A BUS RAPID TRANSIT ORIENTED APPROACH TO LAND USE CHANGE: A CASE OF HATFIELD

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Abstract

The post-apartheid administration of South Africa inherited a disjointed and sprawling urban land use pattern amid the pressures of growing urbanisation. The current urbanisation rate significantly exceeds urban planning agencies' capacity to supply infrastructure for a burgeoning population, hence intensifying sprawl. In search of solutions, drawing from literature and examples from other emerging economies, the South African government advocates for the implementation of Transit Orientated Development (TOD) by leveraging existing investments in mass public transit, such as Bus Rapid Transit (BRT) services. TOD promises a global shift from sprawling, fragmented cities to compact, inclusive mixed-use projects. The City of Tshwane Integrated Development Plan (IDP) stipulates utilizing the A Re Yeng BRT service as a catalyst for TOD-led land use change.

This research explores how the A Re Yeng BRT system serves as a catalyst for land use change in Hatfield. A literature review was conducted to shed light on the key concepts of Transit-Oriented Development (TOD), Bus Rapid Transit (BRT), and Land Use Change. Qualitative data was collected from multiple sources, including archival records, direct observations by the researcher, and interviews with relevant stakeholders. The research found that the exemplary BRT-oriented development (BRTOD) land use change patterns and characteristics are present in Hatfield. However, no evidence could be found which suggests that the BRT system serves as the catalyst for these land use changes. Insights from the data collected suggest that other external forces, such as the University of Pretoria and the Gautrain, serve as stronger catalysts. The A Re Yeng BRT service presently remains as a means of transportation.

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List of Abbreviations

BRT	Bus Rapid Transit
BRTOD	Bus Rapid Transit Oriented Development
CBD	Central Business District
CID	Community Improvement District
GDP	Gross Domestic Product
GIS	Geographical Information Systems
IDP	Integrated Development Plan
ITDP	Institute for Transport and Development Policy
NDP	National Development Plan
NPC	National Planning Committee
OECD	Organisation for Economic Cooperation and Development
PPHPD	Passenger Per Hour Per Direction
PPP	Public Private Partnerships
SACN	South African Cities Network
SAPOA	South African Property Owners Association
SDF	Spatial Development Framework
STATS SA	Statistics South Africa
TOD	Transit-Oriented Development
UN	United Nations
USA	United States of America

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Introduction:

This chapter provides a contextual background of the research. It starts with an introduction to urbanization and its effects on development. The sections that follow introduce the key concepts pertinent to the research of Bus Rapid Transit (BRT), Transit Oriented Development (TOD), and Land Use Change. The chapter then links BRT and TOD and provides a brief discussion on the potential of utilizing investments in BRT services to trigger TOD, and subsequent land use change, as a mitigation of the consequences of urbanization.

The suburb of Hatfield in the City of Tshwane is identified as a location for exploring the land use change leveraging the presence of the *A Re Yeng* BRT service, followed by an outline of the problem statement, research question, aims, objectives, and proposition. The research approach to be utilized and the limitations relevant to the research will also be specified.

The chapter will conclude with a summary of the research structure.

1.2 Background to the study:

1.2.1 Urbanisation and development

Urbanisation is described as an increase in the percentage of the urban population relative to the rural population (Zhang, Xing Quan, 2016, Nuissl & Siedentop, 2021, OECD, 2024). Urban areas are frequently regarded as significant hubs for economic development that create growth for low-income individuals. Nevertheless, studies on the causal relationship between urbanisation and growth, especially in emerging nations, remain unclear. Annez & Buckley (2009) conducted a cross-country correlation analysis that compared urbanization rates with the rise in average salaries, revealing a strong statistical association. Data from the Organisation for Economic Co-operation and Development indicates that over 30% of Africa's per capita GDP growth over the past two decades may be attributed to urbanisation. Nonetheless, urbanisation is also known for its adverse effects, particularly urban sprawl, congestion, and overburdened public services. Urban sprawl is commonly defined as the unregulated expansion of a city's built-up area characterised by low-density development, expanding beyond the original city boundaries (Kganakga, 2019, Magidi & Ahmed, 2019, Ziervogel, 2019). Inadequate investment in public infrastructure inhibits effective urban

growth. This is especially apparent in the cities of the Global South, where, alongside financial constraints, the pace of urbanisation surpasses the capacity of planning departments to improve infrastructure (Cervero & Dai, 2014, Criqui, 2015)

South Africa exhibits unique urbanisation characteristics stemming from the legacy of apartheid-era spatial planning, which created a specific kind of urban sprawl that enforced a segregated land use system, thereby marginalising a significant demographic from the urban core (Tomlinson, 2017, Kganakga, 2019). The apartheid rule in South Africa formally concluded in 1993, leading to rapid urbanisation in the nation's cities. In 2018, the urban population was documented at 63%, with projections indicating an increase to approximately 71% by 2030 (United Nations, 2022). The rate of urbanisation has surpassed the ability of government planning departments to effectively implement developmental strategies that mitigate sprawl and promote inclusion (Todes, 2012, Mazeka, Phinzi & Sutherland, 2021).

1.2.2 Sprawl to Inclusive using transit

Urbanisation leading to urban sprawl is a worldwide phenomenon, primarily witnessed in cities of the global south (Habibi & Asadi, 2011, Nuissl & Siedentop, 2021, Amponsah et al., 2022). The post-apartheid administration in South Africa has been introducing various spatial development framework policies to tackle the sprawling urban structure and promote spatial inclusivity (Tomlinson, 2017, Ziervogel, 2019). The primary urban planning document is the Integrated Development Plan (IDP), which functions as a framework for the future development of South African cities (NPC, 2012). The IDP not only directs spatial development but also integrates transport planning policies, facilitating projects like the Gautrain Rapid Rail Link and Bus Rapid Transit (BRT) services in South Africa's major metropolitan areas. The integration of spatial development and transport planning paved the way for the adoption of TOD in South Africa, which has gained global recognition as an urban planning strategy that optimizes compact, dense, mixed land-use developments in proximity to transit stations, with the transit stations serving as catalysts for these land uses. (Carlton, 2009, Salat & Ollivier, 2017)

BRT services have gained global popularity, including in South Africa, as an economical solution to urban mobility challenges that provide sprawling suburban areas with convenient and affordable access to economic centres (Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016, Tsotetsi et al., 2018). Implementing TOD is appealing to government urban planning departments as it provides a chance to utilise existing investments in BRT infrastructure to

catalyse shifts in land use from sprawling to compact and inclusive. (Cervero & Dai, 2014, Aigbavboa & Ogra, 2018)

1.2.3 Land Use Change

The definition of land use change is ambiguous in the literature because of its multidisciplinary use across multiple contexts. To understand it within the context of this research, it is essential to first understand the definition of land use. Mazeka, Phinzi & Sutherland (2021:135) define land use as the "*human utilisation and management of the earth's surface, including urban activities which lead to land cover modification"*. The definition of human utilisation varies as well with the purpose it serves, whether it be agricultural, provision of shelter, commercial or recreation, and so on. The aforementioned human utilisations of land have always been part of civilization to cover the earth's surface. However, since the amount of available land is constant, it is a proportion of the earth's surface occupied by these utilisations, which is subject to changes (Briassoulis, 2020). Therefore, land use change in this research refers to changes in the proportions of human utilisation of the Earth's surface.

Pezeshknejad, Monajem & Mozafari (2020) argue that analysis of land use change systems is critical as it can help planning authorities adequately prepare for the present and future. Therefore, exploring the development strategies that mitigate the negative consequences of urbanisation, such as urban sprawl, is vital in the cities of the global south.

1.3 Background to the problem

The world's cities are experiencing unprecedented population growth (Nuissl & Siedentop, 2021, OECD, 2024). As the urban population grows, the land continues to face development challenges to support the growing population (Ingram & Brandt, 2013, Buckley & Kallergis, 2014). South African cities have not been spared the consequences of urbanization as the government's ability to adequately prepare for the surge of new urban residents has lagged behind the pace of urbanization (Tomlinson, 2017, Mazeka, Phinzi & Sutherland, 2021). A primary consequence of urbanization witnessed in South African cities is urban sprawl, with associated problems of congestion, inadequate infrastructure, fragmented urban form, and transportation problems (Plessis, 2014, Magidi & Ahmed, 2019, Amponsah et al., 2022). The concept of Transit-oriented development (TOD) is advocated globally as a tool to combat the problems associated with urban sprawl (Bickford & Behrens, 2015, Peng, Li & Choi, 2017). The implementation of the internationally adopted TOD design principles is

seen as very straightforward (ITDP, 2021), however, the literature indicates that adopting the TOD principles to drive land use change is complex and can be very context-specific (Olaru & Curtis, 2015, Singh et al., 2017, Sun, Han & Lu, 2024)

The South African TOD strategy is informed by the internationally adopted TOD principles (Bickford & Behrens, 2015, Aigbavboa & Ogra, 2018), and it intends to leverage the investments already made in transit infrastructure like the Gautrain and BRT services in the metropolitan areas (Aigbavboa & Ogra, 2018, Tsotetsi et al., 2018). TOD leveraging rail infrastructure has demonstrated its efficacy as a land use change catalyst (Dong, 2017, Sun, Han & Lu, 2024). However, the efficacy of a BRT service as a land use change catalyst remains largely unexplored (Cervero & Dai, 2014, Prayogi, 2017, Fenske, 2019). The argument in literature is that the key characteristics of a BRT system (being the dedicated busways, fixed transit stations, right-of-way lanes, and multiple accessways) mimic that of a rail transit system, which begs the question of the systems' efficacy as a land use change catalyst (Cervero & Dai, 2014, Nakamura, Makimura & Toyama, 2017, Prayogi, 2017).

According to Statistics South Africa, the City of Tshwane recorded the highest urbanization rate in the post-apartheid era, surpassing the sister cities of Johannesburg, Cape Town, and Durban (StatsSA, 2022). Magidi & Ahmed (2019) analysed urban sprawl in the City of Tshwane using remote sensing and landscape metrics, and found an increase of 109% in built-up areas from 1984 to 2015. The City of Tshwane is home to the A Re Yeng BRT service, with the first phase consisting of a 7km route linking the Pretoria CBD to the suburb of Hatfield. TOD leveraging the A Re Yeng BRT service has been identified by the City's planning departments as the answer to combating the urban sprawl problems in the City of Tshwane (City of Tshwane, 2021).

1.4 Problem Statement

The use of rail transit as a TOD and land use change catalyst is well documented in the literature, as the system has built a strong track record. Empirical research on the efficacy of a BRT system as a TOD and land use change catalyst is limited, more so in the context of rapidly urbanising cities in the Global South. One of the aims of the A Re Yeng BRT service is to trigger TOD in Hatfield, but research evaluating its efficacy as a catalyst for TOD and subsequent land use changes has not been conducted. The A Re Yeng BRT service has been in operation for over 10 years now, providing an opportunity to explore its effectiveness as a driver for TOD and land use change in Hatfield.

1.5 Research Question

How has the A Re Yeng BRT served as a catalyst for TOD and land use change in Hatfield?

1.6 Research Aim

This research aims to explore how the A Re Yeng BRT system serves as a catalyst for TOD and land use change in Hatfield.

1.7 Research Objectives

The research objectives to be accomplished are to;

- Explore the concept of land use change
- Examine the concept of BRT and TOD and how it has evolved globally
- Assess the influence of BRT on land use change globally
- Track the land use patterns and the prevalence of TOD characteristics in the vicinity of the BRT station in Hatfield.
- Ascertain whether the identified land use changes and TOD characteristics are resulting as an effect of the BRT services.

1.8 Research Proposition

The research proposition is;

The A Re Yeng BRT service merely acts as a transportation service in Hatfield and has not served as a catalyst for land use change in the last ten years.

1.9 Research Method

A single case study approach was used to achieve the objectives set out for the research. The following steps were adopted:

1. An in-depth review of existing literature on land use change, BRT and TOD.
2. A review of documentary evidence relating to BRT influencing land use changes.
3. Semi-structured interviews with professional stakeholders with extensive knowledge of the area and the subject matter. Information gathered from the literature review and documentary evidence informed the questions to be asked.

4. Comparison of historic and current aerial imagery
5. Own Observations from fieldwork – tracking the land use patterns, land use and the prevalence of TOD characteristics in the vicinity of the BRT station in Hatfield.

The analysis of the data was done using pattern matching technique, tracking the theoretical BRT-led land use changes and TOD characteristics in reality.

Finally, conclusions were drawn, and recommendations made

1.10 Ethical Considerations

Ethics approval for the research was sought following the formulation of the initial interview questions and schedule. The documentation of the ethics clearance is contained in Appendix A.

An informed consent to interview form was created by the researcher, explaining the purpose of the research and outlining the objectives. The form clarified that participation is completely voluntary, sought consent to record the interview, and detailed the intended use of the data. The interviewees completed the form, which is attached as Appendix B.

No direct or indirect harm was anticipated by the researcher, and respondents were informed that all data collected would be used solely for the research and no other purpose.

1.11 Limitations

The research limitations are;

- Single Case Study - The research is a single case study limited to the study area, therefore the findings may not be generalisable. Hatfield's case study is suggestive of what may be found in similar scenarios but additional research will be needed.
- Subjectivity - It is mostly the researcher who makes the most decisions regarding the type of data to be collected, the sampling, and the analysis methods. There is an element of subjectivity in case study research.
- Human-eye Matching - A human eye pattern matching analysis of aerial photography was done. A computerized matching software may provide additional and use changes that were not observed by the human eye.

- Lack of participation from Bus Operator - Participation in the data collection process by A Re Yeng bus operator was not received. Key information that may have been obtained for the research was not accessible.
- Timeline - The A Re Yeng BRT service commenced operations in 2014. The timeframe for data collection is between 2013 and 2024.

1.12 Structure of the Research

The research is structured as follows;

Chapter One provides an overview of the subject, and also identifies the major ideas that were covered. The formulation of the research problem was succeeded by the research question, the purpose of the study, and its goals.

Chapter Two provides an overview of the literature on the subjects covered in Chapter 1

Chapter Three discusses the methodology and research approach utilized to obtain the data required to meet the objectives.

Chapter Four presents the data and information gathered during the data collection process, followed by a discussion and interpretation of the findings.

Chapter Five examines the research's combined findings and offers an overview of the entire project by going over the goals and research questions again to make sure they have been satisfied. After that, the chapter will conclude with suggestions for additional research.

References and appendices sections will close the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Chapter 1 introduced the key concepts that are relevant to this study to provide the context for the research. The key concepts of the research are Land Use Change, Transit Oriented Development (TOD) and Bus Rapid Transit (BRT). This chapter reviews existing literature on the aforementioned concepts to contextualize this research. The concept of land use change is first introduced as the main purpose for investments in transit.

The concepts of TOD and BRT are then reviewed individually, subsequently leading to their integration, resulting in Bus Rapid Transit-Oriented Development (BRTOD) as a potential catalyst for land use change.

2.2 Land Use Change

2.2.1 Defining Land Use Change

Land use was introduced in the previous chapter and defined as "*human utilisation and management of the earth's surface, including agriculture, forestry and urban activities which lead to land cover modification"* Mazeka, Phinzi & Sutherland (2021:135). A more thorough examination of this definition is necessary for understanding its meaning, particularly within the context of this research. The human utilisation of the Earth's surface is typically for agricultural, residential, and commercial purposes and has been a part of human civilisation since the dawn of time (Briassoulis, 2020). The size of the earth's surface does not change. However, it is the proportions of the human utilisation of the earth's surface that are subject to changes. Therefore, land use change refers to the changes in the proportions of human utilisation (Nuissl & Siedentop, 2021). The dynamic nature of human needs drives modifications in land use.

2.2.2 Land Use Change, a theoretical perspective.

This research focuses on analysing land use, as well as the interventions that are responsible for how the use of land changes. Theories on urban morphology emerge as representative of the research. Urban morphology is described as *"the study of human settlements, their structure and the process of their transformation"* (Kropf, 2018:9). Urban morphology is primarily concerned with the urban landform, its growth and changes in its

usage, asserting that human actions or interventions are the main catalysts for land use change (Kropf, 2018, Kristjánsdóttir, 2019)

Urban morphology can be traced back to the teachings of Saverio Muratori and Michael Robert Günter Conzen (Muratori, 1960, Conzen, 2004). The studies led by Conzen concentrated on what is called the '*plan unit'* analysis which took into account a cluster of *buildings,* their associated *open spaces* and *streets* that come together to form a geographical town. Conzen understood land use change as catalysed by how these three elements in a geographical town interact with each other (Whitehand, 2007). However, Muratori's studies suggested that, in addition to Conzens's three elements, consideration needs to be given to the activity patterns and historical context of the area (Muratori, 1960). Muratori contended that land use change is influenced not by geographical factors alone but must also account for human interventions on the land (Cataldi, Maffei & Vaccaro, 2002). The integration of the Cozen and Muratori studies is regarded as the most significant achievement in the analysis of urban land use and its changes (Caniggia & Maffei, 2001, Cömert, 2013, Irani, 2017).

Kropf (2018) discusses four broad approaches to urban morphology; typo-morphological, configurational, historic-geographical, and spatial analytical. Typo-morphological analysis of an urban form involves deconstructing the urban structure into its morphological elements such as streets, squares, buildings, plots and topography, followed by their interconnection and contextualisation as a means of understanding the urban form (Leite & Justo, 2016). The configurational approach is based on mathematical studies of urban form, concentrating on the analysis of geometric and topological attributes of the built environment. It seeks to understand the interconnections among various attributes and quantifies how different spatial forms influence the utilization of urban areas (Karimi, 2012). The historico-geographical approach to urban morphology aims to explain urban form and human settlements through a chronological analysis of basic aspects, such as street and plot patterns. Changes are tracked over time to explain the development process and utilisation of land (Karimi, 2012, Monteiro & Pinho, 2022). The spatial analysis approach grew out of the initial urban growth models proposed by Burgess (1925) and Hoyt (1939). The models indicated that the urban form grew radially in concentric circles or sectorally from a central nucleus. Although the central nucleus was historically regarded as the central business area (CBD) of a region, a nucleus is now broadly understood as any human intervention that serves as a catalyst for land use changes (Park, Robert E & Burgess, 2019, Rawding, 2019). The spatial analysis approach considers cities as complex adaptive systems

characterised by a dynamic, iterative, and reciprocal connection between various socioeconomic interventions and the physical land (Kropf, 2018).

In conclusion, the spatial analysis approach to urban morphology can function as a theoretical framework for exploring land use changes induced by bus rapid transit services. The implementation of the BRT service is regarded as a human intervention, potentially serving as the catalyst for land use changes.

2.2.3 An Overview of the Drivers of Land Use Change

2.2.3.1 Urbanisation and Urban Sprawl

Nuissl & Siedentop (2021) state that urbanization is a primary driver of land use change. When urban population growth outpaces infrastructure development, it results in urban sprawl (McPhearson et al., 2016, Nuissl & Siedentop, 2021). Various definitions of urban sprawl exist in literature due to its multi-dimensional application. Urban sprawl is understood as the expansion of low-density, automobile-reliant development around an established urban region (Habibi & Asadi, 2011, Dadashpoor & Shahhossein, 2024). Habibi & Asadi (2011) argue that this type of urban growth is unplanned, scattered and lacks control by a centralized land use system. Rodriguez, Daniela & Targa (2004) argue that urban sprawl creates spatial inequality, as the outward expansion of the city is often into undeveloped land. People who are residing in peripheral areas typically endure lengthy commutes to the central business district, resulting in reliance on automobiles and a robust public transportation network. For the government, ensuring sufficient transit infrastructure becomes a burden. Urban sprawl is frequently accompanied by the construction of highways and the prevalence of private motor vehicles, which can inadvertently promote the development of land farther from the core business centre and exacerbate sprawl (Karakayaci, 2016).

South African cities are not exempt from urban sprawl (Magidi & Ahmed, 2019, Mazeka, Phinzi & Sutherland, 2021). South African cities are grappling with increased demand for housing, transit and infrastructure. The introduction of GIS mapping tools has assisted South African cities in studying land use change patterns more effectively under the burden of urbanisation (Magidi & Ahmed, 2019).

2.2.3.2 *Transit and Accessibility*

Bree, Fuller & Diab (2020) state that transit and the degree of accessibility of a location are key variables influencing land use change. Transit accessibility measures the ability of a location to be accessed from various areas via transportation (Rodrigue, 2020b). Traditionally, land uses that required high levels of accessibility were typically located in or near the city centre, while land uses with lower accessibility requirements uses were found farther out from the CBD (Yang, Linchuan, 2019). The provision of transport infrastructure can bridge the gap in the degree of accessibility between a location near the city centre and those farther away (Yang, Linchuan, 2019). The transit infrastructure acts as a stimulant attracting land uses that require a high degree of accessibility regardless of the distance from the city centre.

