in creating more sustainable and compact cities. This should bring down future operational costs of the public transport system, and thus make it cheaper in the long run."

4.3.2. Noticeable Land-use Changes and Responses

Although phase 1 was not primarily developed and constructed with TOD principles in mind, later stages and sub-phases presented an opportunity for developers to capture increasing land value around MyCiTi BRT stations. According to Salat and Ollivier (2017), cities are said to encourage development at the most accessible stations within the network, while discouraging development in areas that are more than one kilometre away from a station. In order to reap the benefits of investment associated with transit systems, this approach is central to the achievement of city-wide accessibility targets. Table 4.6 displays the approval and completion of building plans across the eight districts of Cape Town. Figures obtained from the Open Data Portal over the five year period are based on overall building work value, displayed in billions of South African Rand values. The first two districts, Blauuwberg and Table Bay, represent the areas in which phase 1 was rolled out and are indicated with an asterisk for easier identification. The district of Blaauwberg runs along the West Coast, including the suburbs of Milnerton, Table View, Blouberg, Melkbosstrand and Atlantis to the north (Appendix D). Table Bay district incorporates the entirety of Cape Town's CBD, Camps Bay and the city suburbs of Woodstock, Observatory, Pinelands and Kensington (Appendix D). These building plans indicate the value of plans submitted and approved by the CoCT, which in turn paints a picture in how well a district is doing in terms of attracting investment and new development.

From Tables 4.6 and 4.7, it is noticed that the two districts (Blaauwberg and Table Bay) have a consistently higher level of approval and completion of building plans than other districts. This could point towards the increasing value that the MyCiTi BRT can provide, beginning to act as a driver of development and change within these districts. This is in line with the work of Vincent and Jerram (2008) where they found that planning agencies have begun to make no distinction between BRT and rail in terms of its ability to attract TOD. Although one cannot draw direct conclusions pertaining to BRT and new developments from these results, it is interesting to see the growth that the Blaauwberg and Table Bay districts are undergoing. From the latest attainable data for the 2016/2017 financial year, it is noticed that both these districts have dramatically increased in the overall value of new building plans, which could be attributed to the increasing service and roll out of the MyCiTi BRT. The Table Bay district has

consistently been in the top two districts with regards to the value of new building plans approved each year, with Blaauwberg seeing very similar trends.

Table 4.6: Approval of Building Plans per District

District	ZAR (Billions of Rand)				
	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
Blauuwberg*	1,580	2,714	3,706	2,875	4,177
Table Bay*	2,258	2,990	3,730	3,457	5,019
Cape Flats	0,841	1,254	1,586	1,449	1,260
Helderberg	1,124	1,431	1,813	2,633	2,582
Mitchells Plain / Khayelitsha	0,923	4,229	1,906	1,886	2,955
Northern Sub	2,381	2,026	3,048	4,268	3,888
Southern Sub	1,333	1,668	2,892	2,618	3,012
Tygerberg	1,785	3,029	2,430	3,443	3,326

Source: Open Data Portal 2017

Table 4.7: Completion of Building Plans per District

District	ZAR (Billions of Rand)				
	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
Blauuwberg*	0,824	0,948	1,822	3,179	2,750
Table Bay*	0,947	1,380	1,924	1,316	2,127
Cape Flats	0,194	0,426	0,732	0,823	1,210
Helderberg	0,648	0,680	1,168	1,431	1,737
Mitchells Plain / Khayelitsha	0,309	0,545	0,961	1,010	2,509
Northern Sub	1,034	1,440	2,516	2,471	2,950
Southern Sub	0,611	0,658	1,132	1,632	2,268
Tygerberg	1,150	0,869	1,187	1,267	2,025

Source: Open Data Portal 2017

As phase 1 of MyCiTi BRT matures, it is bringing with it an improved level of service that is constantly expanding, improving and attracting new riders. These can all culminate in fostering TOD due to improved mobilities and accessibilities around the

built environment. Vernon Moonsamy maintains that Blaauwberg Road in the West Coast Corridor is a perfect example of how the MyCiTi service is beginning to impact and transform the urban environment. The West Coast Corridor is also considered to be one of the fastest growing development corridors in Cape Town, with land use along Blaauwberg Road being predominantly characterised by single residential dwellings and scattered commercial activity (CoCT 2017b). However, in recent years many residential properties have been converted in to commercial space, especially those surrounding the four MyCiTi stops that traverse Blaauwberg Road (Figure 4.8 and Figure 4.9). Vernon maintains that this is one of the perfect areas in which TOD can be implemented, harnessing the powerful effects of the MyCiTi BRT in which to do so. Here, both the private and public sector share the same development interests for a mixed use, densely defined urban space, thus simplifying the process in creating TOD. This is spurred by the proximity to the main BRT trunk station which runs into the CBD.

Implementing the appropriate form of TOD in this region has improved the operational viability of the City's transport investment, which requires a greater intensity of commercial, economic and mixed use development to substantially improve bi-directional flows, seat renewal and off-peak ridership levels. Suzuki, Cervero & Iuchi (2013) maintain that TOD can take years and even decades for a city to reap or even see the full benefits that it creates. According to Smith et al (2013), the concentration of new transport capital investments in a one kilometre radius around transit stations offers an opportunity to change and shape cities into more efficient, inclusive and liveable areas.

However Stone points out that, "It is still relatively unknown if MyCiTi has had a direct impact on land values" (Stone 2017, Pers com).