2.2.3.3 *Higher Educational Institutions*

Educational institutions like Universities are seen as crucial drivers of land use change in the towns where they are located (Ruoppila & Zhao, 2017). The role of higher education institutions driving land use change is evidenced by the existence of 'university towns' or 'student villages' describing locations that have developed around the presence of a University (Li, Li & Wang, 2014). Universities often invest in infrastructure such as student accommodation buildings, transportation services, and sports facilities, positioning them as significant catalysts for changes in land use.

2.2.4 An Overview of Land Use Planning in South Africa

There is a belief in literature that a majority of what is known about land use planning in Africa comes from outside the continent (Bolay, 2015). The case is the same for South Africa, where colonialism was the vehicle transferring land use planning systems from the global north to the south, influenced by globalization trends in those regions (Watson & Agbola, 2013, Cilliers, 2020). In South Africa, land use planning occurred mainly through British, German and Dutch influence using master planning document tools like zoning and building regulations (De Satgé & Watson, 2018). Some of these urban planning tools are still present in today's post-colonial government with the state maintaining control of zoning and land use rights. Control of land use rights has also extended to housing in South African cities, where approved plans and building permits are required to classify a house as formal. A challenge exists as obtaining these approvals is time-consuming and expensive, hence why a majority of the urban poor settlements are classified as informal.

Land use planning in South African cities has developed into a balancing act between political, social, economic, and environmental concerns (Cilliers, 2020). The idea of creating new urban spaces has largely been associated with '*catching up with the W*est', making it appealing to governments and the elites seeking such a perception (Watson, 2009:174). However, municipalities are struggling to cope with the rising urbanization rates which put pressure on strained public infrastructure, and local planning departments are seeing the importance of a formal 'planning with' approach to the use of land. The 'planning with' approach demands incorporating real on-the-ground data on the challenges and complexities which affect South African cities (Cilliers, Dirk Petrus, 2010). A need exists for fieldwork capturing the needs and aspirations of the population to formulate a meaningful 'planning with' approach.

Ziervogel (2019) argues for the development of a new land use planning approach which is pro-poor as it is evident in South Africa that the proportion of the urban poor exceeds the well-off. Urban areas planned with the assumption that a majority of the residents own a private motor car become highly unequal. According to Thomas (2016) lower-income households in South Africa are usually located on cheaper land at the urban peripheries and find themselves having to pay high transport costs to access places of economic production. The separation of land uses into monofunctional zones further generates high volumes of mobility, which further disadvantages the urban poor who end up using their house as an economic unit as well (De Satgé & Watson, 2018). From the commercial perspective, the advantage of economies of scale that can be achieved through agglomeration of a mixture of land uses in a single node is compelling, however, they also have the opposing effect of being exclusionary and laden with hierarchical principles (sometimes on racial and ethnic differences) for residential zones (Watson, 2009).

2.2.5 Transit and Land Use Change

Transit-oriented strategies for urban land use change have gained popularity in several cities, representing a planning approach that seeks to promote growth by capitalising on proximity to public transport stations (Salat & Ollivier, 2017). It is characterised by the grouping of interacting human activities around public transit stations, on the principle that land use change and urban transport can be efficiently managed when designed together (Suzuki, Cervero & Iuchi, 2013). Zhou & Gao (2020) state that urban transportation profoundly influences the urban land and the development of a symbiotic link between urban transportation and land use has garnered considerable global interest. The interacting

dynamics between urban land use changes and transport networks can facilitate the development of innovative spatial development strategies (Rodrigue, 2020b)

The development of the railway enabled the initial observations of the influence of transit on land use change (Jackson, 2006, Pan & Zhang, 2008) The railway facilitated the establishment of dispersed mixed land-use villages, known as trackside suburbs, which were separate from the city centre and each other (Rodrigue, 2020a).

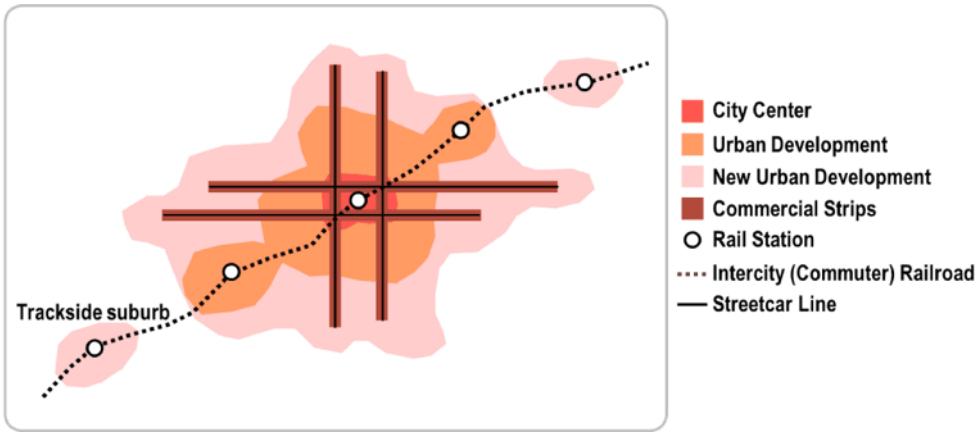


Figure 1: Rail and Land Use (Rodrigue, 2020a)

The trackside suburbs emerged at the sites of rail stations and extended up to 30 kilometres from the city centre, see Figure 1.

Cervero (2013a:18) discusses the 5 D's *`density, diversity, design, distance to transit, and destination accessibility)* which have gained popularity in assessing the impact of transit on land use change in the global north. Higher densities present the maximum opportunity to engage with the transit system (Suzuki, Cervero & Iuchi, 2013). Diversity not only describes the demographics of land users but also a mixture of land uses (Moos et al., 2018). Distance to transit needs to be walkable to/from final destinations and provide seamless access to places of activity (Fenske, 2019).

Transit-oriented land use changes often exhibit two forms of development; corridor development and nodal development (Suzuki, Cervero & Iuchi, 2013, Su et al., 2021). Corridor development describes land use changes that develop adjacent to and following the linear route between two stations, while nodal development sees land use changes extending outwards radially or in sectors with the station serving as the nucleus of the development (Suzuki, Cervero & Iuchi, 2013, Kamruzzaman et al., 2014). Both these land use change forms seek to decentralize the central core city to that of a polycentric urban

structure whereby the central place is made up of various nodes which interact with each other (Kganakga, 2019). The selection of the transit station's site is frequently determined by the perceived socio-economic potential of the node, resulting in that node being spatially targeted for development (Singh et al., 2017, Kganakga, 2019). From a South African perspective, spatial targeting of a node has primarily been employed for mass housing development as outlined in the National Development Plan (NDP) (NPC, 2012). However, this approach can also be used to facilitate the implementation of compact mixed-use development strategies like transit-oriented development (TOD) (Singh et al., 2017, Su et al., 2021)

2.3 Transit Oriented Development (TOD)

2.3.1 Defining TOD

Transit Oriented Development (TOD) is defined as a *"planning and design strategy to ensure compact, mixed-use, pedestrian- and bicycle-friendly, and suitably dense urban development organized around transit stations (Salat & Ollivier, 2017:xxiv).*
The concept of TOD was first proposed by Peter Calthorpe in the 1980s as an innovative strategy for urban planning (Carlton, 2009). Since then, The Institute for Transportation and Development Policy (ITDP) has been an advocate for Bus Rapid Transit (BRT) and TOD working to standardize the idea so that it can be implemented in additional cities.

TOD addresses various issues faced by today's cities, such as congestion, pollution, and urban sprawl (Salat & Ollivier, 2017, Liu et al., 2022). TOD aims to maximize land use and transit synergy, by leveraging transit investments and services as a guide to land development (Salat & Ollivier, 2017).

2.3.2 Principles and Characteristics of TOD

The ITDP promotes that eight essential principles named; walk, cycle, connect, transit, mix, densify, compact' and 'shift must be prevalent in any high-quality TOD node (ITDP, 2017). The principles of TOD are globally accepted and well-defined in the literature (Wey & Chiu, 2013, ITDP, 2021, Liu et al., 2022). Successful TOD precincts incorporate the aforementioned principles in their designs and have several common characteristics that contribute to their effectiveness namely; proximity to transit; mixed-use development, pedestrian-friendly design; high-density development; and public spaces.

2.3.2.1 Proximity to transit

Proximity to a major transit hub, such as a train or bus station, is at the heart of any TOD project (Olaru & Curtis, 2015). TOD demands the establishment of a central node featuring high-density residential units and a mix of commercial land uses within walking distance of the transit station. In a TOD location, walkability is understood as incorporating urban designs that promote non-motorized transportation options (ITDP, 2021). Ozbil, Peponis & Stone (2011:126) uses the phrase 'walking catchment area' to denote the distance that people are inclined to walk to reach a destination, although refrain from approximating a specific distance, contending that the society is heterogeneous and that people will walk differing lengths for different reasons. For example, a train station may possess a larger walking catchment area compared to a bus stop or tram stop, and a student may be willing to walk longer distances to reach their place of activity than a senior citizen (Ozbil, Peponis & Stone, 2011). In a TOD context, locations with lower densities lead to larger walking catchment areas of approximately 1000 to 1500m, while inner cities with high densities exhibit catchment areas of 300 to 600 meters, equating to an approximate walking duration of 10 to 15 minutes (Sarker, Mailer & Sikder, 2019).

In addition to walkability, proximity to transit is closely aligned with the TOD principles of connect and transit. The principle of *connect* is discussed from several angles in literature. Olaru & Curtis (2015) uses the terms 'closeness' and 'centrality' implying the availability of a dense network of streets and pathways, resulting in short trips and connections to activities using the public transit (Olaru & Curtis, 2015). Transit refers to the availability of rapid and efficient transportation networks that encourage people to choose public transit over cars. While TOD is theoretically focused on the neighbourhood level, its proximity to transit can establish connections to other TOD neighbourhoods and transit nodes, thus having an impact on a citywide scale (Cervero & Dai, 2014, Olaru & Curtis, 2015).

2.3.2.2 Mixed-Use Development

The most common goal of TOD is to get people to walk, cycle and use public transit instead of cars. This requires the creation of a diverse mix of residential and non-residential uses within the TOD node, hence reducing the need for long commutes to places of activities (Singh et al., 2017). Non-residential uses may encompass elements such as retail facilities, offices, leisure, open parks and community/recreation centres. Mixing of uses is widely advocated in North America, Europe and Asia (Moos et al., 2018), while the Global South

has been comparatively slower in adapting these notions to their local settings (Wood, 2021).

2.3.2.3 Pedestrian Friendly Design

Kelly, Charlotte et al. (2011), Wey & Chiu (2013) use the phrase 'pedestrian-friendly design' to describe the human interaction with the local environment in a way that is not possible with motorized transport. Pedestrians will consider a place pedestrian-friendly if it features clean, wide sidewalks, secure crossing zones, effective accessibility to diverse services, and a perception of safety (Kelly, Charlotte et al., 2011)

The principle of cycle enhances the pedestrian-friendly designs by further expanding the non-motorized catchment area from the local (neighbourhood) level to the regional (city) level. In addition to pedestrian walkways, TOD urban design requires the incorporation of dedicated cycleways (Cervero & Dai, 2014, Aigbavboa & Ogra, 2018). There is little empirical evidence though of transit services acting as a destination point for cyclists in a compact TOD context. Research indicates that the two can often act in competition with one another as residents will elect to walk and use the bus/tram services or cycle directly to their places of activity (Cervero & Dai, 2014, Singh et al., 2017). In literature, what is common is that the principle of cycle can be used together with walkability as an added measure of accessibility that allows residents to interact with places of activity without the use of a motor vehicle (Olaru & Curtis, 2015, Fenske, 2019).

2.3.2.4 High Density Development

TOD promotes increased density to maximize the use of land and accommodate a greater population within a compact space (Ozbil, Peponis & Stone, 2011). Density relates to the deliberate intensification of the residential and commercial spaces near high-capacity transit stations to ensure workers have access to high-quality transit (Ogra & Ndebele, 2014). It assumes that residents will be more enticed to abandon their cars in favour of the mass transit system. Creating compact spaces requires the transformation of existing urban infrastructure to enable people to reside closer to places of employment, activities, etc. Salat & Ollivier (2017) state that focusing on development within a 1km radius of a transit station offers a unique potential to change the urban, rendering them more inclusive for residents. The compact nature of TOD is largely influenced by the distances that people are willing to walk (Ozbil, Peponis & Stone, 2011). The 1km radius, or even slightly larger, may be

suitable for rail transit whereas a bus rapid transit service tends to have a smaller catchment radius of approximately 400m (Sarker, Mailer & Sikder, 2019).

2.3.2.5 Open Spaces

TOD projects frequently incorporate open spaces such as parks, community centres, etc. offering residents places for socialising (Olaru & Curtis, 2015). These public places improve the quality of life quality further making a TOD node an attractive place to live.

2.3.2.6 Measure of success

Singh et al. (2017) argue that the shift principle is more measured as the result of the successful implementation of the above TOD principles and the prevalence of the characteristics above. Indications of successful modal shit to public transit include less traffic congestion and a reduction in the provision of adequate parking spaces (Olaru & Curtis, 2015, Singh et al., 2017).

2.3.3 Location Potential for TOD

Not all locations have the same TOD potential (Singh et al., 2017), as certain locations may lack the requisite commercial value required for such development. Understanding timing, location and how potential value can be created, requires tools that distinguish the opportunities presented by various sites within a mass transit network (Cucuzzella et al., 2022).

Bertolini (1999) developed the node/place model, see Figure 2, by analysing transit stations in Amsterdam and Utrecht in the Netherlands seeking to understand the correlation between transportation and the neighbourhood potential for TOD.

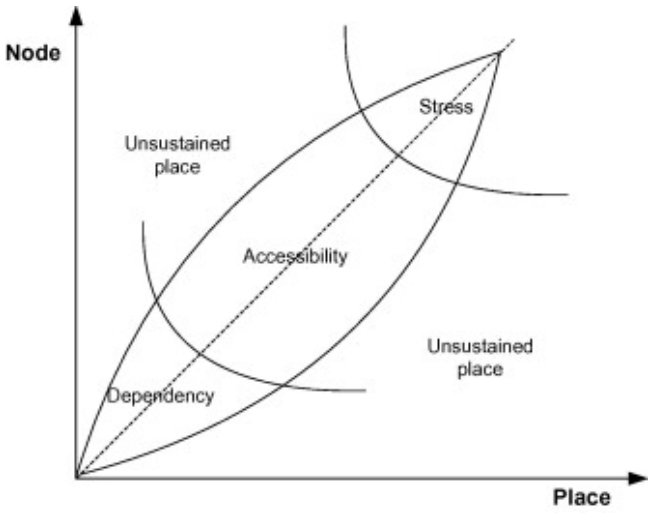


Figure 2: Bertolini Node/Place Model (Bertolini, 1999)

The node/place model assesses the probability of human interaction with a transit node by considering accessibility. The possibility of human connection is described by both the y and x variables. The "*node-value"* or accessibility of a place is represented by its y value (i.e. the more people who can reach it, the more interaction opportunities there are), while the x value represents an area's *"place-value",* or the variety and intensity of activities that take place there. Bertolini (1999) says the four circumstances that can be mapped out are *"stress, dependency, accessibility, and unsustained place".* The areas on the model where the node and the place are equally strong, and have the greatest potential for TOD implementation, are those along the centre diagonal line, which is where accessibility is realized. The places under stress, at the top of the queue, are those with the highest levels of human interaction and transportation flows with land uses; however, this also indicates that there is a higher likelihood of conflicts due to the various uses that are available. The unsustained places are those where place variables or node variables predominate too much to allow for efficient TOD implementation.

The Node/Place model has been applied in various locations using a variety of indicators to measure the accessibility and TOD potential of a node. The model was used by Reusser et al. (2008) to evaluate every train stop in Switzerland to assess TOD potential with varying results. The model was also used by Chorus & Bertolini (2011) to investigate the potential for spatial development of Tokyo's BRT station areas. Pezeshknejad, Monajem & Mozafari (2020) applied the model to assess the possibility of land use integration of Tehran's Bus Rapid Transit (BRT) stations and incorporated factors such as potential market value, the premise being that the model on its own is too general while TOD is significantly context-based and each area has its differentiators that can TOD influence the result significantly.

Their research ultimately demonstrates that the surrounding pedestrian accessibility of a BRT station is a critical factor in determining its efficiency.

Cucuzzella et al. (2022) developed a TOD index that focuses on integrating the socio-environmental attributes, commercial viability and development potential of a site. The index was successfully applied to various transit stations in Montreal, Canada, to identify the stations with the highest and lowest potential for TOD.

2.4 Bus Rapid Transit

2.4.1 Defining BRT and its Origins

Bus rapid transit (BRT) is defined by the Institute for Transport and Development Policy (ITDP) as a *"high-quality bus-based transit system that delivers fast, comfortable, and cost-effective services at metro-level capacities through the provision of dedicated lanes, with busways and iconic stations typically aligned to the centre of the road, off-board fare collection, and fast and frequent operations" (ITDP, 2016:1)*

In literature, BRT is occasionally compared to LRT (Light Rail Transit) as a rapid transportation modality that combines the efficacy of rail transit with the flexibility of buses that run on dedicated busways (Levinson et al., 2002). The idea of BRT has been around since the 1930s (Levinson et al., 2002). The BRT can be traced to the city of Curitiba, where busways and feeder services were introduced in the 1970s. The City of Curitiba found that implementing BRT service was up to 99,8% cheaper when compared to building a full subway system (Goldwyn, 2013). After its success in Curitiba, other towns in Brazil started introducing the service before its expansion to other cities in South America. The Bogotá BRT service in Colombia is regarded as a significant advancement in BRT systems, exemplifying superior performance in speed, capacity, and reliability (Nakamura, Makimura & Toyama, 2017). BRT services increased globally following the success of the Bogota service.

The critical characteristics that are now linked to BRT developments were innovations that originated in Brazil and Colombia. According to Global BRTData, as of January 2024, 5 842 kilometres of bus rapid transit have been installed in more than 191 cities worldwide, carrying close to 32 million passenger journeys every day (BRTData, 2024)

2.4.2 The Justification for BRT

There are numerous justifications for creating BRT systems. Rodriguez, Daniela & Targa (2004) contend that as the city grows, improved access and mobility become a necessity. The cases in Curitiba and Bogota have shown that BRT is a more cost-effective option to build and serves a broader range of urban environments compared to rail transit (Lindau, Hidalgo & Facchini, 2010). Bus Rapid Transit (BRT) has become more preferred because many cities in the Global South lack the financial resources required for substantial expenditures in conventional public transportation systems such as trains or subways (Fenske, 2019).

Citing a few examples in the USA and Canada, Levinson et al. (2002) says that BRT systems can frequently be deployed swiftly and gradually from a community setting to an entire region. BRT increases the accessibility potential of rail lines by providing feeder routes into areas with densities too low to effectively operate rail transit (Zhang, Xing Quan, 2016). In the western and eastern suburbs of Brisbane, Zhang, Xing Quan (2016) found that there is a property value increase of up to 1.64% for every 100 meters closer to feeder bus stations with regular services.

Suzuki, Cervero & Iuchi (2013) cite examples in Boston, Ottawa and Brisbane where BRT has been part of integrated transit and land-use strategies further supporting economic development opportunities.

2.5 Linking BRT and TOD (BRTOD)

2.5.1 BRT-led TOD

Theoretically, a significant investment in transit increases accessibility to a place, making it more attractive and leading to a higher concentration of people and jobs (Bree, Fuller & Diab, 2020, Rodrigue, 2020b). Leveraging this interaction in urban development is central to TOD. TOD aims to maximize the land use and transit synergy, by leveraging transit investments as a guide to land development (Salat & Ollivier, 2017, Liu et al., 2022). The impact of rail transit on TOD is well documented in literature as the system has built a track record (Dong, 2017, Peng, Li & Choi, 2017, Sun, Han & Lu, 2024). However, the question of whether Bus Rapid Transit (BRT) can stimulate Transit-Oriented Development (TOD) remains highly debatable (Cervero & Dai, 2014, Prayogi, 2017, Pezeshknejad, Monajem & Mozafari, 2020). Chen (2023) states that this suggests that a hierarchy of TOD transit modes exists, indicating that BRTOD may find its niche in low-density or suburban settings.

2.5.2 Success and Risk Factors to BRTOD

The efficacy of BRTOD is inherently connected to the operational efficiency of the BRT system (Cervero & Dai, 2014, Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016). If the BRT service fails to meet the necessary efficiency standards, then successful implementation of BRTOD is unattainable. Mallqui & Pojani (2017) established a seven-point theoretical framework of the key success or failure factors of a BRT service, consequently impacting the capability of the system to trigger TOD. The categories included in the framework are; institutional and legislative context, political leadership and commitment, management of competing modes, public participation, funding and coordination, physical design, and image promotion (Mallqui & Pojani, 2017).