Figure 4.8: Current Zoning along Blaauwberg Road. Source: CoCT 2016a

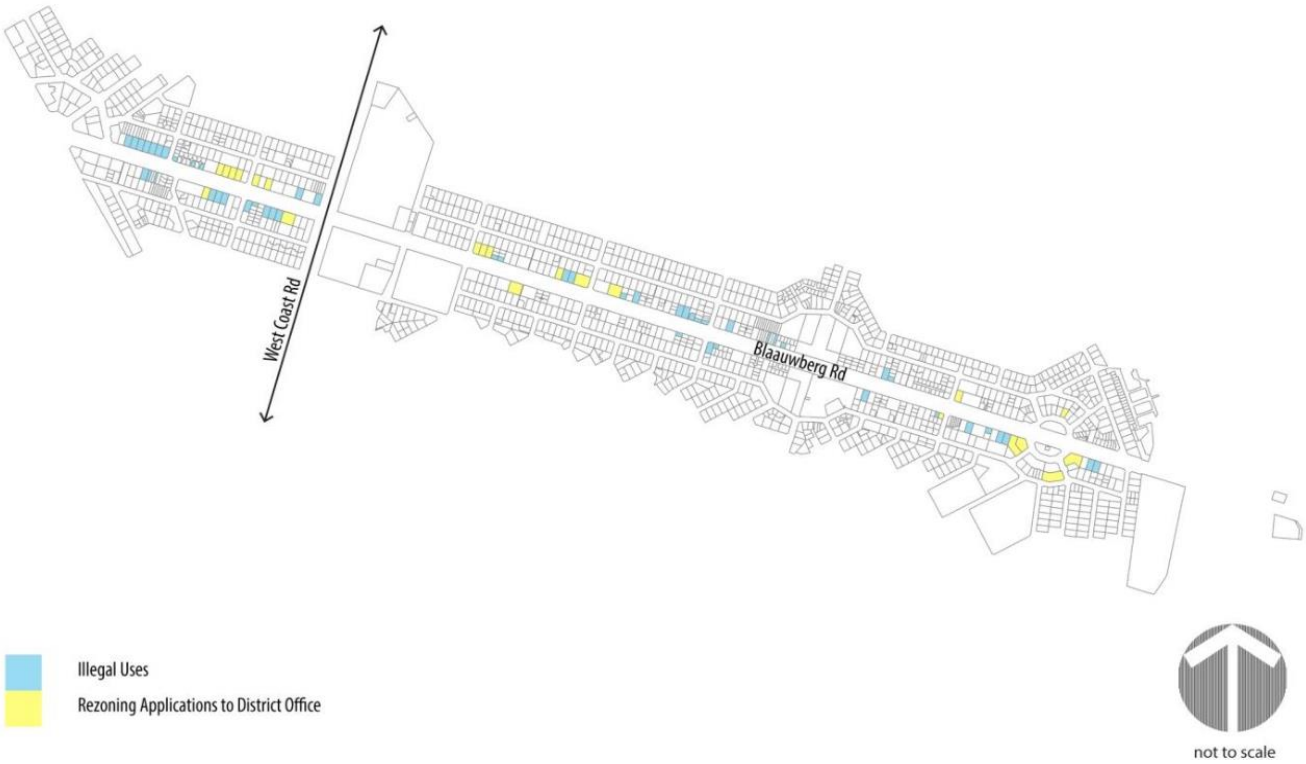


Figure 4.9: Demand for commercial development. Source: CoCT 2016a

Tables 4.6 and 4.7 also show the relative strength of the Northern Suburbs and Tygerberg districts. These are established nodes in which many employment opportunities are located. The data also shows that the Cape Flats, Helderberg, Mitchells Plain/Khayalitsha and Southern Suburb districts are continuously underperforming when compared to the other districts. This is not to say that new investments and development has not been occurring, rather when taken into the context of Cape Town, one can see the polarity that lies between different areas. This points to the social inequity of various districts, and one in which the CoCT is hoping to drastically narrow with the start of phase 2 of the MyCiTi BRT. Challenges and implementation issues will be discussed later, as there many lessons learnt that were applied for Phase 2.

4.4. MYCITI BRT: PHASE 2 EXPANSION AND INTEGRATION

4.4.1. Background and Future Operating Environment

In early 2017, the CoCT approved the IPTN Implementation Strategy which prioritises the extension and roll-out of five new MyCiTi corridors as well as the construction of the new Blue Downs rail link between Nolungile and Kuils River stations. Phase 2 of the MyCiTi BRT is a large undertaking that will take up to fifteen years to fully implement along all five of its identified corridors. According to Brett Herron, the City's Mayoral Committee Member for Transport and Urban Development, the five new corridors will serve at least five times the passengers that are currently travelling on the existing MyCiTi network (DA 2017). The new IPTN Implementation Plan therefore has prioritised the following MyCiTi corridors and trunk routes:

- T11 MyCiTi corridor connecting Khayelitsha and Wynberg
- T12 MyCiTi corridor connecting Mitchells Plain and Claremont
- T17 MyCiTi corridor connecting Khayelitsha and Century City
- D12 MyCiTi route or Klipfontein Road corridor connecting Mitchells Plain and the Cape Town central business district (CBD)
- T13 MyCiTi route or Symphony Way corridor connecting Mitchells Plain and Durbanville

The CoCT has also decided to implement Phase 2 in sub-stages, starting with the T11 and T12 corridors, known as Phase 2A (Appendix D). This is due to limited available funding due to estimated construction costs, as well as the time it would take to complete infrastructure along these trunk routes. The implementation of Phase 2A is directly in-line with the City's new 2017 Organisational Development and Transformation Plan (ODTP), which recognises that a dense and integrated city based on the principles of TOD is a key priority. Phase 2 was designed primarily with TOD in mind, making use of the MyCiTi BRT infrastructure to lead the way in developing and opening areas up for new investments.

Moonsamy (2017, Pers com) maintains that Phase 2 had a more extensive planning process, making use of several spatial and analytical tools to identify and prioritise where the optimal routes and trunk services should be placed. A transport demand model was utilised in order to identify areas that suffer from a lack of accessibility, both to public transport facilities and across the built environment. All the corridors and trunk routes that are to be developed for Phase 2 have displayed the highest need for public transport interventions. Thus, in determining which MyCiTi routes to prioritise, the TDA specifically considered areas where:

- the routes had the highest number of prospective passengers. This is where the most residents would benefit from a new route, thus increasing ridership numbers.
- the routes with the highest time savings between origin and destination. Travelling by MyCiTi in a dedicated bus lane should always be faster than conventional public transport in mixed traffic.
- the routes served a higher number and percentage of low-income households. Serving low-income households are prioritised in order to meet the City's targets in improving efficiencies and access to public transport to those who need it the most.
- the route has several integration opportunities with other forms of intermodal transport. This could be rail or NMT opportunities that allow for a swift and seamless change between different transit.

The CoCT then undertook a spatial study on what available resources (i.e. city owned land) it has for new MyCiTi infrastructure, and how they can use it in order to get development to speak and relate directly to transport (Moonsamy 2017, Pers com). This is so that the City can be aligned to a common spatial goal in ensuring that development takes place in the same manner according to TOD. Thus all planning, housing and transport mechanisms must be aligned with the vision of the TDA, which is "to reverse the effects of apartheid spatial planning by implementing TOD strategies to redress the imbalances of the past, and provide inclusive opportunities for all its residents" (TDA 2017). Any new human settlement planning and new development must now go through the TDA, in order to realise and bring TOD to fruition. Vernon goes so far as to say that, "TOD is fundamental for the future vision of Cape Town." This places TOD at the forefront of changing Cape Town's built environment.

Ongoing sprawl over the years has contributed to Cape Town's inefficient urban form, perpetuating disparities in income and social standings. Due to Mitchells Plain and Khayelitsha being relatively far from the main economic and employment nodes, the cost of service provision to these areas is relatively high.
The TDA thus took into account the capital and operational costs for each route including:

- the estimated cost of the infrastructure and fleet needed for each route
- total annual operational cost for each route
- revenue/cost ratio per route

Apart from the trunk routes, scheduled feeder services will be provided by buses in areas where there is a high demand for the MyCiTi service and where the MyCiTi stations and rail stations are not within walking distance. Unscheduled feeder services will be provided by minibus-taxis in areas where the demand is lower. Hence the MyCiTi service will not replace Metrorail services, but will now aim to connect the unconnected areas of the city and provide the 'last kilometre' service between rail and citizen's destinations. The National Treasury has, through the conditional Public Transport Network Grant, allocated R1,4 billion and R1,6 billion respectively for the

2017/18 and 2018/19 financial years to the CoCT for the further provision of public transport infrastructure.

4.4.2. Current Land-use and Residential Characteristics

Phase 2A has been prioritised to service the Metro South-East (MSE) areas of Khayelitsha and Mitchells Plain, as well as further developing the node of Philippi. Khayelitsha, Mitchells Plain and Philippi account for some of the most marginalised and neediest communities in the city's built environment (CoCT 2017a). Sub-places within these areas, such as the Sweet Home Informal Settlement within Philippi, are currently characterised by high household and residential densities. Data gathered from Census 2011 show a profile of these suburbs, and can be seen in table 1. It is noticed that these areas have significantly higher densification levels compared to those in Phase 1. As public transport and in particular BRT need higher levels of population density in order to sustain and make it feasible, Phase 2A points to these thresholds being met. The TDA and CoCT also envisage that Philippi will become a major social mobility node, with trunk services and several feeder routes meeting and coming together to form a major intermodal station. Philippi forms one of the five Priority catalytic TOD projects that will over time come to anchor the corridor and contribute to growth for the region.

In accordance with the IPTN 2032, six of the ten trunk routes will interchange in Philippi. There is therefore a major opportunity to develop the transfer interchange around the principles of TOD, while also facilitating and catalysing surrounding development. Phase 2A will thus formally establish a corridor and trunk route connecting the MSE with the sub-metropolitan nodes of Claremont and Wynberg in the Southern Suburbs (MyCiTi 2017). This link is seen as a vital component in establishing an open and direct access way in improving mobility flows between trip generator land uses (residential areas in the MSE) and to attractor land uses (employment opportunities within the Southern Suburbs). However, the CoCT hopes to achieve a more equal distribution of trip journeys, contributing to higher levels of bi-directional flows around the city.

Figure 4.10 displays the current situation in Cape Town, displaying current spatial distribution of residential and non-residential land use throughout the city per Transport Analysis Zone (TAZ). TAZs are spatial areas that are subdivided for the purpose of transport modelling and analysis. Within Figure 4.10, the yellow represents current trip productions (residential development), whilst the red depicts trip attractions (non-residential such as retail, office, industrial). This further reinforces the significant level of polarity in Cape Town's built environment, as the Metro South-East has no real formal economic sector. However following a transport optimisation process for the TOD-C land use model, Figure 4.11 represents the optimal location of new trips in 2032 per TAZ. In this figure, the yellow depicts new trip productions (generated from future residential development), while the red represents new trip attractions (generated from future non-residential development such as facilities). The future intensity of mixed use land development, and the relative distance between them is therefore paramount in improving flows.