Category	Risk factor
Institutional and legislative context	• Unaligned interest of stakeholders • Decentralised transit and land use planning departments, resulting in uncoordinated effort towards BRTOD
Political leadership and commitment	• A lack of commitment of municipal officials leaders in championing BRT planning and implementation • Risk of discontinuation in case of electoral changes. • No support from legislative perspective
Management of competing modes	• Competition and opposition to BRT from car owners • Opposition and competition to BRT from existing transit operators • Opposition from existing property owners
Public participation	• No relationship with major property developers, who would invariably kick off BRTOD projects. • Lack of public education activities on the advantages of BRT over other modes and how to use the system once its built • Lack of communication, transparency, and media or community engagement.
Funding and coordination,	• Significant upfront investment - directly (building infrastructure) or indirectly (road space / stations / bus depots/terminals).

	• A lack of innovative funding sources (e.g., public-private partnerships, transfers from regional or national government, taxation, value capture from TOD)
Physical design	• Poorly designed BRT system (no lane separation, no special buses, a lack use of technology for information displays and fare payment, etc.) • No forward thinking in planning for multiplier benefits like TOD, leading to isolated corridors and nodes.
Image promotion	• Failing to leverage the backing of stakeholders who would gain from BRT, such as the public, property owners, developers, etc. along the proposed route.

Table 1: Barriers to successful BRT Implementation. Adapted from (Mallqui & Pojani, 2017)
Other sources (Dibakwane, 2011, Kumar, Zimmerman & Agarwal, 2012, Prayogi, 2017, Nguyen & Pojani, 2018, Asimeng & Heinrichs, 2021, Sagaris, 2021, Su et al., 2021, Walker, 2021, Chen, 2023, Goedeking, 2024)

This research is not exploring the BRT operational efficiencies itself, but rather borrowing from those aspects that would directly speak to the themes of this research.

Institutional and legislative context

Cervero & Dai (2014) conducted an online survey with more than 50 BRT urban planners globally, and found that the lack of institutional support and coordination was a primary barrier to the implementation of BRTOD. Aigbavboa & Ogra (2018) performed a case study examining BRTOD in Curitiba, Brazil; Bogota, Colombia; Ottawa, Canada; and Ahmedabad, India, and found that the efficient coordination of the various stakeholders, such as government departments, transit authorities, property developers, professional teams and community groups, as critical for the success of BRTOD projects. A well-integrated bus transportation and land use development plan can be utilised as an enabler to promote development and make a city more accessible. In Curitiba and Bogota, BRT planning is an integral part of the city's urban design and management plan (Lindau, Hidalgo & Facchini, 2010, Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016). In Brisbane, Australia, BRTOD development was the result of careful coordination between government agencies and negotiations with private developers in the targeted growth areas (Yang, Katie & Pojani, 2017). Simultaneously, well-defined legislation enabling BRTOD is crucial. Effective legislation would enable transit departments and other stakeholders to combine and make joint development agreements (Chen, 2023).

Political leadership and commitment

Decision-making around the public transit system is highly political, which can result in political dynamics as a s barrier to BRTOD implementation (Chen, 2023). Political support by a BRTOD champion (usually a mayor) is critical, but it can also backfire in an electoral system should the champion vacate office and the opposition parties challenge the BRT system as a means to tarnish the champion's legacy (Goedeking, 2024). Thomas, Ren & Bertolini (2017) examined 11 cases in Tokyo, Perth, Melbourne, Montreal, Vancouver, Toronto, Naples, Copenhagen, Amsterdam-Utrecht, Arnhem-Nijmegen, and Rotterdam-Den Haag, finding that cases who have the highest levels of national and regional political stability achieve greater success with the multiplier effects of land use integration.

Management of competing modes

Clashes with private motor vehicles are a challenge common in most BRT developments. Often private cars and informal paratransit operators invade the BRT bus lanes, impacting the efficient operation of the BRT service (Nguyen & Pojani, 2018). Often, paratransit operators oppose the introduction of BRT systems, in some cases leading to widespread violence (Wijaya, Imran & McNeill, 2017). As governments around town sought to revitalize public transit using BRT systems, paratransit operators feel neglected with a belief that their livelihoods are threatened (Asimeng & Heinrichs, 2021). This risk of often difficult to manage for city officials.

Public participation

Public participation in the BRT is often orchestrated haphazardly because of the lack of a proper governance system for public participation (Dibakwane, 2011). The city officials are usually under pressure to meet specific deadlines and do not take time to develop initiatives that increase awareness of the BRT system. Community engagement has long been known as a crucial step in the good transport decision-making process (Sagaris, 2021). Bus transit users are far from being a captive market and may have other alternatives to commute if the system does not respond to the needs of their needs (Goedeking, 2024). Chen (2023) states that public participation also takes the form of creating joint ventures with major property developments, which would be positioned to kick-start BRTOD initiatives. Developers should be provided with incentives like reduced parking ratios, simplified plan approval processes and mixed zoning approvals when developing a site close to the BRT station (Chen, 2023).

Funding and coordination,

Heading Cervero & Dai (2014) list of critical factors to the success or failure of BRTOD is the availability of dedicated funding for TOD. BRTs are often promoted as a low-cost capacity transit innovation, however, similar to most large-scale public transport interventions, BRT requires significant public funding to cover the upfront capital costs (Goedeking, 2024). Public funding comes in different forms primarily the national fiscus, however innovative ways to fund the project are needed. Consideration needs to be given to public-private partnerships (PPPs) and value capture from the increase in property values in the vicinity of the stations (Aigbavboa & Ogra, 2018, Goedeking, 2024). Zhang, Min et al. (2020) state that in some cases, the BRT system has led to an increase in property values, resulting in increased property taxes. However, in low-density areas, there were no significant connections between BRT stations and property values and low-density residential areas.

Physical design

According to Suzuki, Cervero & Iuchi (2013), property developers are less likely to support bus-transit development if there is no long-term transit infrastructure. The fixed bus stops and dedicated lanes provide comfort for the bus system's future operation. Nakamura, Makimura & Toyama (2017), Prayogi (2017) state that there is room for growth the more the BRT service starts to resemble rail transit's high-profile infrastructure, such as elaborate stations, priority traffic signals, right-of-way, and fixed guideways serving as the rail tracks. In Brisbane, Zhang, Min et al. (2020) assessed BRTOD potential by exploring the BRT system route types and comparing open and closed BRT route configurations. Closed configuration consists of a single trunk route where the BRT operates, while open configuration allows the BRT bus to enter and exit the dedicated busways at any point and operate as regular buses on the local streets. Findings indicated that open configuration BRT services allowed the greatest accessibility into the system and thus have more development potential on a regional level which mimics rail in some contexts (Zhang, Min et al., 2020, Walker, 2021)

Image promotion

Among the reasons is that BRT is typically disliked in residential areas because of the noise levels and unfavourable perception of bus services (Cervero & Dai, 2014). The service may be perceived as an inconvenience, as the blocked mid-section of the street where the busways are located, of the street impedes the residents' ability to execute speedy turns

when exiting their properties, necessitating a diversion around the block for ordinarily what would be a quick manoeuvre. Prayogi (2017) research examined various BRT services to identify the most effective performance measures for promoting Transit-Oriented Development (TOD). The findings indicated that the ridership numbers were the most influencing factor for TOD potential. Metrics that considered passengers per hour per direction (PPHPD), the transit system availability, dependability, and on-time performance all affect the number of ridership metrics. For example, Bogota and Curitiba's BRT systems transport over 40,000 passengers in each direction every hour, which mimics rail in some contexts (Hidalgo, Lleras & Hernández, 2013). In some contexts, TOD is still viewed as an elitist, unaffordable development concept that may induce gentrification and potential low-income group displacement in the communities of the global south (Padeiro, Louro & Da Costa, 2019). Gentrification is still regarded as a process with negative outcomes, which could have an impact on the ridership potential of the BRT if those the system intends to serve cannot afford to reside in the TOD node (Dong, 2017).

2.5.3 Typical BRTOD Land Use Change Patterns

In instances where BRT has triggered TOD, two distinct land use change categories emerge *transit corridor* and *node/place development* (Rodriguez, Daniel & Vergel, 2013, Cervero & Dai, 2014, Kamruzzaman et al., 2014, Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016). A transit "*corridor development"* describes land use changes that develop adjacent to and following the linear busways between two BRT stations (Suzuki, Cervero & Iuchi, 2013, Kamruzzaman et al., 2014), while *"place development"* sees land use changes extending outwards radially or in sectors with the station serving as the nucleus of the development.

The literature broadly defines exemplary land use change patterns emerging from BRT investment within the two primary categories of corridor and location development. Basheer, Boelens & Bijl (2020) outlines the main outcome patterns namely; *functional change, structural change, new development,* and *no change*.

Functional Change Pattern

Functional change pattern encompasses all parcels of land where land-use function change is evident without significant alterations to property structures or new developments (Pérez-Soba et al., 2008). Land use function is the private and public goods and services offered by the different land uses.

Structural Change Pattern

*Structural Ch*ange pattern describes changes within the building or adding newly built areas to the existing structure. Verburg et al. (2009) state that functional land use change is not always readily apparent, although, in many cases, land use change may also be deduced from observable changes to the structural components of the building. In Dhaka, Bangladesh, Mukherjee & Bagui (2018) investigated the development impact of a BRT line in an already developed city and found that structural change was the most observed land use change pattern characterised by existing low-rise structures converting to multi-story mixed uses. In a sample of BRT stations in Seoul, South Korea, the predominant land use change was characterised by single-family to multi-family residential structures (Cervero, 2013b).

New development Pattern

New Development pattern describes originally vacant parcels of land, that are developed with new structures primarily to meet the increasing need for housing and new enterprises (Basheer, Boelens & Bijl, 2020). In Curitiba, Brazil, the local government mandated that all small to medium new development be sited along a BRT corridor, which spurred region-wide growth (Cervero, 2013b). However, Mukherjee & Bagui (2018) states that the new development land use change pattern would be difficult to occur in an already dense node.

No Change Pattern

Within the *no-change* pattern, the parcel of land where used has remained unchanged since the opening of BRT (Basheer, Boelens & Bijl, 2020). Cervero & Dai (2014) provides three case studies where the no-change land use pattern was witnessed. The no-change land use pattern was also observed in a sample of Dhaka, as the BRT service was running in an already dense environment with limited opportunities to further densify the sites (Mukherjee & Bagui, 2018). In Ahmedabad, India, no significant changes were also witnessed in the vicinity of the Janmarg BRT stations due to a lack of land use integration in the planning of the BRT system. To date, the Janmarg system has remained purely a mobility investment with no land use integration planning.

2.6 Chapter Conclusion

This chapter provided a review of existing and emerging literature on the concepts of land use change, transit-oriented development (TOD) and bus rapid transit (BRT), and subsequently discussed their interrelations and mutual influences.

Theory on urban morphology emerged as the most indicative of the research, anchoring the concept of land use change within the spatial analytical domain of urban morphology. The spatial analysis approach developed from the initial models of Hoyt (1939) Burgess (1925) and says that a city grows radially in concentric rings or sectorially from a central nucleus. The central nucleus can be any human intervention catalysing urban development, including the traditional CBD or transit stations. A transit station acting as the nucleus for land use change paved the way for the introduction of TOD. The chapter further discussed the use of BRT service as a catalyst for land use change, birthing BRTOD. Using BRT for TOD has been tried and tested globally, however, the literature shows that findings on the BRT efficacy as a TOD and land use change catalyst remain divided.

Some researchers have tied the successful implementation of BRTOD to the operational efficiency of the BRT systems itself. Literature also argued that land use change would not occur spontaneously and emphasised the importance of a conducive environment coupled with a definitive goal from planning authorities to implement BRT and TOD. In locations where BRTOD has been successful, the literature identifies the typical land use change patterns that emerge being corridor and nodal development. Exemplary land use patterns are further broken down into four distinct patterns being; functional change, structural change, new development, and no change. These land use change patterns were defined, alongside the essential characteristics and design principles of BRTOD. The typical land use change patterns and design characteristics were used as a benchmark for the data collection process in this research.

The literature review indicated that BRTOD is quickly becoming a popular urban development strategy for land use change. However, the evidence supporting the effectiveness of the strategy as a development tool is very context-specific. A key takeaway from the literature is that there is no standard approach when it comes to BRTOD, instead, cities must experiment and take into account their unique contexts. Limited research has been done in a South African context on the efficacy of BRT as a land use change catalyst.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the overarching research philosophy for the study, including an explanation and justification of the methodology chosen. It further outlines the research strategy of the case study, data collection sources and analysis techniques used.

3.2 Methodology Overview

Saunders et al. (2015) provides a five-step framework that researchers can utilize to illustrate the underlying choices and assumptions the researcher makes that influence the data collection, analysis methods, and how the data will be interpreted. The framework is presented in Figure 3.1, which also guides how this chapter is arranged.

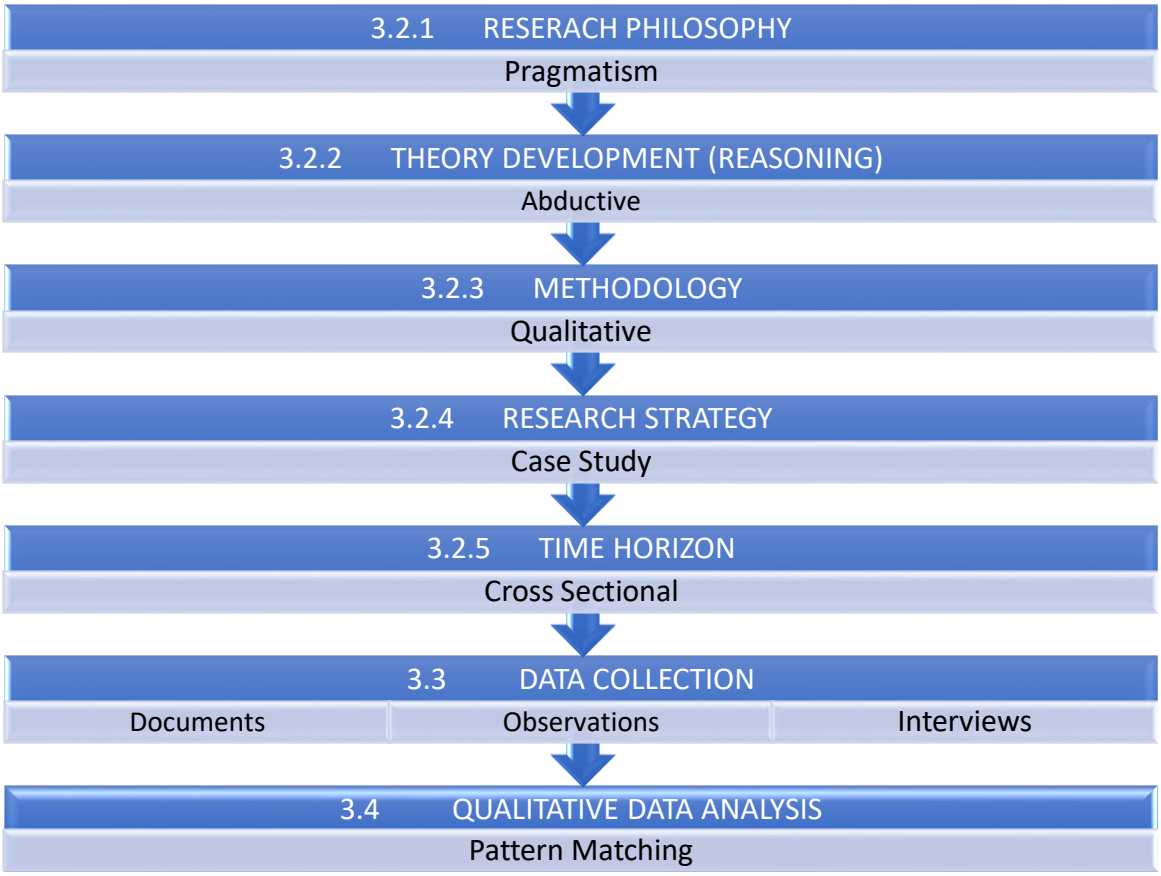


Figure 3: Research Framework. Adapted from (Saunders et al., 2015)

3.2.1 Pragmatism Research Philosophy

Saunders et al. (2015) discusses the research philosophies named Positivism; Critical Realism; Interpretivism and Pragmatism

The positivism philosophy is rooted in the belief that knowledge can be obtained by way of objective experiments, observations and measurements of numerical data, therefore it leans more towards quantitative methods (Park, Yoon Soo, Konge & Artino Jr, 2020).

Critical realism philosophy opposes the positivist stance by highlighting how fallible the human sense can be, claiming that there is a real world that exists independently from the researcher's objective knowledge of it, therefore allowing a certain degree of subjectivity (Sayer, 2004). Fletcher (2017) advises that critical realism would be more suited to social research, where there is a need to explain or critique empirical evidence with further reasoning and mental processing.

Interpretivism takes the position that reality is subjectively constructed by the observer through their experience of it (Saunders et al., 2015). Alharahsheh & Pius (2020) argue that the methodology was developed as a critique of the positivist philosophy, much like critical realism, as reality is considered through intersubjectivity. Interpretivism philosophy is geared toward research that aims to understand the meanings and interpretations of individual observations and experiences and is more suitable for social or cultural research adopting qualitative methodology (Saunders et al., 2015)

Pragmatism philosophy combines elements of both positivism and interpretivism philosophies and can make use of either one or both quantitative and qualitative data (Biesta, 2021). The pragmatist researcher adopts more of a 'problem solver' approach, seeking pragmatic solutions that consider both the hard and soft evidence (Ormerod, 2021).

The pragmatism philosophy appears to be the most suited for this research as it seeks to understand how the A Re Yeng BRT system serves as a TOD catalyst for land use change. The TOD principles are well documented in the literature, and tracking the prevalence of these in Hatfield will provide positivist hard physical evidence. Archival records comparing old and current aerial photography will also provide hard evidence of land use change. In contrast, interviews with stakeholders will provide subjective data, which makes up the soft data. This combination of objective (hard evidence) and subjective (soft evidence) positions the research within the pragmatism philosophy.

3.2.2 Abductive Approach to Theory Development

Saunders et al. (2015) outlines three approaches to theory development in research namely; deductive; inductive; and abductive. The deductive approach is used when existing opinions or theories in the literature are tested through the study design (theory testing), whereas the inductive approach is used in the absence of prior theories or research findings (theory building), leading to the emergence of new theories or findings as the data analysis progresses (theory building) (Armat, Assarroudi & Rad, 2018, Cardno, 2018). The abductive approach is understood to enable the researcher to move back and forth iteratively between theory testing and building and theory building in a bid to either develop, test or modify theory (Saunders et al., 2015, Awuzie & McDermott, 2017, Vila-Henninger et al., 2024).

This research adopted an abductive approach to theory development. A substantial body of research exploring transit-oriented development and land use change is available, therefore, existing theory can be tested in reality. Observations tracking the prevalence of the TOD principles and studying the archival records on land use changes in the vicinity of the Hatfield BRT station will provide hard evidence but fall short of providing a direct link to the actual BRT system. The connection to the BRT system as the catalyst can be explored through interviews with relevant stakeholders providing soft evidence. A process of moving back and forth between theory testing and theory building utilizing hard and soft evidence will be undertaken, which is a key element of abductive theory development.

3.2.3 Qualitative Methodology

The two main research methods are identified as quantitative and qualitative, with a third category being a mix of both methods (Brannen, 2017, Naoum, 2019). The quantitative method is inherently objective, utilizing data that is countable or measurable to test a theory or hypothesis, often providing generalizable findings (Naoum, 2019). In contrast, qualitative research is subjective and focuses on exploring meanings, experiences, and unique viewpoints, which are often verbally described, to derive insights (Creswell & Poth, 2016).

This research is rooted in a pragmatism philosophy, which can yield itself to both quantitative and qualitative methodology (Saunders et al., 2015). In making a decision, Naoum (2019) reminds the researcher to be guided by the research objectives, the sources of data, and the type of raw data that is available. This research is exploratory, seeking to uncover how the A Re Yeng BRT service serves as a land use change catalyst in Hatfield. The type of data available will consist of direct observations by the researcher and verbatim

accounts from interviews (Naoum, 2019). Qualitative methodology is deemed the most representative of the research.

3.2.4 Case Study Research

There are different approaches to conducting research, each with its own way of collecting and analysing data. A few are discussed by Saunders et al. (2015) namely experiment, survey, case study, action research and grounded theory. The strategy deemed the most representative of the research is a case study approach.