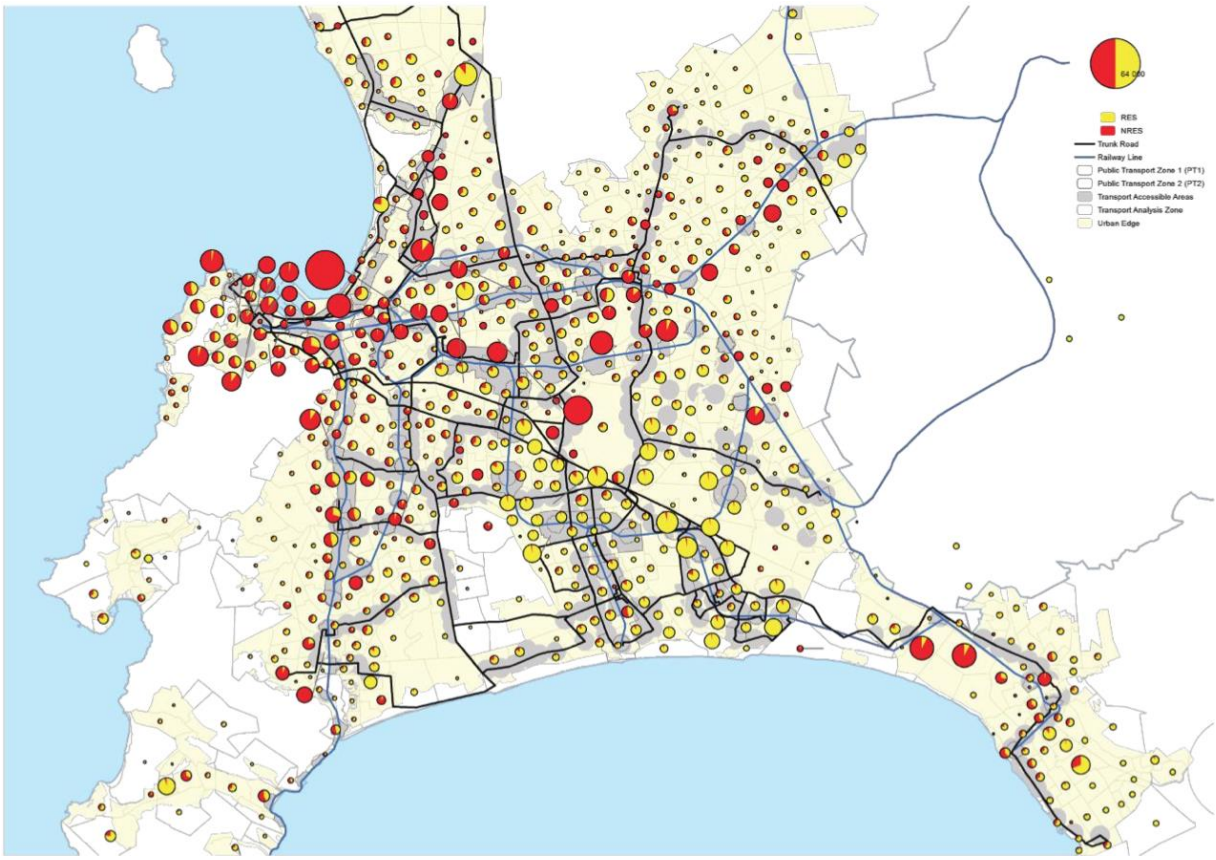


Figure 4.10: Current Trip Productions and Trip Attractions Source: CoCT 2016a

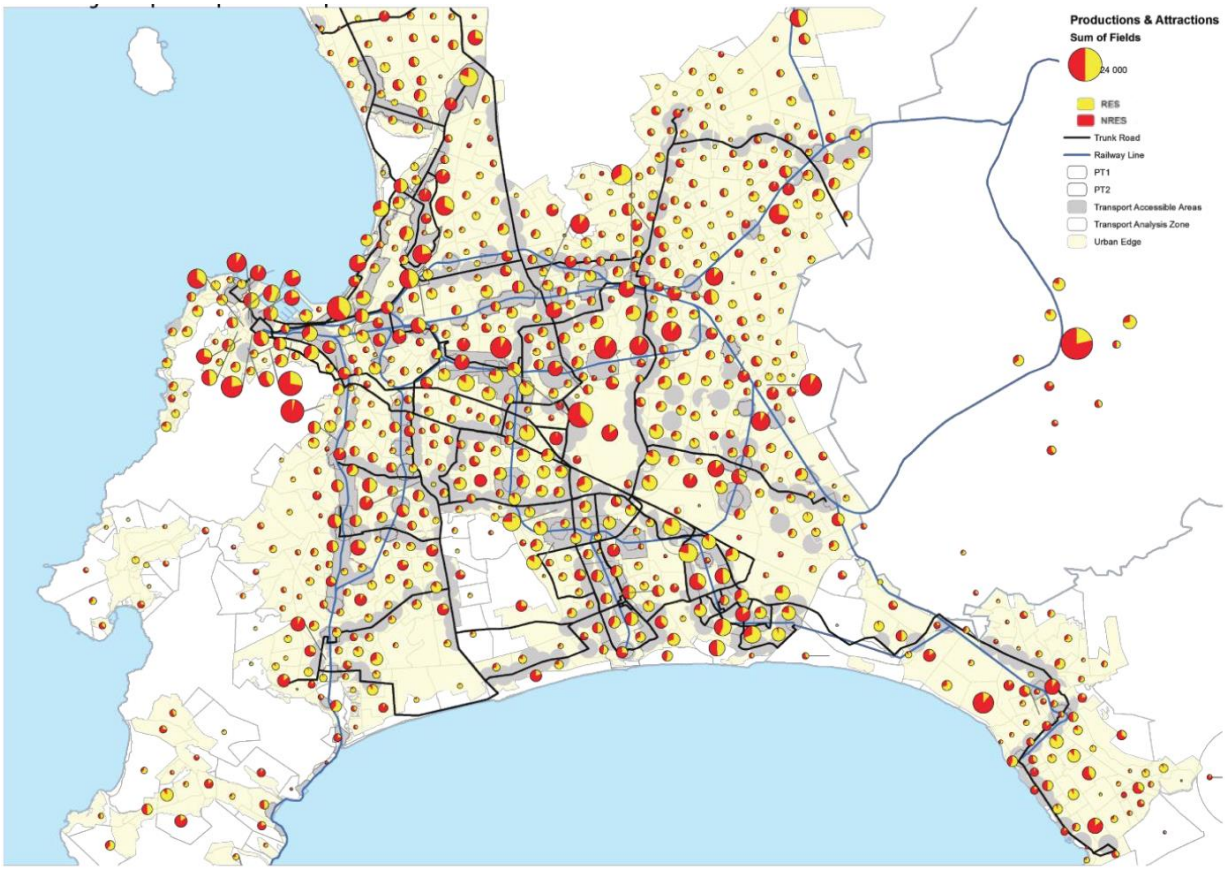


Figure 4.11: Future (2032) trip Productions and Trip Attractions Source: CoCT 2016a

When comparing the two spatial distributions over time (Figures 4.10 and 4.11), it is noticed that there is a need for more trip attracting land uses in the Metro South-East which is currently dominated by residential land use. There is also a need for more trip producing land uses (residential) along economic and development corridors, as well as within nodes that contain high levels of trip attracting land uses (i.e. Cape Town CBD). This necessitates the need for more residential opportunities so as to create a more dense, mixed use environment that is conducive in fostering higher levels of TOD. The CoCT therefore sees that by limiting the growth in the peripheries, it will hope to achieve a more intense, compact city development.

Results indicated that most TAZs could accommodate requirements in terms of future trip origin or trip production land uses. However, a number of the primary economic nodes within the City (i.e. the CBD, Century City and Bellville) do not have sufficient capacity to absorb demands for increased residential development (i.e. trip producing

land uses). To address this shortfall in land supply, the following variables were adjusted to optimise this supply:

a) Adjustment of land use mix and intensity of use of building floor space (persons per square metre: household size/employment density);
b) Space recovered through parking zone change (lower parking requirement);
c) [a] and [b] further optimised through rezoning/departure from standard development rules (height, coverage, floor factor);
d) Relocation to the nearest adjacent TAZ with spare floor area capacity.
e) Focus on new nodes (i.e. Philippi) with TOD first to generate economic activity.

The City is therefore said to be on track with its attempts to implement TOD and to address some of the challenges associated with sprawl. The adoption and implementation of densification, a focus on inward growth and TOD through instruments such as the new SDF and IDP, BEPP and IPTN is a significant step towards addressing the imbalances in the current growth patterns and resultant form of Cape Town.

4.5. IMPLEMENTATION CHALLENGES AND OBSTRUCTIONS

Since phase 1 of the MyCiTi BRT has been completed, there have been a number of challenges in the overall implementation of the system. According to Vernon Moonsamy (2017, Pers com), one of the main challenges associated with the MyCiTi BRT was lower than expected ridership levels. User culture forms a big part of this issue, whereby perception of public transport has been negatively skewed after years of poor management, coupled with a general association of it being inaccessible, inefficient and informal in nature. As private transport has seen a four percent year-on-year growth since 2011, it has increasingly become the dominant form of travel (CoCT 2016b). Therefore one of the main challenges lies within the private transport user category, and the ways in which to reduce this demand. Often passengers have their preferred mode of transport and will complete their journey using one mode or service so there is little transfer between private travel, BRT, rail or minibus taxi.

A recent study by Barendse (2016) argues that the MyCiTi BRT still has not become integrated enough with other forms of transport, and many of the stations along Phase 1 trunk routes are somewhat isolated. As mentioned previously, Phase 1 of the MyCiTi BRT was not constructed with TOD values in mind, rather it was based on a route network analysis in which spatial considerations were limited and not taken in to account. This has resulted in many stations and stops not recognising and seeing the estimated demand, resulting in many routes becoming unsustainable. Stations along the West Coast Corridor trunk route were also designed and situated within the middle of the road reserve, requiring people to cross at an intersection. This has also limited its TOD potential, as nothing can be built or constructed around its direct vicinity. The number and time of transfer speeds should also be a criterion as people do not like to move between different modes of transport. This ultimately deters both new and existing commuters from using the system. The city is therefore moving away from a hub and spoke network by adding trunk route extensions, which allows for the reduction of the number of transfers. Currently there is not a great enough incentive for GABS buses and minibus-taxis to take their passengers to a MyCiTi station. This ultimately means that intermodal transfers between different forms of public transport are not possible which require longer changing times, thus limiting the goals of TOD, the IPTN and ITP.

The TDA is now considering a greater role for non-BRT services such as the minibus-taxi industry and improving the quality of bus-based services as a more cost effective approach than implementing BRT with formalised feeders (CoCT 2017b). The city is now also investigating a ‘hybrid model’ where the mini-bus taxis are included to make up for the massive change between the peak and off peak demand. The minibus-taxis are also able perform a certain service in that they are able to infiltrate informal settlements whereas the MyCiTi bus cannot. However the level of service provided by the minibus-taxi industry needs to be improved first to ensure there is no overcrowding, and that it is clean and safe to use. However there are still shortcomings with the minibus-taxi industry that need to be addressed, such as a lack of an official payment scheme and integration with the ‘MyConnect’ off board fare collection scheme. The MyConnect card is a form of prepaid contactless payment that is currently only used and offered on MyCiTi BRT routes. The City is hopeful that by 2032 the MyConnect will be used on all forms of public transport, be it rail, minibus-taxi or BRT. A large

challenge is getting the minibus-taxi industry on board, and in coordinating new and possible routes with them. The City is also however actively looking at new technologies such as e-hailing and mobile applications as a means to locate and pay for public transport on the go as a demand responsive service. The flexible nature of the minibus-taxi service means that they can provide services on non-trunk routes more cost effectively.