Yin (2018) states that a case study approach should be selected when the research is intended to provide answers to *'How?' and 'Why?'* questions. The research questions phrased in this manner lead the reader to understand that the study will be exploratory requiring an in-depth analysis of some contemporary phenomenon (Merriam & Grenier, 2019, Naoum, 2019). Yin (2018) further recommends that a case study approach be selected when the research encompasses a clearly defined proposition that draws attention to the contemporary phenomenon under exploration. A proposition allows the researcher to be able to draw links between the data to be collected and the conclusions to be drawn to the initial research questions of a study (Busetto, Wick & Gumbinger, 2020).
The research aims to investigate '*how'* the A Re Yeng BRT system is serving as a land use change catalyst in the suburb of Hatfield. The research question is exploratory, therefore a case study can be used in this instance (Naoum, 2019). The literature review indicated that there is no one-size-fits-all approach when it comes to the idea of leveraging BRT investments for development (Cervero & Dai, 2014, Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016). The only way forward is for cities to experiment and to build from their specific contexts, experiences and the review of experiences of other cities in similar situations (Cervero & Dai, 2014). The research proposition states that the A Re Yeng BRT service merely acts as a transportation service for the City of Tshwane and has not acted as a catalyst for land use change in the last ten years. The proposition draws attention to the contemporary phenomenon to be investigated, being BRT-led land use change.

3.2.4.1 Unit of Analysis

Yin (2018) states that case study research requires a clear identification of a unit of analysis that defines what the case study is focusing on. Merriam & Grenier (2019) provides an example stating that if your research is concerned with individuals, then an example of the unit of analysis would be the actual individuals, customers, employees, etc. Grünbaum

(2007) argues in some case study research, the detection of the unit of analysis is not always so clear, which can be problematic and question the credibility of the research and ultimately result in conflicting views of what the unit is and what the case is. Patton (2014) argues in these instances, the 'unit of analysis' and the 'case' can simply be seen as identical twins and should not be separated. What would be required is that the description of the unit of analysis and case be bounded to reflect the main theme of the research question (Stake, 2005, Patton, 2014).

This research aims to explore how the A Re Yeng BRT system serves as a land use change catalyst in the suburb of Hatfield. The location of the case study is Hatfield, and the unit of analysis is land use change. Therefore the unit of analysis is bound to the location of the case study as they need to go together to capture the scope and theme of the research accurately. The unit of analysis identified for this research is therefore described as 'land use change in Hatfield'.

3.2.4.2 Case Study Classification

Yin (2018) states that case study research can be categorized into two dimensions, being single-case or multiple-case designs. If the research aims to study a specific phenomenon arising from a specific entity, then a single case study research must be pursued (Hancock & Algozzine, 2017). To increase the validity of the findings in a single case research, Yin (2018) recommended that data should be collected using multiple techniques. The findings from the multiple sources can then be triangulated to derive common key findings. Multiple case design on the other hand should be pursued for an in-depth understanding of the specific phenomenon where data can be collected from multiple cases (Hancock & Algozzine, 2017, Naoum, 2019). A cross-case analysis will then be done by the researcher to draw out themes and then research draws parallels from the multiple cases in an attempt to derive an overall picture as a conclusion (Yin, 2009, Heale & Twycross, 2018).

At present, there is only one fixed BRT station in Hatfield, the General M Seyothula Station on Arcadia Street. The case study design is therefore is single case.

3.2.4.3 Multiple Data Sources

The research method selected is qualitative as described in the previous section. A case study has also been selected as the approach most suitable for the exploration. What follows after selecting the method and approach is the decision regarding the techniques for

data collection (Naoum, 2019). The strength of single case study research lies in the use of multiple sources of data (Stake, 2005, Yin, 2018, Merriam & Grenier, 2019). Documents, Observations, and Interviews are the most common sources of data in case study research, followed by a triangulation of the data (Hancock & Algozzine, 2017, Harrison et al., 2017). However, Naoum (2019) argues that sources of data are not limited to these and can be quite extensive and include archival records, photographs, films, or video recordings. Yin (2018) recommends that when selecting sources of data, the researcher needs to select sources that will accurately reflect reality. For this study, the sources of data selected were direct observations, archival records, and interviews.

3.2.5 Cross-sectional Time Horizon

Saunders et al. (2015) identifies two time horizon categories namely; cross-sectional and longitudinal. Cross-sectional research studies a particular phenomenon at a particular point in time, while longitudinal research studies phenomena at more than one point in time (Rindfleisch et al., 2008). Rindfleisch et al. (2008) argue that if the likelihood of response biases is low and the research is underpinned by an existing string theoretical foundation then a cross-sectional time horizon is the most suitable. Response biases have been mitigated for this research owing to the multiple techniques of data collection employed. Literature on the impact of transit on land use change is also well-developed meaning the likelihood of alternative explanations at a different point in time is also low.

The cross-sectional time horizon was identified as the most suitable for this research.

3.3 Data Collection

3.3.1 The Case Study Area and Context

According to Statistics South Africa, The City of Tshwane is estimated to have a population of 4,040,315, representing an increase of 38,2% from the last census conducted in 2011 (StatsSA, 2022). The City's percentage growth rate is far outpacing the provincial and national average.

The suburb of Hatfield is located in Region 3 of the City of Tshwane in Pretoria. It is distinctly separated into two parts, Hatfield North and Hatfield South, by a railway line cutting through the suburb. The Statistics South Africa population data at the ward level has not been published yet. However, the population numbers between 1996 and 2011 had doubled in Hatfield, with a projected growth of approximately 60% by 2020 (StatsSA, 2022). A

majority of the population in the node is between the ages of 18 and 25, due to the number of students attending the University of Pretoria (Habitat Landscape Architects et al., 2021). The lack of disposable income, due to a large number of students in the area, further motivated why the area is targeted for the implementation of the TOD strategy (Lepelle, 2019). Public transport in Hatfield includes mini-bus taxis, buses and trains, all operating independently, with 65% of the city's population depending on these services (City of Tshwane, 2015). Hatfield is recognised as a student town, with several student accommodation structures, therefore possessing a population capable of supporting the implementation of TOD and facilitating the integration of various public transport systems accessible in the suburb.

The City's Spatial Development Framework (SDF) states that the intention of TOD in the City is to combat urban sprawl, by stringing together the fragmented nodes (SACN & SAPOA, 2016). Urban sprawl is a consequence of urbanization in the City post-1994 (Tomlinson, 2017, Kganakga, 2019). Given the investment the City has already made and allocated to BRT infrastructure, exploring how the A Re Yeng BRT serves as the TOD and land use change catalyst is critical.

An aerial view of the Hatfield CBD is presented in Figure 5 below;

Figure 4: Hatfield North and South (own Mapping) Adapted from Google Earth

3.3.2 Archival Records (Geo-spatial data)

Archival records are one of the recommended data collection sources in case study research (Saunders et al., 2015, Yin, 2018, Naoum, 2019). Archival data refer to existing data, such as survey responses, documents, texts, or other materials (Fisher & Chaffee, 2018). Archival records can be classified into two categories; statistical, which offers numerical data, and descriptive, which provides textual or visual evidence. (Naoum, 2019). Positivist researchers generally prefer archival records as they document previous events; nevertheless, these records can also serve as a dependable source of objective evidence in pragmatic research (Fisher & Chaffee, 2018). The researcher must be guided by the research objectives in determining the sort of archival data to be collected (Yin, 2018).

Archival records in the form of geospatial data are frequently underutilized, yet valuable resources in research (Ventura, Maggi & Oriolo, 2011, McAuliffe, Lage & Mattke, 2017). Nebiker, Lack & Deuber (2014) state that geospatial data in the form of historical aerial photography is particularly powerful in built environment research for detecting building changes through image-matching analysis. Geospatial data are frequently taken by international commercial firms like Google, but these can also be organized at the governmental level (Nebiker, Lack & Deuber, 2014). Yin (2018) states that most archival records are produced for a specific purpose and a specific audience, which the researcher needs to consider before deciding if the data is relevant to the research. The conditions attached to such data must be adhered to fully.

Access to geospatial data has evolved in response to technological advancements. McAuliffe, Lage & Mattke (2017) state that emphasis has largely been focused on the development, preservation, and sustainability of online collections. Google Earth and Google Maps offer geospatial data through aerial and street-view photographs. Clicking the historical imagery toolbar and adjusting the timeline enabled the researcher to obtain the required data. In recent years, numerous academic institutions have adopted Google Earth and Google Maps as academic research and mapping tools (Dodsworth & Nicholson, 2012).

The City of Tshwane also provides an interactive web-based portal, managed by a private company, that contains views into the Geographical Information Systems layers of the city. The governmental portals in South Africa mostly function as static databases for documenting the current state or doing retrospective analyses of historical urban growth

trends (Olatoye & Fru, 2024). Geospatial data included land use layers, that could be manipulated by changing the dates to provide a view of land use at a point in time. This provided an opportunity to analyze the historical and current land use layers.

A typical sampling strategy for such data is to limit by a specific time frame (Karppinen & Moe, 2019). The A Re Yeng BRT began operations in 2014, so the time frame for the data will be between 2013 and 2024.

3.3.3 Direct Observations

Observations in qualitative research are regarded as one of the oldest and most fundamental methods (Yin, 2018). This method involves collecting data by using one's senses, especially looking and listening (Smit & Onwuegbuzie, 2018). Noor (2008) states that it is important for the researcher to be immersed at the site of the case study, especially where physical evidence may not be available from documentary evidence. Observations are that they often need to be reinforced with other data collection methods, like interviews, to counter the researcher's bias that is inherent when observing from a single lens (Smit & Onwuegbuzie, 2018).
Ciesielska, Boström & Öhlander (2018) state that the approach to observations must always be guided by the initial research problem and objectives and that observations can either be the main data collection method or complementary to other collection methods in a qualitative study. Observations are favoured by pragmatic researchers as they allow the collection of both objective and subjective data for analysis (Kelly, Leanne M & Cordeiro, 2020). The consideration of both the hard and soft evidence further lends itself to an abductive approach to theory development (Kelly, Leanne M & Cordeiro, 2020).

Ciesielska, Boström & Öhlander (2018) highlights three critical factors that researchers must contemplate during observations; the chosen observation technique, the observational field, and the method of record-keeping.

3.3.3.1 Observation technique

Ciesielska, Boström & Öhlander (2018) state that observations can either be direct or indirect. Direct observation is when the researcher is looking at events occurring in front of him with their own eyes, while indirect observations refer to the researcher reporting on the observations of others. Depending on the active role of the researcher, direct observations

can also be participant or non-participant (Smit & Onwuegbuzie, 2018). Participant direct observations are when the researcher plays an active role in the phenomena being studied, while direct non-participant observations are where the researcher plays no part in the phenomena being studied and merely observes and records. The participant observation technique would be recommended when the researcher must provide an in-depth understanding of an organization or social group though from an external point of view, while the non-participant technique should be undertaken for recording observations as an outsider and events being observed have already occurred.

For this research, the observation technique adopted is direct non-participant. The type of data being collected does not give room for the researcher to play a role in the phenomena being observed as the events, being land use patterns and prevalence of TOD principles, have already occurred. The goal of the observation is simply to record occurrences that have already manifested themselves.

3.3.3.2 Mapping the Field (The Sub-study Area)

Marvasti (2014) discuss the importance of defining a specific field for observations. Although tradition indicates that the field needs to be equal to a physical place like a town, village, etc, the field can also be determined by a set of criteria derived from literature where interesting events and occurrences are known to occur (Ciesielska, Boström & Öhlander, 2018).

After defining the field, the next step is to arrange access, which can be a problem if access to the site is cumbersome either through restricted access or informal gatekeepers in the community (Marvasti, 2014). The researcher needs to be aware of this when selecting the field to undertake observations.

According to Salat & Ollivier (2017), the greatest capacity to transform urban areas through transit exists within a 1-kilometer radius of transportation stations. Nonetheless, other studies contend that while a 1-kilometre distance would be viable for rail transit, the development potential for a BRT system is comparatively lower, with an average projected range of approximately 400 meters (Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016, Mbuyi, 2017, Prayogi, 2017).
This research involved selecting and mapping a sub-study area with a 400m radius from the General M Seyothula BRT station in Hatfield, utilising the circle mapping tool in Google

Earth. This rendered the observation feasible and very localised. The sub-study area is depicted.

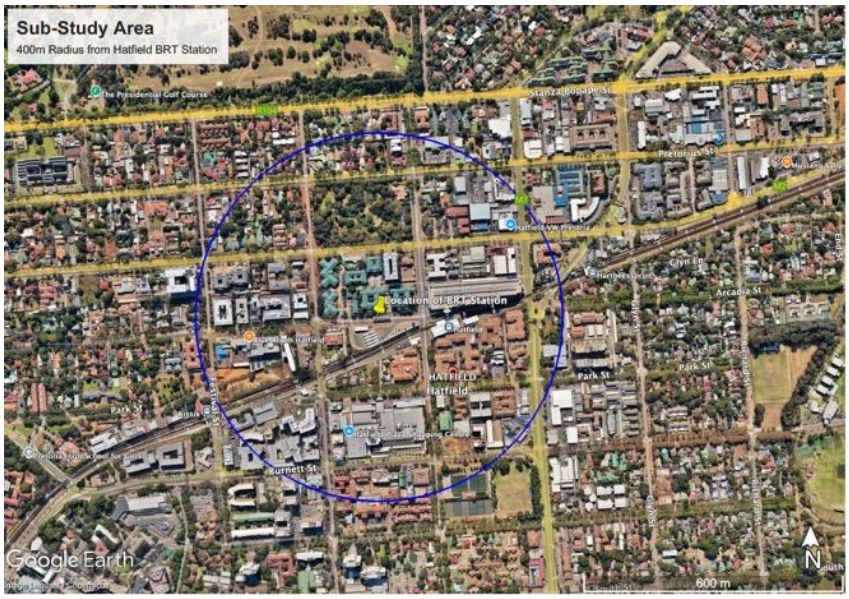


Figure 5: Sub-study Area for Observations

3.3.3.3 Recording of Observations

Smit & Onwuegbuzie (2018) describe note-taking as a crucial aspect of fieldwork. Ciesielska, Boström & Öhlander (2018) propose five steps as a guide to researchers when undertaking note-taking from observations;

1. **Decide what the main goal of the observation is.**
   For this research, the goal of the fieldwork was to identify the land use patterns in the sub-study area and track the prevalence of the transit-oriented principles in the sub-study area.

2. **Describe, rather than make judgements.**
   For this research, the approach was to look and record only while making descriptive text in the process.

3. **Record or transcribe where necessary.**
   For this research, the observations were recorded using photographs taken by the researcher with field notes.

4. **Your notes should address the research problem, questions, aims and objectives.**

   The occurrences to be observed, being land use patterns and transit-oriented principles are at the core of the research.

3.3.4 Interviews

Rowley (2002), Jamshed (2014) describe interviews as a fundamental method of collecting qualitative data. Interviews are generally used to collect qualitative data where the researcher is interested in collecting facts-based insights, understandings of opinions, experiences, attitudes, observations, etc (Rowley, 2012). There are many approaches to collecting data using interviews, however, the most common approach used by researchers is either to utilize a questionnaire or an interview (Naoum, 2019). Questionnaires have the advantage of that they allow the researcher to obtain feedback from a large group of people, though has a disadvantage that it can be time-consuming to obtain feedback from a representative sample of that population (Rowley, 2012, Naoum, 2019). Gentles et al. (2015) states that the researcher also needs to take into account of their available time resources for both conducting the interview and analyzing the data.

3.3.4.1 Selection of Interview Type

Three types of interview techniques are widely discussed in literature, being structured, unstructured and semi-structured interviews (Rowley, 2012, Naoum, 2019, Busetto, Wick & Gumbinger, 2020). Structured interviews are those where a few questions are asked and usually require short answers (Rowley, 2012). Busetto, Wick & Gumbinger (2020) likens structured interviews to a questionnaire where instead of the respondent providing answers on a written document and returns to the researcher, the answers are provided verbally. Structured interviews have the advantage that the data gathered is less complex to analyse, but does not give much room for flexibility with the risk of losing out on added detail and insight that the interviewee might provide.

Unstructured interviews require the interviewer to prepare potential questions around an issue or topic, which then allows the respondent to talk more about a theme in a conversation setting (Rowley, 2012, Rezigalla, 2020). The interviewer may adapt their questions to suit the particular circumstances of each interviewee. Jamshed (2014) argues that such interviews require expert-level skill and will often generate different transcripts which will be too time-consuming and complex to compare and analyse.

The most common interview type is a semi-structured interview Rowley (2012), Jamshed (2014), Busetto, Wick & Gumbinger (2020). Semi-structured interviews are appropriate for novice researchers as they centre around a prepared set of well-chosen questions as a good starting point, with the leeway of asking sub-questions to gain more detail and insight into the interviewee (Rowley, 2012). On this basis, it becomes easier to analyse data with a basis of comparison.

For this research, a semi-structured interview type was chosen as it follows a set structure and will allow for an easier process of comparing and integrating responses from the respondents for the researcher. Jamshed (2014) advises that recording of interviews, for future verbatim transcripts, should be the preferred method of capturing what was said in the interview as often handwritten notes can be unreliable. This is the method of taking notes that will be done with the interviews.

3.3.4.2 Selection of the Interview Questions

Rezigalla (2020) Jamshed (2014) state that interview questions need to be selected to generate data that will respond to the research questions and test the hypothesis, though the questions need not be direct research questions but designed to encourage the interviewee to talk more about the topic or theme. Research questions can be formed by the literature review, practice or experiences that the researcher has made in the journey of the research.
For this research, the questions were prepared beforehand and followed a numerical order. The chosen semi-structured interview also allowed the researcher to ask follow-up questions and have a conversation based on the answers and key themes that arose during the interview process.

3.3.5 Selection of the Interview Participants (Sampling)

In all cases, a sample of interviewees has to be drawn from the population (Naoum, 2019). Two primary methods of sampling named random (probability) and non-random (non-probability) sampling as well as their various sub-sampling techniques are widely discussed in literature (Taherdoost, 2016, Naoum, 2019, Busetto, Wick & Gumbinger, 2020) . Random sampling means everyone in the population has an equal chance of participating in the survey, while non-random sampling targets a specific subset of the population and is intended to examine real-life phenomena. Gentles et al. (2015) cautions the researcher to be cognisant of the time constraints when doing interviews, so a non-random sampling

technique will have to be used as interviewing the entire population with an interest in the land use change of Hatfield will not be possible.

Busetto, Wick & Gumbinger (2020) argues that qualitative data from non-random sample interviews does not require a specific sample size, but the key criteria are that the researcher selects, as far as possible, a sufficient number of people from different roles, backgrounds, experiences and some other variability that might influence the results of the study. The chosen interviewees need to be able to generate a wide enough spectrum to ensure that the findings are sufficient (Robinson, 2014). Patton (2014) calls this sampling technique purposive sampling and argues that the researcher would select participants who are in a good position to answer the research questions and provide the insight that is required. Robinson (2014) further discusses an acceptable sub-method of purposive sampling for qualitative research called *intensity sampling* where the researcher should select an *'information rich'* respondent who is seen to be insightful, comprehensive and honest.

To this end, seven interviewees were identified for the research;

Interview 1 *(Coded HCID*): Representative Hatfield CID.

Interview 2 *(Coded TownPl):* The town planner with experience working with the City of Tshwane. The town planner will have expert knowledge of BRT-led land use change strategies by the City.

Interview 3, 4 *(Coded PropDev1*) and *(PropDev2):* These are property developers on the ground.

Interview 5 *(Coded PropVal)*: This is a property valuer with exposure to Hatfield

Interviews 6 and 7 *(Coded Academ 1 and Academ* 2): These are academics in town planning and construction economics.

Upon the expression of interest to participate, the permission to interview form was emailed to the interviewee which provided more details about the study and explained the boundaries upon which the interview will be undertaken. The date and time of the interview was then agreed.

A technique of snowballing sampling was also considered for the research, based on referrals that may come from the interviewees above for other sources of valuable data (Gentles et al., 2015). Berndt (2020) states that the researcher will have to track a sampling error, which may not be easy to do, as the referrals can be biased due to the interviewees' personal preferences and opinions.

3.4 Data Analysis

Data analysis consists of the examination, extraction, categorization, and interpretation of the data collected to address the research's initial claims (Yin, 2018, Naoum, 2019). The data collected for the research was obtained from multiple sources, including archival records, observations, and interviews. The data analysis adhered to a strict process, commencing with archival records, subsequently proceeding to other sources, and concluding with interviews. Interviews were analysed last, as they were essential to either corroborate or contradict the evidence from observations and archival data and to establish the connection between the empirical data and the BRT system. The data collected from archival records comprised aerial images and land use layers. The data from observations included the researchers' images and field notes, whereas the data from interviews consisted of transcripts.

There are various methods of analysing the data collected, with each potentially suiting a particular data collection source (Saunders et al., 2015, Naoum, 2019). However, Yin (2018) states that case study research should always strive to have a single general analysis strategy applied to the data collected. The adopted approach to theory development should also lead the researcher in the section on the appropriate analytical method (Saunders et al., 2015). This research adopted an abductive approach to theory development, which incorporates principles of both the deductive and inductive approaches in an iterative manner as the researcher analyses the data. An analytical method of pattern matching was deemed to be the most suitable for research.

Pattern matching is a method that can be used in abductively based analytical procedures (Marvasti, 2014, Saunders et al., 2015, Sinkovics, 2018, Bouncken et al., 2021). Pattern matching allows the researcher to compare the theoretical realm, usually derived from existing literature, with empirical data in reality. Marvasti (2014) states that comparison is the basic element of pattern matching, which enables the researcher to identify similarities or differences between the theoretical and reality realms. Marvasti (2014) further states that

there are various approaches to pattern matching, but what's common is that there must be two realms being compared and a contestant unit of analysis being observed.

On the other hand, the reality realm consists of the actual data collected (Bouncken et al., 2021). See Table 1

PATTERN MATCHING	
THEORETICAL REALM	Conduct theoretical process • Literature review • Hunches of the researcher • Views from stakeholders Translate the theory to specifiable patterns and construct. • Construct an analytical framework • Describe the raw data that is relevant • Describe how the data will be collected • Describe how the data will be analysed
REALITY REALM	Access Archival Records • Aerial imagery base year • Aerial imagery current year • Organise the data • Analyse the data • Match the theoretical pattern to the observed pattern • Interpret the findings Conduct fieldwork • Record field notes • Organise the data • Analyse the data • Match the theoretical pattern to the observed pattern • Interpret the findings Conduct Interviews • Transcribe • Organise the data • Analyse the data • Match the theoretical pattern to the observed pattern • Interpret the findings

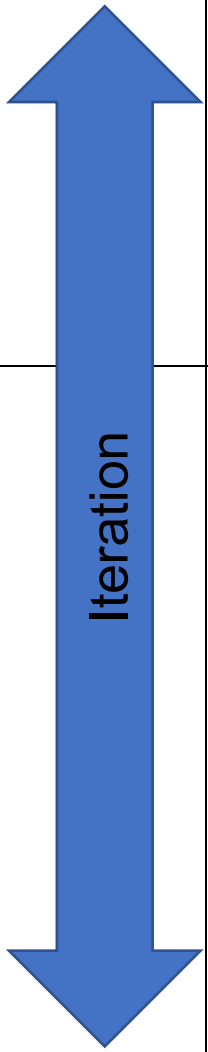


Table 2: Pattern Matching iterative process

Sinkovics (2018), Bouncken et al. (2021) discussed the three broad categories of pattern matching, being partial, full and flexible pattern matching. Partial pattern matching is applied in a bottom-up approach, where the idea is to start with the data and then identify patterns that emerge from it. Full pattern matching is conducted when the researcher starts with having multiple theories that can explain a phenomenon, and then subsequently goes about testing all the theories to find one that is the most accurate in a top-down approach. Bouncken et al. (2021) states that flexible pattern matching intends to find a balance between the two by allowing for elements of deduction and induction, combining rigour with flexibility. A flexible pattern-matching analysis was deemed to be aligned with an abductive approach to theory development (Bouncken et al., 2021).

3.4.1 Theoretical Process

The theoretical realm can have many sources, usually coming from a formal literature review, it may also be based on the ideas and hunches of the researcher, or researchers' hunches and/or the perspectives of the stakeholders in the observed phenomena (Sinkovics, 2018). The main purpose of the theoretical realm is to establish the raw data that can be observed which forms the basis of the empirical data (Yin, 2018)

3.4.2 Generating codes and patterns

Braun & Clarke (2012) state that codes can be thought of as labels identifying details that are of interest in the data. Codes can be created either inductively or deductively (Braun & Clarke, 2012, Terry et al., 2017). In practice, pragmatic researchers often adopt an abductive approach to generating codes by applying the principles of both induction and deduction (Saunders et al., 2015). The researcher begins the analysis by having an idea of initial codes, guided by the research objectives and literature, while also maintaining an open mind to generate new codes based on the data (Maguire & Delahunt, 2017, Naoum, 2019).

This research has adopted an abductive approach to theory development, so codes were generated abductively. The iteration between the inductively and deductively generated codes resembles the reciprocal interaction between theoretical constructs and empirical realities in pattern matching. The codes generated from the data were grouped into wider themes representing the common, recurring patterns across the dataset and meaning derived from how the themes are linked to each other in a visual thematic network (Terry et al., 2017, Naoum, 2019). In creating a theme, Terry et al. (2017) recommend that the

researcher be guided by the research question to help determine the potential clusters of findings.

For this research, the hunches of the researcher and the literature review provided ideas regarding what the initial codes could be. These were derived from the globally accepted TOD principles and the common BRTOD land use change patterns discussed in Chapter 2.

3.4.3 Interviews Data Preparation

Data from interviews required preparation before they could be ready for analysis (Saunders et al., 2015, Naoum, 2019). Researchers normally adopt a process of transcribing spoken words from interviews into written text for analysis (Roulston, 2014). According to Thunberg & Arnell (2022), the transcripts are commonly punctuated and exclude utterances like um, uh, yeah. Etc, however, Roulston (2014) argues that these can be included in transcripts more so in cases where data is being transcribed for topical content and to respect participants who frequently use these utterances in their everyday speech or for different dialects.

For this research, the initial transcripts were auto-generated by transcription options available through software utilized to conduct interviews. The COVID-19 epidemic has transformed research methodologies, resulting in digital interviews utilizing audio-visual assistance. Thunberg & Arnell (2022) Lobe, Morgan & Hoffman (2020) argues that video conferencing software interviews are equally as productive and satisfying as in-person methods for gathering data. Interviews with HCID, TownPl, PropDev1, PropDev2, PropVal, Academ 1, and Academ 2 were conducted by video on Microsoft Teams. The interviews lasted between 30 and 45 minutes. Thereafter, the researcher read through the transcripts and edited them for punctuation to improve the readability. Some descriptive texts like laughter, facial expressions and body language were also included in the text, as well as utterances like um, uh, yeah, etc. were also included in the final transcript to represent the tone and emotion of the interview.

3.4.4 Explanation Building Procedure

Yin (2018) discusses various procedures that researchers can use to analyse qualitative data through single case studies. The explanation-building procedure is a specific type of pattern-matching that analyses data from multiple sources by building an explanation about the case (Yin, 2018). The procedure is predominantly used in proposition-generating

research, however, it can also be utilized in exploratory research provided an initial pre-determined proposition is being tested (Saunders et al., 2015, Yin, 2018). The procedure is frequently seen as an advanced method that builds from exploratory research, however, explaining in this context refers to the process of establishing a series of causal links regarding 'how 'or 'why' a phenomenon has occurred (Baskarada, 2014)

The procedure is iterative, necessitating an initial proposition and anticipated outcomes from the literature, which are then compared against the case study evidence. Based on any variances found, the proposition is retained or modified and then compared against data collected from another source. This process is repeated until the data from all the sources has been analysed and an explanation can be made. A conceptual model of the process is provided in Figure 6

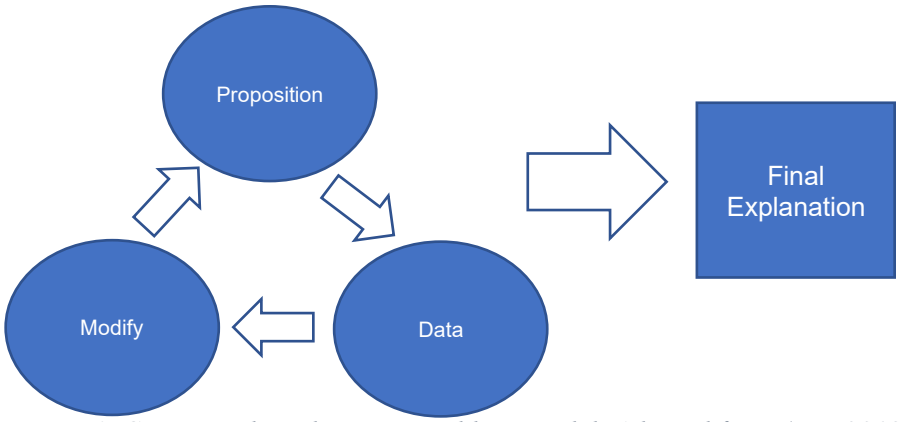


Figure 6: Conceptual Explanation Building Model. Adapted from (Yin, 2018)

Bouncken et al. (2021) state that in pattern matching analysis, findings can be derived from either a mismatch or a match between the theoretical pattern and the observed empirical pattern as each new set of data is analysed. Findings can also be derived from the appearance of new patterns or unexpected patterns (Sinkovics, 2018).

For this research, the explanation building procedure was as per below;

1. **Observe the initial proposition** - The A Re Yeng BRT service merely acts as a transportation service for the City of Tshwane and has not acted as a catalyst for land use change in the last ten years.
2. Pattern-matching analysis using **archival data** was conducted
3. **Revisit the initial proposition**, and **modify** where necessary based on variances
4. Pattern-matching analysis using data from **direct observations** was conducted
5. **Revisit the revised proposition**, and **modify** where necessary based on variances

6. Pattern-matching analysis using data from **interviews** was conducted
7. **Revisit the revised proposition**, and **modify** where necessary based on variances
8. **Establish a final finding and explanation** after considering the multiple methods of data

The iterative nature of the process may result in the researcher drifting off course and focusing on other plausible propositions. The researcher is reminded to constantly reference the original proposition and purpose of the research to mitigate this problem (Baskarada, 2014, Yin, 2018).
For this research, the initial proposition as well as the initial codes and themes from the literature were kept close. The existing literature further provided a base for pattern matching from a theoretical realm.

3.5 Strengths and Limitations

The strength of a case study lies in the multiple sources of data (Yin, 2018). This study collected data from archival records, observations, and interviews. The data further needs to be triangulated using analytical approaches to increase the credibility of the research findings (Yin, 2018, Naoum, 2019). This was conducted using a pattern-matching analysis technique, further enhanced using a procedure called explanation building. This procedure assisted the researcher in formalizing the consolidation of the analysis of the three sources of data.

This research also carries a few imitations. Firstly, the scope of case study research is to understand a particular situation, concerning its context, so the findings cannot be generalized to the broader level (Simon & Goes, 2013). At most, the Hatfield case study is suggestive of what may be found in similar scenarios but additional research will be needed. Secondly, although not impossible, case study research is often difficult to replicate. The qualitative data obtained from interviews is inherently subjective and may not yield uniform responses among participants. To address this, Rowley (2012) recommended that the selected respondents hail from varied backgrounds, each providing a unique perspective on the phenomenon. This recommendation was adopted for this research.

Thirdly, it is mostly the researcher who made the most decisions regarding the type of data to be collected, the sampling, and the analysis methods. There is an element of subjectivity in case study research. To counter this, the research followed a methodological framework which guided and aligned the philosophy, theory development approach and strategy.

Despite this limitation, case study is still the most enlightening research approach to understanding social phenomena in their context (Yin, 2018).

3.6 Chapter Summary

This chapter outlined the research framework, beginning with the philosophical underpinning of the study, the adopted developmental strategy, and the use of qualitative methodology. The chapter then discussed the selection of a case study methodology, particularly a single-case study. The data collecting methods, including archival documents, observations, and interviews, were introduced and elaborated upon, along with the sampling procedures employed. This was followed by a discussion on the selected data analysis approach and the synthesis of the multiple empirical data procedures. The chapter concluded by highlighting the strengths and limits of the research.

The chapter that follows sees a presentation of the data that was collected, which will be followed by a discussion in Chapter 5.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

Chapter 3 outlined the research methodology, specifically focusing on the research framework, data collection sources, and analysis techniques undertaken.

This chapter presents the data collected from the sources of data, archival records, observations, and interviews. Archival records contained geospatial data in the form of aerial and street-view photography. Observations were done directly by the researcher for the empirical exploration of Hatfield, and records were taken using field notes and photographs. A total of seven interviews were done with multiple stakeholders in Hatfield.

This chapter is merely a presentation of the data collected, whereas the discussion and consolidation of the findings will be done in Chapter 5.

4.2 Findings from Archival Records

4.2.1 Introduction

This section tracks the BRTOD land change patterns in the sub-study area. The typical land use change patterns discussed in the literature review were; functional change; structural change; new development and; no change. The sub-study area was previously defined in Chapter 3 as a 400m radius from the General M Seyothula BRT station in Hatfield. The presentation will match the theoretical land use change patterns to reality.

The sources of data were archival records in the form of aerial and street-view photographs extracted from Google Earth, as well as GIS land use layers contained in the City of Tshwane GIS portal. To obtain a view of the real land use changes, historical and current aerial images and GIS land use layer, we compared and analysed to track the theoretical land use change patterns. The year 2013 has been used as the base year for comparison the most recent available image in 2024.

4.2.2 BRTOD Land Use Change Pattern

4.2.1.1 Aerial and Street View Imagery

This section contrasts a historical image with the most recent image of the sub-study area. Aerial imagery was accessible on Google Earth, whilst Google Maps included additional data for street-view images. The dates, scale, orientation, and coordinates are documented. The base year remains 2013, signifying the commencement of the A Re Yeng BRT service, while the latest taken photographs are from 2024.

Functional Change

Functional change pattern was described in the literature as parcels of land where land-use function change is evident without significant alterations to property structures or new developments.

Figure 7: Functional Land Use Change Type (Image from Google Earth)

Functional change patterns could not be accurately tracked by the human eye-matching analysis using aerial imagery.

Structural Change

Structural Change pattern was described as changes within the building or adding new built areas to the existing structure. Land use change may be inferred from observable structural elements in the building.

Figure 8: Structural Land Use Change Type (Image from Google Earth)

The land use changes found by human eye matching analysis are described in Table 7 below;

RING	2013	2024
	Low density residential	High density residential
	Commercial	High density residential
	Commercial	High density mixed use (Retail, offices and residential)
	Commercial	Redeveloped - high density commercial

Table 3: Structural Land Use Change Type

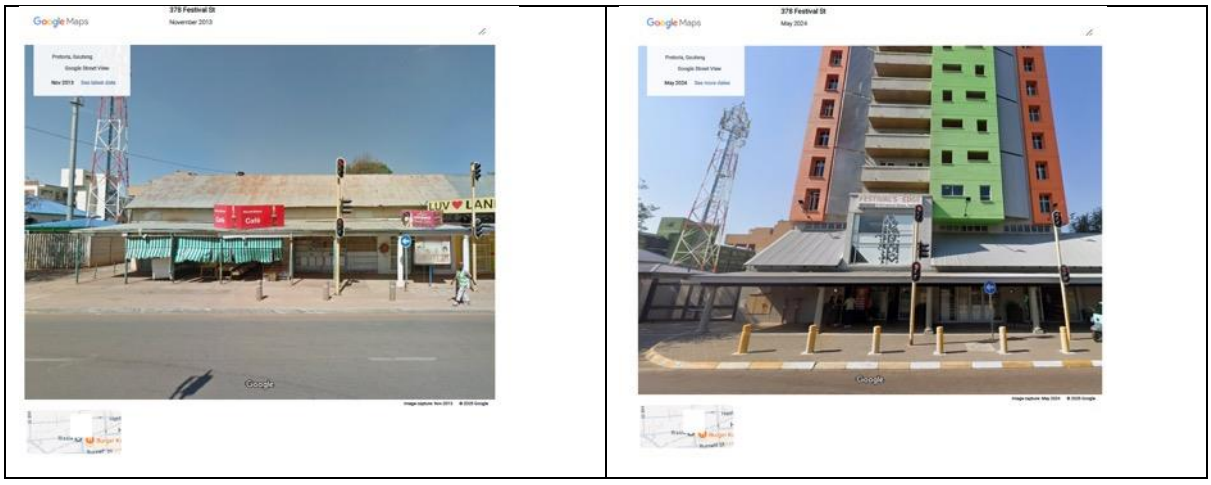
Low Density Residential to High-Density Residential

Figure 9: Structural change pattern - low-density (single-dwelling) to high-density residential

Commercial to High-Density Residential

Figure 10: Structural change pattern - commercial to high-density residential

Commercial to High-Density Mixed Use



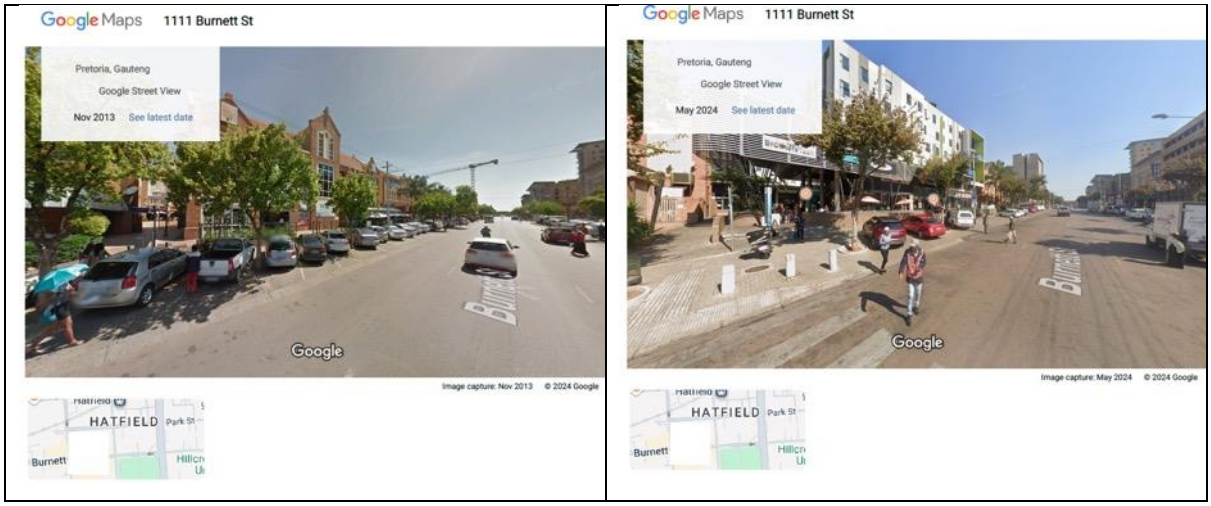


Figure 11: Structural change pattern - commercial to Mixed Use

Redevelopment - Increased density

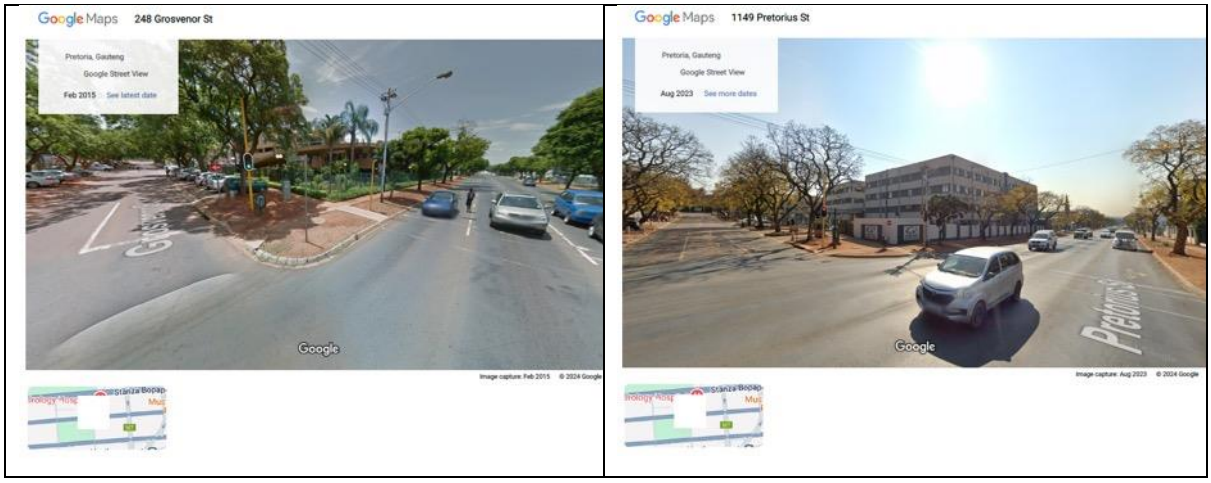


Figure 12: Structural change pattern - re-development

New Development

New Development pattern was described as originally vacant parcels of land, which are developed with new structures. Vacant land is limited in `Hatfield, so this land use change pattern could not be tracked on the aerial images.

Figure 13: New Developments Pattern

No Change

Within the no-change pattern, the parcel of land has remained unchanged since the opening of BRT.