According to Moonsamy (2017, Pers com), “Engineering standards pose a large hindrance in the overall implementation of TOD”. Old engineering guidelines and parameters that have not yet been updated to reflect the principles of TOD cause institutional delays. For example, access guidelines, restrictive title deed conditions, road widths and parking requirements that are needed for new developments still follow old prescriptions and models used. This causes conflict in the evolving and changing urban form being held down by mechanisms that still prioritise the private car as opposed to public transport. This is evident along Blaauwberg Road whereby the approval of applications to rezone to business or commercial uses are limited to properties located every 90m from an intersection along its length.

4.5.1. Interventions and Incentives for Further Growth

The CoCT have developed a set of interventions and incentives to try and make people use the MyCiTi BRT and public transport network more. Moonsamy (2017, Pers com) says that the Travel Demand Management Strategy (TDMS) aims to change the behaviour of people who do not use public transport. Within the TDMS, there are a host of incentives to make people use the MyCiTi BRT such as:

- Parking levies and decreased numbers of on-street parking
- Car-pooling schemes
- Flexi-time work hours in order to stagger peak travel times, thus reducing congestion levels
- Changing MyCiTi fare structures so that it is cheaper to travel in shoulder of peak periods
- Offering discounts in certain times so that people can travel earlier/later in order to improve bi-directional flows and seat renewal

- Congestion tax for private cars (still under investigation)
- Smart Travel Plans by both the private and public spheres to initiate a public transport switch over by subsidising a monthly allowance

The TDA has also introduced a host of new plans to boost and improve the image of the MyCiTi BRT. These are:

- Offering free Wi-Fi on buses (limited pilot project) and within stations
- Operating a 'Free Ride Day' on October 29 2017 in order to get more people to experience, and hopefully switch over to the MyCiTi BRT
- Continued and extensive integration with Google Maps, whereby one can use it to navigate easily around the city

Ultimately, many of these incentives are influenced by the principles of TOD. Therefore future growth of the MyCiTi BRT lies within private car users and potential integration with the minibus-taxi industry.

5. RECOMMENDATIONS AND CONCLUSIONS

Cities such as Cape Town need to support millions of citizens, whilst at the same time investing in a myriad of socio-economic developments. According to Cape Town's 2012-2017 IDP, the city has been developing at an average rate of 1232 hectares per year, which has pushed the urban edge further outwards. More often than not, accessibility to and from areas in the periphery are somewhat limited, placing accessibility at the heart of Cape Town's mobility issues. One of the city's main challenges is to therefore transform its spatial and social legacy in to a more inclusive and connected city. One of the key strategies in the new 2017-2022 Spatial Development Framework is to direct urban growth and to promote a more compact and integrated city. Higher densities are now being actively encouraged in targeted locations (TAPs and PT Zones) to make a more effective and efficient use of infrastructure, social facilities and public transport links. The CoCT sees transit links as a vital component for the future growth of the city, and one that should mitigate the on-going effects of sprawl. Currently, the city's rollout of phase 2 of the MyCiTi BRT project is considered to be their main priority with regards to new capital investment of infrastructure (CTBP 2017).

From this analysis, it is seen that Cape Town has radically overhauled its approach toward development, adopting the new TOD Comprehensive land use model. Krugman et al (2011) points out that a strong political drive, coupled with stakeholder engagement and a change in the public's perception is needed to effectively establish a public transport system. The CoCT has shown it has the political willpower to initiate such a system, which has culminated in a host of new documents in direct support of TOD and its associated initiatives. What remains to be seen is whether the general public will shift over to public transport, and in particular MyCiTi. Changing the transport user culture in an environment dominated by the use of the private car is proving to be quite challenging for the CoCT. Therefore, the City needs to actively be in talks with various stakeholder groups across the city in determining what initiatives and incentives are best to implement.

Going forward, up-to-date information and data is vital in determining whether particular routes need to be changed, altered or suspended. Phase 1 has been a good learning lesson for the CoCT, which has directly contributed to the city adopting a new land use strategy. Phase 1 has shown the CoCT that there is room for more integration of the MyCiTi BRT with both the surrounding land use environment and with other forms of transport. However, there needs to be better integration between urban planners and engineering specialists in the optimal location of new stations and stops. Stone (2017, Pers com) maintains that, “It is still unknown if the MyCiTi BRT has had a direct impact on surrounding land use and land values.” Therefore more research into the understanding behind how BRT can foster TOD needs to be undertaken in order to see and identify any latent relationships.

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PERSONAL COMMUNICATIONS

Moonsamy V 2017. TDA – Senior Spatial Planner. Cape Town. Interview on 17 August about TOD.

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Appendix A: Ethical Clearance

NOTICE OF APPROVAL

REC Humanities New Application Form

23 August 2017

Project number: GEO-2017-0941-582

Project Title: MyCiTi BRT: A TOD Approach in Transforming Cape Town's Built Environment

Dear Mr Matthew Miller

Your REC Humanities New Application Form submitted on 10 August 2017 was reviewed and approved by the REC: Humanities.

Please note the following about your approved submission:

Ethics approval period: 23 August 2017 - 22 August 2020

GENERAL COMMENTS:

Make it more explicit in the consent form that the participant has the choice to remain anonymous or not.

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: Humanities, the researcher must notify the REC of these changes.