Figure 14: No Change pattern

The No Change pattern formed the predominant land use pattern observed as described in Table 3;

RING	2013	2024
	Mixed use (Residential + Offices)	Mixed use (Residential + Offices) - same density
	Open space - parks	Open space - parks
	Commercial uses (Office + Retail)	Commercial uses (Office + Retail) - same density

	Mixed use (Office + Retail + Residential)	Mixed use (Office + Retail + Residential)
	Commercial use - offices	Commercial use - offices - same density
	Mixed use (residential + Hospitality + Offices + Retail)	Mixed use (residential + Hospitality + Offices + Retail)

Table 4: No Change Pattern

4.2.1.2 GIS Land Use Layers

The researcher undertook a visual analysis of the land use layer contained in the City of Tshwane GIS web mapping portal. The GIS portal provided a historic land use layer mapped in 2013 and 2021 by zoning when the City was compiling the Gauteng Spatial Development Framework. The primary land use zoning on the portal are educational; core; and mixed-use. The core represents the Hatfield CBD characterized by both functional and structural land use patterns. A comparison of the two land use layers provided a view into the land use changes in the study area. See figure 15 and table 4

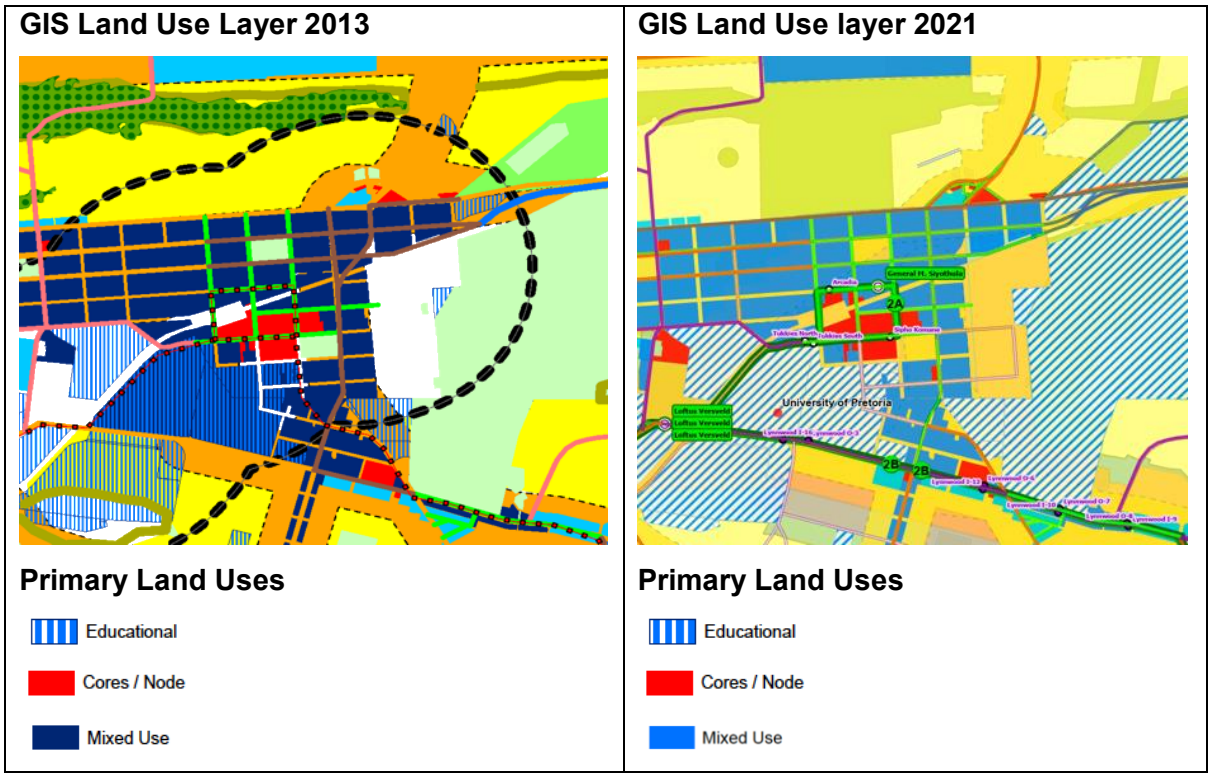


Figure 15: GIS Land Use Layers

KEY	PATTERN	2013 - 2024
Educational	No Change	No change visible
Cores / Node	Functional / Structural	Increased CBD footprint
Mixed Use	Functional / Structural	Decreased mixed use footprint

Table 5: Tshwane GIS Land Use Layer

4.3 Findings from Direct Observations

4.3.1 Introduction

This section tracks the prevalence of BRTOD characteristics in the sub-study area. The distinctive characteristics of BRTOD are globally recognised and thoroughly documented in the literature. The literature review addressed these, namely; proximity to transit (walkable, connected, transit), mixed-use development (variety of uses), pedestrian-friendly designs (walkable, cycling), and high-density development (density).

The sub-study area was previously defined in Chapter 3 as a 400-meter radius from the General M Seyothula BRT station in Hatfield. The presentation will match theoretical BRTOD characteristic patterns with reality.
The data sources were direct observations conducted by the researcher, information gathered from field notes, and own photographs.

4.3.2 BRTOD Characteristics

4.3.2.1 Field Notes and Own Photographs

The central aerial images were obtained from Google Earth and illustrate the sub-study area. The researcher captured street view photographs to provide support for the BRTOD characteristic.

Proximity to transit

Proximity to a major transit hub through the creation of a central node comprising high-density residential and a mixture of commercial uses within walking distance of the transit station is at the heart of BRTOD. The researcher traversed the sub-study area to track the mixture of land uses in proximity to the BRT station. The results are reported in Figure 16 and Table 5.

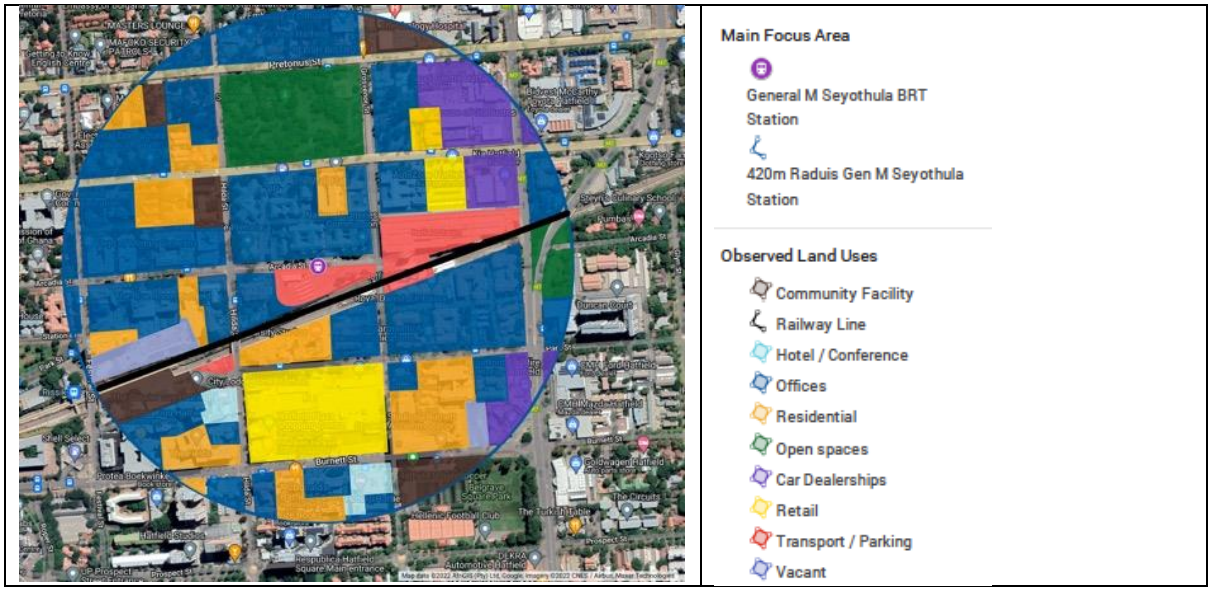


Figure 16: Land Uses in sub-study area. (Own Mapping)

CODE	LAND USE	APPROX. AREA (Hectare)
	Community Facility	3,02
	Offices	21,39
	Hotel / Conference	0.96
	Residential	7,96
	Recreation / Parks	4,27
	Car dealerships	3,70
	Retail	4,40
	Transport / Parking	2,54
	Vacant Space	1.14

Table 6: Observed Mixture of Uses in the sub-study area

Nine distinct land uses were identified in the sub-study area. Office use is the predominant land use observed in the sub-study area. This is characterised by low-rise private office complexes, government buildings, and embassies. Residential is the next most prevalent land use characterised by mid to high-density student accommodation buildings. Retail use is intensified around Hilda, Burnett, Grosvenor and, Park Street. This area is home to Hatfield Plaza which acts as the primary retail center of the Hatfield area.

The Gautrain station is located less than 100m from the General M Seyothula BRT station. The proximity of the Gautrain station offers further connections to the Pretoria CBD as well as neighbouring cities. See Figure 17.

Figure 17: Connection to Gautrain (Own Mapping)

In addition to the Gautrain, there are various municipal City of Tshwane bus stops and informal mini-bus taxi stops scattered throughout the study area. Dedicated cycle paths were not seen in the sub-study area, and a consequence is that cyclists are sharing the road with motorcars.

Mixed-Use developments

It is essential to recognize that a mix of use of uses can also exist within a single building. Retail land uses frequently occupy the ground floor spaces of several residential and office buildings in the sub-study area. Figure 18 presents mixed u-e developments in the sub-study area. The colour-coded dots in the street view images below signify the types of mixed-use properties located within the sub-study region. The colour-coded dots in the street view images can be correlated with their corresponding locations in the study area by utilising the identical colour dots on the central aerial image.

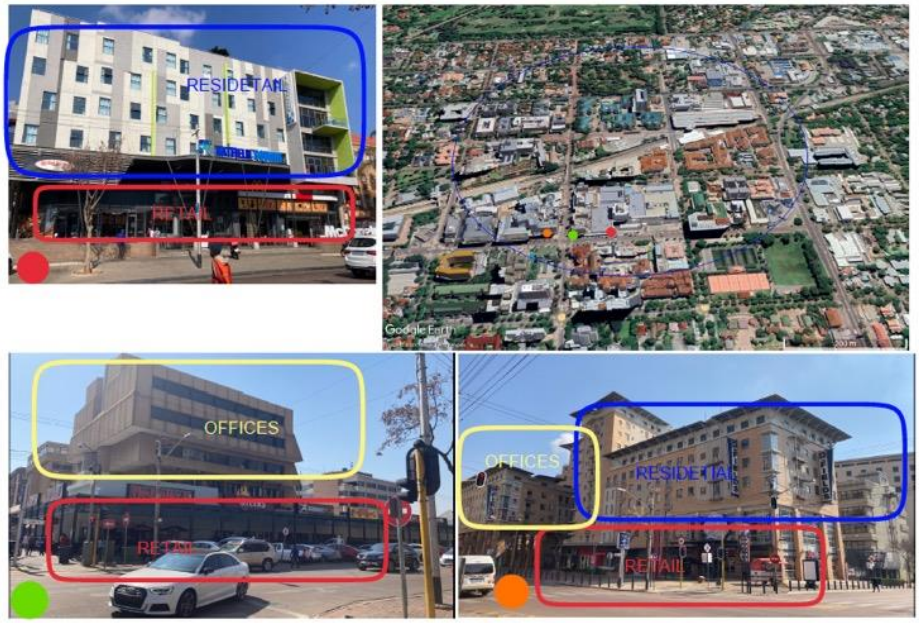


Figure 18: Mixed Use Developments BRTOD characteristic (Own Photographs)

Pedestrian Friendly Designs

Observations show that the sub-study area contains dedicated footpaths alongside the roadways and adjacent to the facades of the buildings, see Figure 19. This is also evidenced by the large number of the community who are travelling on foot to access services in the sub-study area. A potential problem observed by the researcher is the norm of motor vehicle drivers who utilize these footpaths as parking areas, especially around the Gautrain Stations forcing pedestrians to venture into the road.

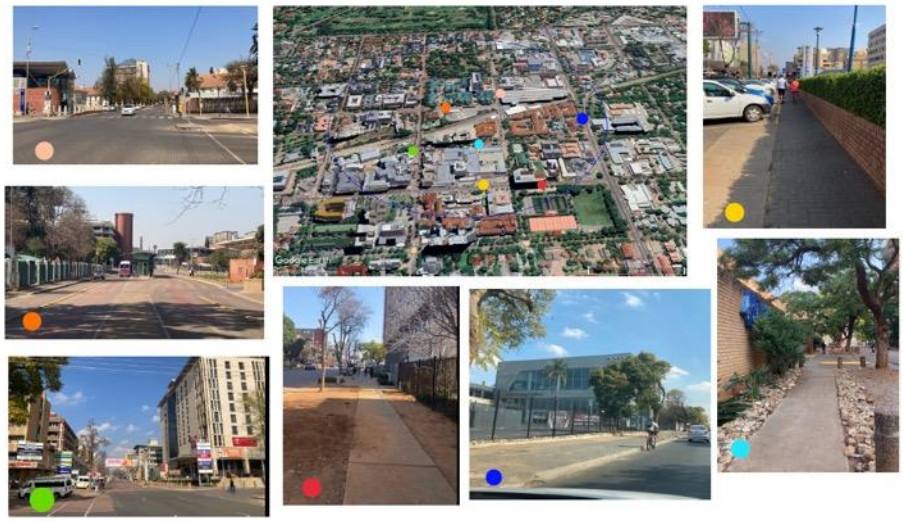


Figure 19: Walkable BRTOD characteristic area (Own photograph)

There’s also sufficient directional signage inside the study indicating the location of the BRT station, see Figure 20.

Figure 20: Walkable BRTOD characteristic (Own photograph)

High-Density Development and Compact,

Density relates to the deliberate intensification of the residential and commercial spaces near high-capacity transit stations. Figure 21 presents the location of high-density developments observed in the sub-study area.

Figure 21: High-Density Developments BRTOD characteristic

Observations on-site point to a deliberate intensification of high-density residential development in the node's proximity to the BRT and Gautrain. The majority of these

developments are conversions from low-rise office buildings to high-density student accommodation apartments.

Open spaces

BRTOD nodes frequently incorporate open spaces such as parks, community centres, etc. offering residents places for socialising. Springbok Park in Hatfield provides open space in the sub-study area. See Figure 21

Figure 22: Open Space BRTOD Characteristic

4.4 Findings from Interviews

4.4.1 Introduction

This section presents the findings derived from the interview data-gathering approach. The interviewees were representatives from the Hatfield Community Improvement District, coded (HCID); a town planner in Hatfield, coded (TownPl); a property valuer in Hatfield, coded (PropVal); two property developers, coded (PropDev1 and PropDev2); and two academics, coded (Academ 1 and Academ 2).

To set the scene, the interview commenced with the researcher providing a brief introduction to the topic and, thereafter, assessing the participant's comprehension of TOD and land use change. The interview thereafter elicits the interviewee's observations regarding land use changes in the research area, together with their perspectives on whether these changes may be ascribed to the implementation of the BRT service in the region. The discussion of the findings will be undertaken in the subsequent chapter.

Interview transcripts are documented in the Appendix attached to this research.

The coding and grouping of the codes were done manually by the researcher. NVIVO software was used to get a visual presentation of the predominant codes and themes arising from the interviews. The NVIVO codebook is attached in the Appendix to this research.

4.4.2 Understanding TOD

This part gives a snapshot of the level of understanding of the concepts of TOD and Land Use Change from the interviewees. See Figure 18 below;

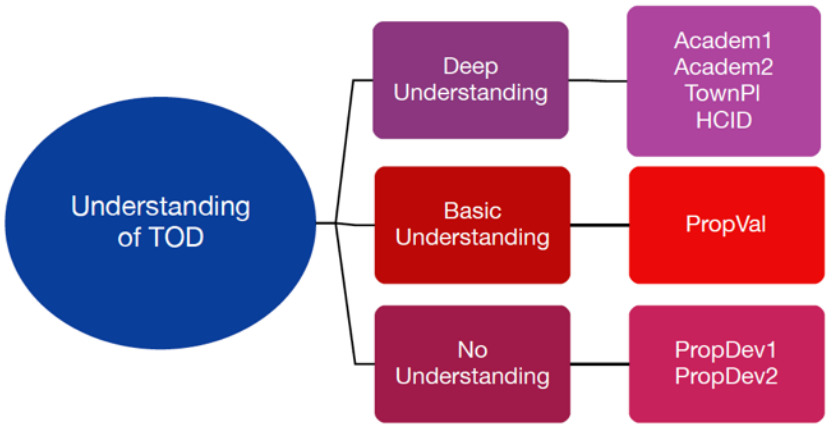


Figure 23: Understanding of TOD among the interviewees

The different levels of understanding indicate that TOD in general is still relatively new in South Africa and relatively understood in pockets. The concept is well understood by those in the academic fields, but property developers who are on the ground seem to have little or no understanding of the concept.

4.4.3 BRTOD Characteristics in Hatfield

High-Density Development

These findings indicate that the sub-study area is generally considered a high-density node with an increase of high-rise residential buildings coupled with commercial uses all within walking distance of the BRT station.

> *"We are seeing a lot of densifications happening along… let me just say, Lynwood Rd. It is a very, very important strip economic strip, and there are a lot of densifications that occur here"* - Academ1.

" We have a few clients who are developing high-density residential there" - PropVal.

"Yeah, so I did the calculation the other day, the densification that happened in Hatfield over the last five years….more than 700%. - HCID

TownPl stated that the recent reduction in parking standards in Hatfield has allowed for further densification along a section of the BRT corridor.

"But what I said to them was that… if you are serious about providing an integrated public transport service that will be successful, then you must be able to lower your parking standards and the developer will take the risk. They were initially resistant but later then they accepted it....that made a huge contribution towards residential densification along the section of the BRT Corridor". - TownPL

Although densification is happening, a direct link to the BRT service being the catalyst for the densification was highly contested by the interviewees.

"Yes, densification is happening, but it is happening for other people for other reasons" - Academ1

"Hatfield exhibits certain characteristics that many other stations do not have. You know what that is? Hatfield is a student town, and it's already very dense" - Academ2.

PropVal also advised that they have clients who are building high-density residential properties in the area, however, these are not attributed to the BRT service.

"We have a few clients who are developing high-density residential there, but no one can link those land use changes to the BRT service." - PropVal.

Mixed-use development

HCID was the only interviewee who spoke about the prevalence of mixed-use developments in the sub-study. These are mostly characterised by residential or office developments with a component of retail on the ground floor.

> *"So, definitely a move towards privately owned student residential land use with almost all of them having a small element of retail. Sort of ground floor retail and then student accommodation upstairs"* - HCID

However, the prevalence of a mixture of uses in Hatfield was spoken about more frequently by Academ1 Academ 2, and TownPl. They clearly distinguish between mixed-use development and A mixture of uses that are not necessarily located in the same property is a main feature of the sub-study area.

Proximity to transit

TownPl advises that the proximity to transit characteristic is prevalent in Hatfield. A variety of commercial uses are located within walking distance of the BRT station.

> *"Burnett Street is the major business street, and then also Jan Shoba Street, those are the true main activity spines in Hatfield with a mixture of land uses, while Arcadia Street is the BRT route, which is just one block away to the north"* - TownPl.

The interviewees generally associated the proximity to transit characteristic with references to the Gautrain station and not the BRT station. The Gautrain station and BRT stations are located less than 100m from each other. Literature has indicated that the efficacy of rail transit as a land use change catalyst is far greater than that of BRT. So this is another characteristic that makes it difficult to speculate about the A Re Yeng BRT service being the catalyst.

> *"Hatfield is a positive example of the demand for development. In and around the Gautrain station there's been quite a few developments taking place over there"* - PropVal.

"they are still being beaten in my view, by the Gautrain bus service. I think that service is used a lot more and you know but used by people who work in the university and the government buildings and all of those places" - Academ1

Further, proximity to the A Re Yeng BRT transit station has not been considered as a factor by property developers when making a location decision.

"It just so happened coincidentally that the piece of land had the BRT station just outside, so the transit station was not considered as anything, as a stimulant, to develop - PropDev1

It became apparent when we were already there that the bus route was just around the corner. I did not have an effect on us purchasing the building - PropDev2.

Despite the presence of diverse residential and commercial land uses near the BRT station, it appears the system does not catalyse these land uses. The BRT service seems to be a follower rather than a trendsetter.

Pedestrian friendly designs

HCID was very vocal about the sub-study area not being pedestrian-friendly. HCID believes that Hatfield was designed for cars rather than for pedestrians. Frequently, the available kerbside walkways are utilized as parking by cars, particularly near the Gautrain station which is located less than 100m from the BRT station.

" I think we have done it the wrong way around...one of the big things that we're looking at is non-motorized transport. If you consider that we are a student suburb, and a lot of people are walking all right" - HCID

4.4.4 BRTOD Patterns in Hatfield

This section tracks theoretical exemplary land use change patterns emerging from BRT investment namely; functional change, structural change, new development, and no change in the responses provided by the interviewees.

Functional Change

Functional change is described as a modification in land use without major adjustments to the building's structure. Five interviewees referenced functional change at different phases of the interview. Two main functional land use changes emerged; a transition from office use to residential use and a shift from single-dwelling use to high-density residential use.

> *"One of the things that happened in quite a significant way in and around the University is that a lot of land was bought up and student residential properties were put up"* - HCID.

> *"So, some of the offices are now changing into student accommodation because of the need for student accommodation"* - TownPl

> *"Look, there's a lot of student accommodation that is currently developed in the area, high-rise buildings,"* - PropDev2.

The results further indicate that the primary motivator for land use change in Hatfield is the University of Pretoria as the primary functional change is towards student accommodation.

> *"The University of Pretoria owns that much land, they just bought the businesses that were there, and then they put in student accommodation"* - Academ1.

The presence of the University is another characteristic that makes Hatfield unique. Although functional change is occurring, the causal link to the BRT service cannot be established.

> *"And the other thing that has come up in the last 10 years is that they have had a huge investment in student accommodation, there are also offices and Hatfield Plaza already. That is what I'm saying: Hatfield has characteristics that cannot allow you to speculate. In that sense, you cannot attribute it only to BRT"* - Academ2

Structural Change

Since a functional change may not always be visible, the theory on BRTOD says that land use change can be inferred from modifications to the building's construction and area. Structural change was referred to in four interviews, though some of the interviewees would intertwine functional and structural change.

> *"Most properties are converting to student accommodation"* - PropDev2

> *"The way the structure of our building is set up currently facilitates a student accommodation"* - PropDev2.

Once again, a causal link to the BRT investment could not be established as the interviewees were attributing the structural change characteristic to other drivers like the University or the Gautrain.

> *"So, what we did as part of the development team, was to try and engulf this taxi rank and make it bigger, renovate it, and make it look like it was a part of our development. That's as far as we went in terms of considering a transit node"* - PropDev1.

> *"So, when the Gautrain was built, you know, some redevelopments took place in the immediately adjacent area".* - TownPl

No Change

The no-change pattern refers to parcels of land where no functional or structural change has occurred. Academ1 and TownPl were the two interviewees who stated that a significant part of Hatfield has remained the same. Hatfield was already a dense environment, so the BRT service has not had the desired impact of stimulating land use change.

> *"We are seeing a lot of densifications happening along… let me just say, Lynwood Rd. It is a very, very important strip economic strip, and there are a lot of densifications that occur here. However, it was dense before the BRT service was introduced"* - Academ 1

> *"But the BRT section running through Hatfield did not change because obviously I mean the office already existed along the route that was selected"* - TownPl.

It is clear that densification is happening, but the driver of the land use change is not attributed to the BRT service.

> *The presence of the BRT at this stage, Is not as prominent as it should be, hopefully it will enhance further in the future* - TownPl

> *"I don't think that Hatfield has harnessed the potential of having a BRT or Gautrain station yet.... the A Re Yeng service and its potential have been downplayed in Hatfield."* - HCID.

New development

The new development pattern is where a vacant piece f and is newly developed with new structures. This pattern was not referenced in any of the interviews.

4.4.5 Further Insights from Interviews

The responses by the interviewees were strong that the A Re Yeng BRT was not serving as a land use change catalyst in Hatfield. Naturally, in semi-structured interviews, the participants would intermittently pivot and offer their opinions regarding the potential reasons for this. Below are some of the insights provided by the participants;

Hatfield already dense

Hatfield already being a dense node with a mixture of uses is something that was spoken about frequently in interviews, which makes it difficult to attribute the densification to the BRT service. If the node is already dense with a mixture of uses, it is difficult to comprehend that the BRT service would stimulate any type of change.

> "*It has been dense before the BRT service was introduced*" - Academ 1

Presence of other drivers

Hatfield is also a student town, with a lot of land occupied by the University of Pretoria. So with that alone, it is difficult to attribute the densification and land use changes to the BRT service alone.

The BRT station in Hatfield is also located less than 100m from the Gautrain station, which further connects the suburb to the neighbourhood centres of Centurion, Midrand, and Johannesburg without the need to use a motor car. This further makes it harder to attribute the land use changes to the BRT service. The literature review indicated that rail has always outperformed road-based public transit services as a stimulant for land use change.

> *"Hatfield was already mostly office developments along the alignment up to the BRT station because it links into the Gautrain station"* - HCID.

Governance

Effective governance and coordination between the various government departments are also critical in spatial planning. Operational misalignment between the various government departments has the potential to critically impede any efforts by the planning departments to transform the spatial landform. When there is no agreement regarding the implementation of the agreed goals, with no accountability and effective leadership, any development plan will not succeed.

> *"When you start with the service and then hope that, under the umbrella of the reconstruction and the building of a new country, everyone will come on board, and everyone will do their part. But it does not always materialize."* - Academ 1

> *"the problem lies with the institutional weakness that is there, both in local government and transit itself. This institutional weakness to not see, and maybe broadly speak to the skills issue, to not see and leverage the marriage between the infrastructure agents that are there"* - Academ 2

Planning without an understanding of the community surrounding the transit service will also impede any effort for spatial re-structuring. Case studies from South America indicated that BRT-led land use change is likely when the ridership numbers are high. There is no sense in introducing the service in a location where the majority of the community prefers other modes of transit.

> *"Why do you put a Bus service in this place but then also densify at the periphery where the bus is not running... what are you trying to do, where is the logic there? And you find that*

there is no logic you know, so it is fragmented. It is a fragmented approach to reconstructing and rebuilding a country" - Academ 1

"So, what is the point of having the BRT service on the ground here when it is neither providing access to jobs nor supporting the land use activity around it?" - Academ 1

"A typical BRT user doesn't have the luxury of time" - Academ 2

"I just think that sometimes we are out of feeling and out of sync with the reality of the environment" - HCID.

4.5 Summary of Findings

This chapter presented the research findings from the data collected through archival records, observations, and interviews. The data collected tracks the land use changes that have occurred over the last 10 years since the A Re Yeng BRT service began operations.

The archival records reveal that the BRTOD land use change patterns are prominent in the sub-study area. The analysis of historical and recent aerial and street view imagery revealed that the predominant land use change patterns are *structural change* and *no change*. The *new development* land use change type was not detectable. The pattern of *functional change* could not be discerned just through the comparison of aerial pictures. A causal relationship between the theoretical land use change categories and the implementation of the BRT service could not be determined using archival documents.

The data from direct observations supplemented the archival records, demonstrating that the exemplary land use change patterns of *structural change* and *no change* were dominant in the sub-study area. No *new development* land use change type was recorded in the sub-study area. Additionally, direct observations enabled the researcher to monitor the occurrence of the theoretical BRTOD characteristics and their corresponding design principles. The characteristics of *proximity to transit, mixed-use development, pedestrian-friendly designs, high-density development, and open spaces* were observed in the sub-study area. Nevertheless, a definitive causal relationship between the BRTOD land use change patterns and characteristics identified, and the implementation of the BRT service, could not be entirely established. The *pedestrian-friendly design* characteristic, featuring

wide pavements and pathways, included pointing signage to the BRT station, which was the sole visible connection to it.

Data from the semi-structured interviews provided perspectives from a range of stakeholders and professionals. The theoretical BRTOD characteristics and exemplary land use change patterns were often cited in interviews as prevalent in the sub-study area. The interviewees also cited the *functional change* pattern for the first time during the data-gathering process. However, the interviewees were certain that the BRT service is not the primary catalyst for land use changes, rather attributing the changes and characteristics to other factors such as the Gautrain and the University of Pretoria. The interviewees commonly noted that the BRT service has remained a transit service used by a few at this time.

CHAPTER 5 DISCUSSION OF THE FINDINGS AND CONCLUSION

5.1 Introduction to Discussion

This research aimed to explore how the A Re Yeng BRT system serves as a catalyst for land use change in the suburb of Hatfield. The A Re Yeng BRT service has been in operation for since 2014, thus presenting an opportunity to investigate its efficacy as a land use change catalyst in Hatfield between 2014 and 2024. Chapter 4 presented the findings from the data collected from archival records, direct observations, and semi-structured interviews.

This chapter discusses the key findings. The themes emerged from the pattern matching data analysis method employed. The findings of this study suggest the A Re Yeng BRT system does not serve as a catalyst for land use change in Hatfield. The common themes were subsequently categorised into four parts, namely, the physical characteristics of Hatfield, the university town as a constraint to BRTOD, preference for other modes of transit over the BRT service, and operational misalignment, to facilitate the discussion of the main finding of the research. The section will reflect on the findings in the context of the literature with references back to the same and the presentation of the data to support the arguments being made.

The last section will revisit the research question, objectives, and proposition to test if these have been answered.

5.2 Discussion of the Key Findings

Although the exemplary BRTOD land use change patterns namely, *functional change, structural change, and no change,* along with typical BRTOD characteristics such as *proximity to transit, mixed-use development, and high-density development* were prevalent in Hatfield, a causal link with the introduction of the BRT service could not be determined. This arguably suggests that the suburb of Hatfield is emulating a BRTOD node because the BRTOD land use change patterns and characterises are being driven by external forces. The A Re Yeng BRT service has remained purely a transportation service.

5.2.1 Hatfield Physical Constraints to BRTOD

A theme that came out consistently in the data was Hatfield's physical constraints to BRTOD. According to the literature, TOD success depends on high density (Ogra & Ndebele, 2014, Salat & Ollivier, 2017). However, BRTOD in a congested setting is difficult as the existing infrastructure and high densities usually restrict BRTOD (Mukherjee & Bagui, 2018, Fenske, 2019). This research found that Hatfield's high density prevents BRTOD as the suburb was already highly congested and developed before the introduction of the BRT service. No capacity or space exists for new BRT-related land use changes along the BRT corridor. The data showed that the dominant land use change pattern was the *no-change* pattern, indicating that most of the land has remained the same. Linking the present densities and land use change patterns in Hatfield to the introduction of the BRT service would be questionable.

Lynwood Road in Hatfield is also served by the A Re Yeng BRT. Lynwood Road properties are considered prime real estate and appeal to high-earners. According to Nakamura, Makimura & Toyama (2017), most BRT users are low-middle income, raising the question of why the service is operated along that route if it doesn't engage a substantial percentage of the local community. As a result, the A Re Yeng BRT corridor is less effective, reducing BRTOD chance.

Following Bogota and Curitiba's best practices, the BRTOD corridor should be done on two-way streets for maximum functionality (Lindau, Hidalgo & Facchini, 2010, Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016). Data from interviews and observations revealed that Hatfield's street designs and traffic coordination systems are designed for cars, not people. City regulations make Burnett Street, Hatfield's major aerial route through the suburb's main activity centres, one-way. The A Re Yeng BRT service on Burnett Street is one-way, limiting BRTOD and operating efficiency.

5.2.2 The University Town Constraint to BRTOD

Interviews and observations revealed that Hatfield is known as a university suburb with a large population of 18 to 25-year-olds. According to Ruoppila & Zhao (2017) and Profiroiu & Brișcariu (2021) universities are key stakeholders in property and urban development and help achieve the node's development goals. The University of Pretoria owns most of Hatfield's land, making it the main stakeholder in land use. What does this mean for BRTOD? This suggests that an alternative explanation best explains the land use change

patterns in the suburb. Analysing Hatfield land use change data reveals plausible causes. Besides the no-change land use pattern, functional and structural land use changes next dominated the sub-study area. The functional change pattern was largely low-density office to high-density student accommodation conversions. The structural change pattern largely consisted of converting low-density single-dwelling houses to high-density student accommodations. Several interviewees indicated Hatfield's accommodation crisis requires all parties' attention. Academ 1 reported rising University of Pretoria student enrolment, yet there is a land shortage for student accommodation. PropDev2 development strategy is to repurpose office buildings into affordable student housing for those who cannot get university-provided accommodation. This explains why land use patterns changed from low-density commercial and residential to high-density student accommodation.

The University of Pretoria may be the catalyst for these land use changes, which is consistent with literature suggesting universities manage land use changes in their nodes. The University of Pretoria in Hatfield negates the possibility that BRT investments caused land use changes.

5.2.3 Other Modes of Transit

Prayogi (2017) found that ridership measures such as passengers per hour per direction determined a location's TOD potential the most. Prayogi agreed with Curitiba and Bogota's global BRTOD best practice, emphasising strong ridership as vital for BRTOD's success (Lindau, Hidalgo & Facchini, 2010, Cervero & Dai, 2014, Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016). Hatfield was well-developed before the BRT service, several interviewees said the population relies on informal minibus taxis, metro rail, Tshwane bus services, and Gautrain Bus Service. Recently, e-hailing services have also dominated the transit landscape of Hatfield. If customers are not enticed to the BRT service, land use changes near the station and BRT corridor are unlikely, limiting BRTOD implementation.

Unless it is connected to other transit services in the city, Nguyen & Pojani (2018) believe BRT will not expand and generate multiplier effects like TOD. Best practice BRTOD cases in South America, Asia, and Australia involve BRT services connecting to trains, metro lines, and traditional buses as feeder services to carry people from numerous city nodes to the main provincial transit services (Kamruzzaman et al., 2014, Rodriguez, Daniel, Vergel-Tovar & Camargo, 2016). Connectivity comprises more than just placing the BRT station near other transportation modes, it also includes examples like integrated payment systems, communication platforms, and discounts for multi-modal passengers. Hatfield's A Re Yeng

BRT user card is unconnected to Tshwane's other transit modes. This limits the service's growth, ridership, and BRTOD.

Academ1 suggested improving Tshwane's bus service's image in general. The City's buses' poor service reliability has caused the population to switch to other modes of transportation, demanding significant improvements to restore public faith in the bus system. The elimination of the informal minibus taxis to encourage greater use of the BRT service will incite violence and disruption, as evidenced by the introduction of the Re Ya Vaya BRT service in Johannesburg. Despite an agreement between the City of Tshwane and the taxi sector, the Hatfield population still prefer taxis to the BRT. Several interviewees stated that the wealthier populace still prefers private cars. Consequently, this demographic is the one most inclined to spend money on businesses located near the BRT stations and promote BRTOD.

5.2.4 Operational Misalignment

Operational misalignment exists when stakeholders are uncoordinated in their efforts towards achieving a common goal. Nguyen & Pojani (2018) recognised stakeholder alignment as a critical aspect in initiating BRTOD. Stakeholders originate from diverse contexts within the institutional, legislative, political, and public domains, such as government agencies, transit authorities, property developers, professional teams, and community organisations, as demonstrated by exemplary case studies from Curitiba, Brazil; Bogota, Colombia; Ottawa, Canada; and Ahmedabad, India. Goedeking (2024) emphasised the significance of political support for BRTOD by a committed BRT advocate. Dibakwane (2011) highlighted the general public as a crucial stakeholder that needs to be engaged through a well-planned thought-out public participation process. Suzuki, Cervero & Iuchi (2013) emphasised the significance of securing support from private-sector property developers.

In Hatfield, several interviewees said operational misalignment is growing because stakeholders are not aligned on the method and strategy needed to fulfil the City's spatial goal. The data shows that the City lacks a comprehensive TOD framework that utilizes the BRT service or other transportation services in Hatfield. Policy formulation is clear in municipal planning papers, but execution is lacking. As shown in the data, the private sector has filled implementation gaps and succeeded in certain areas, but TOD continues to elude the city. Any BRTOD effort will fail without a clear TOD workflow and procedure.

5.3 Implications of the research

The City of Tshwane BRTOD strategy relies on the A Re Yeng BRT service. BRT services are becoming popular in more South African metros, which are also investigating BRTOD for their cities. This research shows that simply incorporating the TOD principles and characteristics into the City's urban land use change designs does not guarantee that TOD will occur in the BRT corridor. Incorporating TOD principles and characteristics is not easy, as the literature suggests. This research shows that BRTOD implementation is difficult and highly context-specific. City planners must evaluate their city's specific environment and study international best practices in similar cities.

This research added another perspective on BRTOD at a well-developed node. Implementing BRTOD at a well-developed node, like Hatfield, is difficult. In a densely populated area, where external forces like universities and rail transit exist, the BRT should be seen as a way to improve node accessibility only. Thus, BRTOD is more likely to be successful in new and emerging activity nodes than in established ones. BRTOD planning policy for South African cities ought to demand a rigorous node/place analysis to identify plausible locations. Bertolini's node/place could be considered for this exercise.

This research showed that BRTOD and TOD implementation in Tshwane is not synchronised. TOD planning policy should call for the establishment of a centralised entity to amalgamate and coordinate the numerous stakeholder contexts, both public and private, for BRTOD implementation in South African cities. BRTOD initiatives will fail without this central coordination unit.

Finally, A Re Yeng BRT integration with Gautrain, Tshwane Metro buses, and Metrorail must be assessed. Following global best practices, the BRT service may be classified as a feeder service to the regional or provincial transport networks to boost capacity and passenger numbers. Higher passenger numbers will promote land use changes near the BRT stations and corridors.

5.4 Conclusion

5.4.1 Answering the Research Question

The research question posed in Chapter 1 was;

How has the A Re Yeng BRT served as a catalyst for land use change in Hatfield?

The question was answered through the analysis and discussion of the findings. The findings show that Hatfield contains existing characteristics that cannot allow anyone to link the land use changes occurring in the suburb to the A Re Yeng BRT service. The discussion followed the major themes that emerged, classified into four, namely: *the physical characteristics of Hatfield, the university town as a constraint to BRTOD, preference for other modes of transit,* and *operational misalignment*.

Hatfield's physical characteristic (i.e. being an already dense environment) was found to be a constraint to BRTOD. Although TOD requires high density, BRTS is restricted by it. Implementing a BRT service requires land, which is already scarce in a dense environment. The main land use change found in the suburb was "no change", meaning a large proportion of land use in the suburb has remained the same. If any land use change occurs, they would already be driven by other factors that produce existing density, making it impossible to attribute it to the BRT service alone.

Hatfield, being a University Town, was also found to be a constraint to BRTOD. A "functional change" and "structural change" in land use were also observed in Hatfield, characterised by property conversions from low-density commercial and residential to high-density student accommodation, evidencing that it is the University of Pretoria, and not the BRT service, that acts as the driver of the land use change.

Literature linked the high BRT ridership numbers to potential BRTOD success. The passengers are the potential customers who must interact with the associated mixture of land uses near the BRT station and corridor. Low passenger numbers reduce the need to develop a mix of land uses in the vicinity of the BRT stations. The concern with Hatfield is that it was already a dense environment, and the community has already built a reliance and preference for other modes of transit, like informal minibus taxis, leading to low BRT ridership numbers and further impeding BRTOD.

The literature stressed the need for stakeholder coordination in BRTOD. In Hatfield, there is no comprehensive TOD framework that capitalises on the BRT service, hence stakeholders are operationally misaligned in implementing BRTOD. The findings supported literature that BRTOD without a clear TOD workflow and method will fail.

5.4.2 Achieving the Research Objectives

The objectives of the research as stated in Chapter 1 were as follows;

Objective 1: To explore the concept of land use change

The concept of land use change was introduced in Chapter 1 and expanded in Chapter 2. Land use was explored and understood as the *"human utilisations of the land surface",* therefore land use change for the context of the study is defined as " the *modifications to the proportions of the human utilisation of the earth's surface*"

The literature review identified "functional change", "structural change", "new development", and "no change" as the main land use change categories. Functional change is a land use shift that describes a change in the predominant activities being undertaken in the he predominant activities on a piece of land, such as offices, retail, residential, mixed, educational, etc. A rezoning application is usually submitted to the City's building control department for these land use changes. Structural change typically involves increasing the gross building area or the allowable bulk of a site. Function and structural change can coexist in one site. New development is a land use change from a vacant piece of land to being developed for any function, while the no change category in land use is self-explanatory.

The literature review further indicated that a more granular analysis of the actual land use changes occurring within the above-mentioned categories is the best indicator of the driver.

Objective 2: To explore the concept of transit-oriented development and bus rapid transit, and how it has evolved globally

Transit-oriented developments (TOD) and bus rapid transit (BRT) were introduced in Chapter 1 as key concepts of the study and expanded in the literature review. TOD was shown to be a planning and strategy which ensures that compact, dense, pedestrian-friendly designs and mixed-use development is organised around transit stations. The key TOD principles and key characteristics, namely: proximity to transit, mixed-use development,

pedestrian-friendly designs, high-density development, open spaces and shift were also analysed in the literature review. Lastly, the location potential for TOD was also analysed in the literature review using models like the Bertolinis node/place model.