Please use your SU project number (GEO-2017-0941-582) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

FOR CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

Please note that a progress report should be submitted to the Research Ethics Committee: Humanities before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

Included Documents:

Document Type	File Name	Date	Version
Research Protocol/Proposal	Research Proposal MyCiTi	08/08/2017	
Informed Consent Form	Consent Form MyCiTi	08/08/2017	
Data collection tool	Research Questions - MyCiTi	08/08/2017	
Request for permission	Organisational Permission Letter - CCT	08/08/2017	
Request for permission	Organisational Permission Letter - TCT	08/08/2017	

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za.

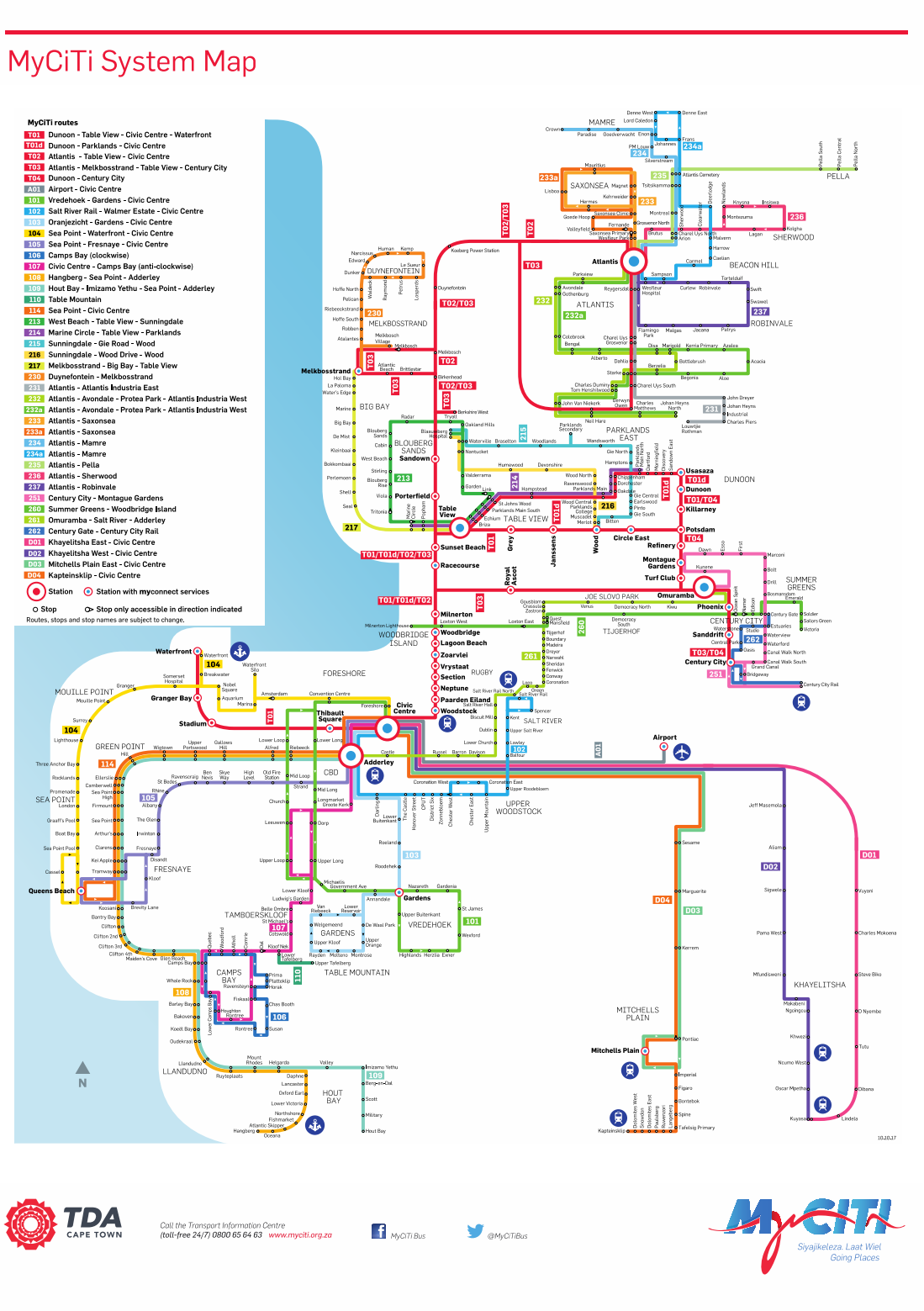
Sincerely,

Clarissa Graham

REC Coordinator: Research Ethics Committee: Human Research (Humanities)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.
The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

Appendix B: Complete Phase 1 Route



TDA CAPE TOWN

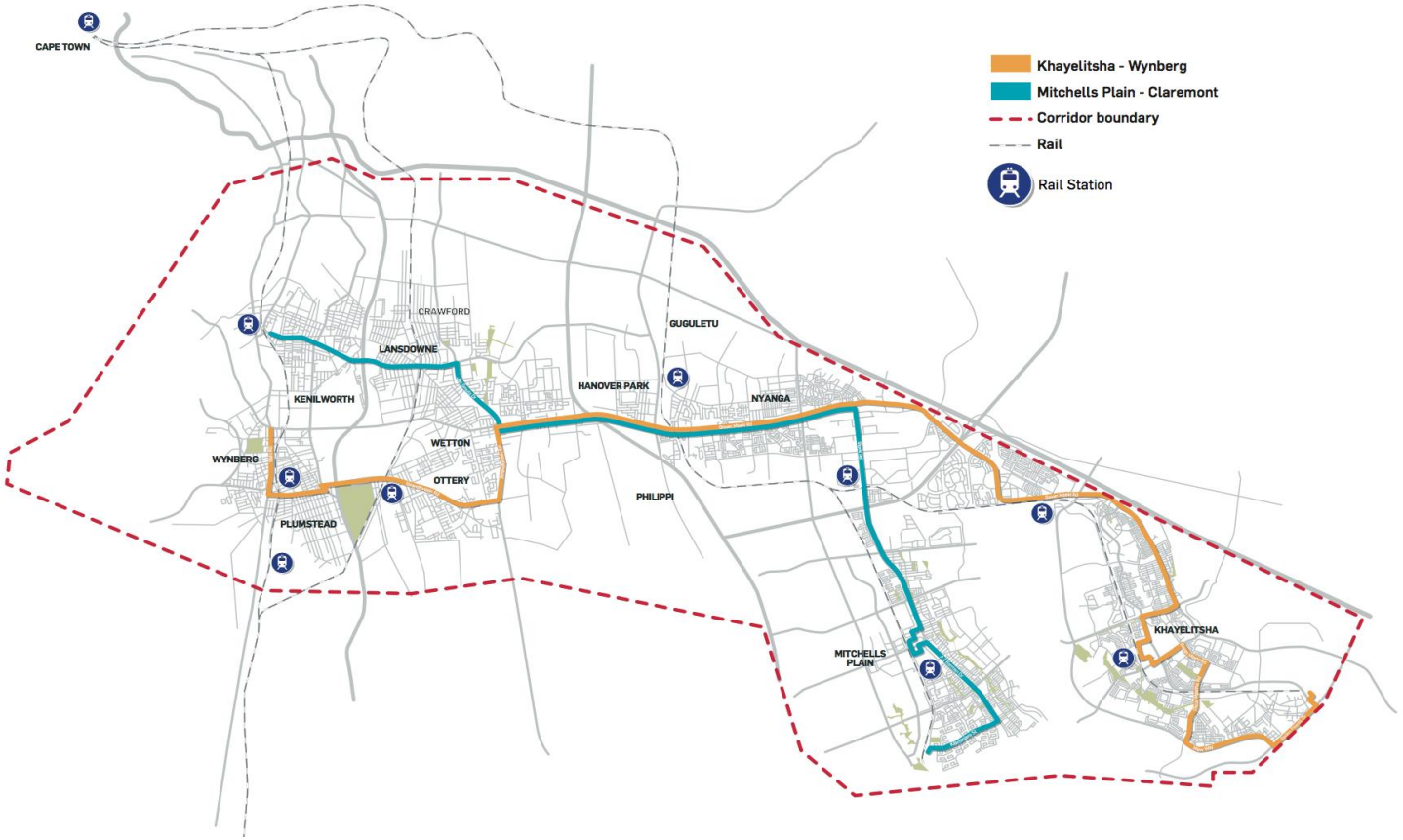
Call the Transport Information Centre (toll-free 24/7) 0800 65 64 63 www.myciti.org.za

MyCiTi Bus @MyCiTiBus

MyCiTi Siyajikeleza. Laat Wiel Going Places

Source: MyCiTi 2017

Appendix C: Phase 2A Route



Source: MyCiTi 2017.

Appendix D: Main Area Profiles of Phase 1

Phase 1 Main Service Areas								
		Blouberg	**Melkbosstrand**	**Atlantis**	**Hout Bay**	**Imizamo Yethu**	**Sea Point**	**Woodstock**
Area (km^2)		25.89	35.64	28.84	28.38	0.57	1.58	3.10
Population		106 222	11 586	67 491	17900	15538	13332	9345
Population Density (per km^2)		4102.25	325.11	2340	630.82	27227.05	8418.16	3018.72
Number of Households		41 186	4003	15 565	5963	6010	7285	2666
Gender (%)	Male	49.88	48.47	48.94	51.93	54.86	46.04	49.16
	Female	50.12	51.53	51.06	48.07	45.14	53.97	50.84
Population (%)	Black African	44.38	7.78	12.91	6.79	91.61	17.97	29.06
	Coloured	6.50	10.05	85.01	32.28	3.71	7.67	50.94
	White	44.67	80.51	0.15	57.40	0.12	67.46	11.59
	Indian/Asian	1.89	0.64	0.36	0.75	0.17	2.81	2.83
	Other	2.56	1.02	1.58	2.77	4.38	4.09	5.59
First Language (%)	English	43.68	43.37	9.43	59.70	10.66	68.58	63.82
	Afrikaans	14.70	51.46	79.5	32.93	4.73	13.33	18.14
	isiXhosa	27.5	1.38	7.67	1.26	59.50	3.63	2.05
	Other	14.12	3.79	3.4	6.11	25.11	14.46	15.99

Source: StatsSA 2011

Appendix E: Main Area Profiles Phase 2

Phase 2A Main Service Areas						
		Mitchells Plain	**Khayelitsha**	**Philippi**	**Wynberg**	**Claremont**
Area (km^2)		43.76 km2	38.71	47.96	5.06	5.21
Population		310 485	391 749	200 603	14472	17198
Population Density (per km^2)		7095.81	10 120	4182.34	2857.28	3299.71
Number of Households		67 993	118 810	64 411	5127	7364
Gender	Male	48.64	48.9	50.26	52.59	52.35
	Female	51.36	51.1	49.74	47.41	47.66
Population	Black African	7.32	98.62	90.33	21.16	16.76
	Coloured	90.77	0.59	8.00	46.13	11.09
	White	0.19	0.08	0.33	23.90	64.08
	Indian/Asian	0.62	0.07	0.28	3.37	4.83
	Other	1.10	0.63	1.07	5.44	3.23
First Language	English	47.35	3.22	6.16	69.58	83.41
	Afrikaans	46.93	1.06	7.32	14.87	7.15
	isiXhosa	3.32	90.54	78.69	5.03	2.23
	Other	2.4	5.18	7.83	10.52	7.21

Source: StatsSA 2011