The origins of BRT were also explored, as well as justification for the growing popularity of the transit service, especially in the cities of the global south.

Objective 3: To explore the influence of BRT on land use change globally

Combining BRT and TOD, birthing BRTOD, was introduced and discussed in the literature review, including a discussion on the key the success and risk factors to BRTOD categorised into seven main types namely; "Institutional and legislative context", "political leadership and commitment", "management of competing modes of transit", "the importance public participation", "funding and coordination", "physical design of the BRT service", and "image promotion".

The literature review then summarised benchmarks where BRT has successfully triggered TOD, leading to a discussion on the exemplary BRTOD land use change patterns, characteristics, and design principles, namely "corridor development" and "nodal development". Corridor development was understood as development expanding following the BRT busways occurring between two stations, while nodal development expands radially or sectorially from the BRT station.

Objective 4: To track the bus rapid transit-oriented development land use changes and characteristics in the vicinity of the BRT station in Hatfield.

The objective was attained through the literature review, data collection and an analysis of the findings. The literature review identified the land use change categories as well as the exemplary BRTOD land use change patterns. The understanding of land use change categories and BRTOD land use patterns equipped the researcher with a foundation for a focused collection process for the type of data required. Data was presented in Chapter 4. The researcher analysed archival records by comparing historical and current aerial and street view imagery, together with conducting fieldwork, to track the land use changes in Hatfield since the implementation of the BRT service. The results indicate that the land use

change in Hatfield may be classified into three categories: "functional change," "structural change," and "no change" in clear nodes.

Objective 5: To identify land use changes in the vicinity of the BRT station in Hatfield occurring as an effect of the BRT service.

The objective was accomplished through the data collection process and analysis of the findings. A detailed investigation of the actual land use changes occurring revealed that the functional and structural land use changes are mostly typified by conversions from low-density commercial or residential use to high-density residential student accommodation. These functional and structural and use changes substantiate that the catalyst of the land use change in Hatfield is the University of Pretoria, rather than the BRT service.

Analysis of interview data further revealed that the BRT is not revered by the community of Hatfield and is secondary to other modes of transit like the mini-bus taxis, e-hailing services, and the Gautrain Bus service. The findings show that Hatfield has not fully capitalised on any transit services in the suburb, including the Gautrain rail service, which literature identifies as having the greatest potential to stimulate TOD.

5.4.3 Revisiting the Research Proposition

The assumed proposition was that;

'The A Re Yeng BRT service merely acts as a transportation service in Hatfield and has not acted as a catalyst for land use change in the last ten years'

The initial proposition is supported. No evidence links Hatfield land use changes to the BRT service. The catalysts of land use change at present are University of Pretoria, perhaps followed by the Gautrain. The A Re Yeng BRT service may be a catalyst in the future, as interviews show that the node has not completely capitalised on transit services in the suburb.

5.5 Concluding Summary of the Research Findings.

The research has discovered that the exemplary BRTOD land use change patterns and characteristics are present in Hatfield. However, a causal link to the introduction of the BRT

service cannot be made. The data indicated that the land use changes are being catalysed by other factors like the University of Pretoria and the Gautrain.

As the BRT service continues to be considered by many cities in South Africa, it's critical that its application as a TOD catalyst be understood and investigated in a variety of contexts.

5.6 Limitations

The study did not focus on the A Re Yeng BRT service itself but on the aspect of the transit service that addresses the research question.

Efforts to interview a representative from the A Re Yeng bus operations or the City of Tshwane planning departments were unsuccessful. These offices may possess data that could have benefited the research. Notwithstanding this constraint, the findings remain relevant due to an interview performed with a professional town planner in the private sector who participated in BRT, TOD, and land use planning for the City of Tshwane.

Analysis of aerial imagery from the archival data was done through human eye-matching analysis. The use of computerised technology to conduct the matching of historical to current imagery may reveal additional land use changes that were not tracked by the researcher. This would not materially affect the research findings, given the primary objective was to establish a causal relationship with the BRT system.

Finally, the A Re Yeng BRT service is undergoing expansion with more phases being launched. Evidence of the *new development* land use change pattern was observed in the A Re Yeng BRT corridor to Menlyn. Therefore, the results of this research should be regarded as a reference to a point in time for the specific sub-study area.

5.7 Recommendations for future research

The following recommendations are based on the findings;

- Additional research is required to understand the challenges facing the implementation of BRTOD in the suburb of Hatfield as well as solutions to addressing those challenges. This research highlighted a few based on insights from interviews. BRTOD is high on the agenda of the City of Tshwane, and other municipalities of South Africa. Further research into identifying and addressing the challenges will be critical.
- The A Re Yeng BRT continues to be extended with new phases underway. The corridor between Hatfield and Menlyn or Pretoria CBD and Rainbow Junction is seeing new developments underway along the route. Perhaps similar research could be repeated in those corridors to investigate how the BRT system is serving as a catalyst for land use changes in those locations

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Appendix A - Ethics Clearance

ETHICS APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/ebe/research/ethics1

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		Mashudu Innocent Sikhwari
Department		Construction Economics and Management
Preferred email address of applicant:		mashudu.sikhwari@absa.africa
If Student	Your Degree: e.g., MSc, PhD, etc.	MSc (Prop Stud)
	Credit Value of Research: e.g., 60/120/180/360 etc.	60
	Name of Supervisor (if supervised):	Mr Uche Ordor
If this is a research contract, indicate the source of funding/sponsorship		N/A
Project Title		A Transit Oriented Based Approach to Urban Land Transformation: A case of Bus Rapid Transit System in The City of Tshwane

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

APPLICATION BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Mashudu Innocent Sikhwari		02 July 2021
SUPPORTED BY	Full name	Signature	Date
Supervisor (where applicable)	UCHE ORDOR		26/07/2021

APPROVED BY	Full name	Signature	Date
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (including Honours).	**Dr. Frank K. Ametefe**		**22/09/2021**
Chair: Faculty ER Committee For applicants other than undergraduate students who have answered YES to any of the questions in Section 1.	**Dr. Frank K. Ametefe**		**22/09/2021**

Academ 1

Information sheet and consent form

Research Topic: ***A Bus Rapid Transit Oriented Approach to Land Use Change: A Case Study of Hatfield***

Hello,

My name is Mashudu Sikhwari, and I am conducting research toward a Master of Science degree in Property Studies with the University of Cape Town. I am busy with my minor dissertation where I'm researching the role of the A Re Yeng BRT service as the catalyst for Land Use change in the suburb of Hatfield, Pretoria. I would like to invite you to participate in the project.

The research is supervised by Mr Uche Ordor from the Department of Construction Economics and Management, contactable at uche.ordor@uct.ac.za

Purpose of the research

The study intends to investigate if Bus Rapid Transit can stimulate land use change. The objectives of the study are;

- To explore the concept of land use change.
- To explore the concept of bus rapid transit and transit-oriented development and how they have evolved globally.
- To explore the influence of BRT on land use change globally
- To track the presence of transit-oriented development principles in the vicinity of BRT Stations in Hatfield
- To track land use changes in the vicinity of BRT station Hatfield since the introduction of the A Re Yeng BRT service
- To explore the influence of the BRT service on land use changes in Hatfield

Participation is voluntary

Please understand that you are not obligated and do not have to participate in this project. Your participation is entirely voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequences. If you choose to participate but wish to withdraw at any time, you will be free to do so without negative consequences. However, I would be grateful if you would assist me by allowing me to interview you.

Expectations from participations

I will only ask you a few questions regarding the subject matter being researched. This should take 15 to 30 minutes. There is no financial obligation from the project or you as the participant. Therefore, there is no payment/reimbursement available.

Recording of the interview
With your permission, I would like to record this interview so I can refer to it for academic purposes concerned with this project only. If you do not agree that is still acceptable.

Benefits to participants
No direct or indirect harm. I am happy to provide feedback on my findings with you which may assist with planning future planning of transit and land use integration.

Risk of harm to participants
No foreseen or unforeseen risks

Sharing and use of data
Data generated from the interview will be synthesized and used to answer the research questions set for this master's project, it may be presented in conferences and may be published in journals.

Confidentiality
The information obtained from the interview shall be used for this research study only and may be presented in conference papers. Every effort shall be made to respect the participant's election confidentiality.

☒I give consent to be identified by name and occupation in the research.

☒I do not give consent to be identified in the research. (By selecting this option, it is only the researcher and supervisor, and possibly the examiner will know your identity)

By signing the consent form, you agree to the terms stipulated in this consent sheet regarding the interview. If you are not comfortable with the terms, please make a note on the form.

Participant

Date 05 August 2024

Signature of participant .....

Name of participant [redacted]

Organisation of participant [redacted]

Researcher:

Name: Mashudu Sikhwari

Signature:.....

Date: 05 August 2024

Academ 2

Information sheet and consent form

Research Topic: ***A Bus-Transit Oriented Based Approach to Land Use Change: A Case Study of Hatfield***

Hello,

My name is Mashudu Sikhwari, and I am conducting research toward a Master of Science degree in Property Studies with the University of Cape Town. I am busy with my minor dissertation where I'm researching the role of the A Re Yeng BRT service as the catalyst for Land Use change in the suburb of Hatfield, Pretoria. I would like to invite you to participate in the project.

The research is supervised by Mr Uche Ordor from the Department of Construction Economics and Management, contactable at uche.ordor@uct.ac.za

Purpose of the research

The study intends to investigate if Bus Rapid Transit can stimulate land use change. The objectives of the study are;

- To explore the concept of land use change.
- To explore the concept of bus rapid transit and transit-oriented development and how they have evolved globally.
- To explore the influence of BRT on land use change globally
- To track the presence of transit-oriented development principles in the vicinity of BRT Stations in Hatfield
- To track land use changes in the vicinity of BRT station Hatfield since the introduction of the A Re Yeng BRT service
- To explore the influence of the BRT service on land use changes in Hatfield

Participation is voluntary

Please understand that you are not obligated and do not have to participate in this project. Your participation is entirely voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequences. If you choose to participate but wish to withdraw at any time, you will be free to do so without negative consequences. However, I would be grateful if you would assist me by allowing me to interview you.

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Benefits to participants
No direct or indirect harm. I am happy to provide feedback on my findings with you which may assist with planning future planning of transit and land use integration.

Risk of harm to participants
No foreseen or unforeseen risks

Sharing and use of data
Data generated from the interview will be synthesized and used to answer the research questions set for this master's project, it may be presented in conferences and may be published in journals.

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☐I give consent to be identified by name and occupation in the research.

☐I do not give consent to be identified in the research. (By selecting this option, it is only the researcher and supervisor, and possibly the examiner will know your identity)

Dy signing the consent form, you agree to the terms stipulated in this consent sheet regarding the interview. If you are not comfortable with the terms, please make a note on the form.

Participant

Date 07 August 2024

Signature of participant .....

Name of participant [redacted]

Organisation of participant Private

Researcher:

Name: Mashudu Sikhwari

Signature: .....

Date: 07 August 2024

Information sheet and consent form

Research Topic: ***A Transit Oriented Based Approach to Land Use Transformation: A Case of A Re Yeng Bus Rapid Transit (BRT) service in the Hatfield Metropolitan Node.***

Hello,

My name is Mashudu Sikhwari, and I am conducting research towards a Master of Science degree in Property Studies with the University of Cape Town. I am busy with my minor dissertation where I'm researching a transit oriented based approach to land use transformation, particularly looking at the role of the A Re Yeng BRT as the catalyst for land use changes in the Hatfield Metropolitan Node and would like to invite you to participate in the project.

The research is supervised by Mr Uche Ordor from the Department of Construction Economics and Management , contactable on uche.ordor@uct.ac.za

Purpose of the research

The study is intended to investigate the nature of use of the A Re Yeng BRT service as a catalyst for any land use transformations in the Hatfield Node. The objectives of the study are;

- To study the concept to land use transformation.
- To explore the concept of Bus Rapid Transit (BRT) and Transit Oriented Development (TOD) and how it has evolved globally.
- To track the application of TOD principles in proximity of A Re Yeng BRT stations in Hatfield.
- To track land use changes in Hatfield Metropolitan Node since the introduction of the A Re Yeng BRT service
- To identify the extent to which the users of land in proximity to the BRT stations interact with or affected by the introduction of the BRT service.

Participation is voluntary

Please understand that you are not obligated and do not have to participate in this project. Your participation is entirely voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequence. If you choose to participate, but wish to withdraw at any time, you will be free to do so without negative consequence. However, I would be grateful if you would assist me by allowing me to interview you.

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Risk of harm to participants
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Sharing and use of data
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☐I give consent to be identified by name and occupation in the research.

☐I do not give consent to be identified in the research. (By selecting this option, it is only the researcher and supervisor, and possibly the examiner will know your identity)

By signing the consent form, you agree to the terms stipulated in this consent sheet regarding the interview. If you are not comfortable with the terms, please make a note on the form.

Participant

Date 23 October 2023

Signature of participant .....

Name of participant .....

Organisation of participant.....

Researcher:

Name: Mashudu Sikhwari

Signature: .....

Date: 22 October 2023

PropDev1

Information sheet and consent form

Research Topic: *A Bus-Transit Oriented Based Approach to Land Use Change: A Case Study of Hatfield*

Hello,

My name is Mashudu Sikhwari, and I am conducting research toward a Master of Science degree in Property Studies with the University of Cape Town. I am busy with my minor dissertation where I'm researching the role of the A Re Yeng BRT service as the catalyst for Land Use change in the suburb of Hatfield, Pretoria. I would like to invite you to participate in the project.

The research is supervised by Mr Uche Ordor from the Department of Construction Economics and Management, contactable at uche.ordor@uct.ac.za

Purpose of the research

The study intends to investigate if Bus Rapid Transit can stimulate land use change. The objectives of the study are;

- To explore the concept of land use change.
- To explore the concept of bus rapid transit and transit-oriented development and how they have evolved globally.
- To explore the influence of BRT on land use change globally
- To track the presence of transit-oriented development principles in the vicinity of BRT Stations in Hatfield
- To track land use changes in the vicinity of BRT station Hatfield since the introduction of the A Re Yeng BRT service
- To explore the influence of the BRT service on land use changes in Hatfield

Participation is voluntary

Please understand that you are not obligated and do not have to participate in this project. Your participation is entirely voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequences. If you choose to participate but wish to withdraw at any time, you will be free to do so without negative consequences. However, I would be grateful if you would assist me by allowing me to interview you.

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Benefits to participants
No direct or indirect harm. I am happy to provide feedback on my findings with you which may assist with planning future planning of transit and land use integration.

Risk of harm to participants
No foreseen or unforeseen risks

Sharing and use of data
Data generated from the interview will be synthesized and used to answer the research questions set for this master's project, it may be presented in conferences and may be published in journals.

Confidentiality
The information obtained from the interview shall be used for this research study only and may be presented in conference papers. Every effort shall be made to respect the participant's election confidentiality.

☐I give consent to be identified by name and occupation in the research.

☐I do not give consent to be identified in the research. (By selecting this option, it is only the researcher and supervisor, and possibly the examiner will know your identity)

By signing the consent form, you agree to the terms stipulated in this consent sheet regarding the interview. If you are not comfortable with the terms, please make a note on the form.

Participant

Date 26 July 2024

Signature of participant .....

Name of participant [redacted]

Organisation of participant [redacted]

Researcher:

Name: Mashudu Sikhwari

Signature: .....

Date: 26 July 2024

Information sheet and consent form

Research Topic: ***A Bus Rapid Transit Oriented Approach to Land Use Change: A Case Study of Hatfield***

Hello,

My name is Mashudu Sikhwari, and I am conducting research toward a Master of Science degree in Property Studies with the University of Cape Town. I am busy with my minor dissertation where I'm researching the role of the A Re Yeng BRT service as the catalyst for Land Use change in the suburb of Hatfield, Pretoria. I would like to invite you to participate in the project.

The research is supervised by Mr Uche Ordor from the Department of Construction Economics and Management, contactable at uche.ordor@uct.ac.za

Purpose of the research

The study intends to investigate if Bus Rapid Transit can stimulate land use change. The objectives of the study are;

- To explore the concept of land use change.
- To explore the concept of bus rapid transit and transit-oriented development and how they have evolved globally.
- To explore the influence of BRT on land use change globally
- To track the presence of transit-oriented development principles in the vicinity of BRT Stations in Hatfield
- To track land use changes in the vicinity of BRT station Hatfield since the introduction of the A Re Yeng BRT service
- To explore the influence of the BRT service on land use changes in Hatfield

Participation is voluntary

Please understand that you are not obligated and do not have to participate in this project. Your participation is entirely voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequences. If you choose to participate but wish to withdraw at any time, you will be free to do so without negative consequences. However, I would be grateful if you would assist me by allowing me to interview you.

Expectations from participations

I will only ask you a few questions regarding the subject matter being researched. This should take 15 to 30 minutes. There is no financial obligation from the project or you as the participant. Therefore, there is no payment/reimbursement available.

Recording of the interview
With your permission, I would like to record this interview so I can refer to it for academic purposes concerned with this project only. If you do not agree that is still acceptable.

Benefits to participants
No direct or indirect harm. I am happy to provide feedback on my findings with you which may assist with planning future planning of transit and land use integration.

Risk of harm to participants
No foreseen or unforeseen risks

Sharing and use of data
Data generated from the interview will be synthesized and used to answer the research questions set for this master's project, it may be presented in conferences and may be published in journals.

Confidentiality
The information obtained from the interview shall be used for this research study only and may be presented in conference papers. Every effort shall be made to respect the participant's election confidentiality.

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By signing the consent form, you agree to the terms stipulated in this consent sheet regarding the interview. If you are not comfortable with the terms, please make a note on the form.

Participant
Date 07/01/2025

Signature of participant .....

Name of participant [redacted]

Orgarisation of participant.....

Researcher:

Name: Mashudu Sikhwari

Signature: .....

Date: 07 January 2025

Information sheet and consent form

Research Topic: ***A Bus-Transit Oriented Based Approach to Land Use Change: A Case Study of Hatfield***

Hello,

My name is Mashudu Sikhwivhi, and I am conducting research toward a Master of Science degree in Property Studies with the University of Cape Town. I am busy with my minor dissertation where I'm researching the role of the A Re Yeng BRT service as the catalyst for Land Use change in the suburb of Hatfield, Pretoria. I would like to invite you to participate in the project.

The research is supervised by Mr Volhe Ondor from the Department of Construction Economics and Management, contactable at [redacted].

Purpose of the research

The study intends to investigate if Bus Rapid Transit can stimulate land use change. The objectives of the study are;

- To explore the concept of land use change.
- To explore the concept of bus rapid transit and transit-oriented development and how they have evolved globally.
- To explore the influence of BRT on land use change globally
- To track the presence of transit-oriented development principles in the vicinity of BRT Stations in Hatfield
- To track land use changes in the vicinity of BRT station Hatfield since the introduction of the A Re Yeng BRT service
- To explore the influence of the BRT service on land use changes in Hatfield

Participation is voluntary

Please understand that you are not obligated and do not have to participate in this project. Your participation is entirely voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequences. If you choose to participate but wish to withdraw at any time, you will be free to do so without negative consequences. However, I would be grateful if you would assist me by allowing me to interview you.

Expectations from participations

I will only ask you a few questions regarding the subject matter being researched. This should take 15 to 30 minutes. There is no financial obligation from the project or you as the participant. Therefore, there is no payment/reimbursement available.

Recording of the interview
With your permission, I would like to record this interview so I can refer to it for academic purposes concerned with this project only. If you do not agree that is still acceptable.

Benefits to participants
No direct or indirect harm. I am happy to provide feedback on my findings with you which may assist with planning future planning of transit and land use integration.

Risk of harm to participants
No foreseen or unforeseen risks

Sharing and use of data
Data generated from the interview will be synthesized and used to answer the research questions set for this master's project. It may be presented in conferences and may be published in journals.

Confidentiality
The information obtained from the interview shall be used for this research study only and may be presented in conference papers. Every effort shall be made to respect the participant's election confidentiality.

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☐ I do not give consent to be identified in the research. (By selecting this option, it is only the researcher and supervisor, and possibly the examiner will know your identity)

By signing the consent form, you agree to the terms stipulated in this consent sheet regarding the interview. If you are not comfortable with the terms, please make a note on the form.

Participant

Date: 16 July 2024

Signature of participant: _____

Name of participant: [redacted]

Organization of participant: [redacted]

Researcher:

Name: Mashuda Sikhwari

Signature:

Date: 16 July 2024

Information sheet and consent form

Research Topic: ***A Bus-Transit Oriented Based Approach to Land Use Change: A Case Study of Hatfield***

Hello,

My name is Mashudu Sikhwari, and I am conducting research toward a Master of Science degree in Property Studies with the University of Cape Town. I am busy with my minor dissertation where I'm researching a Bus-Transit oriented based approach to Land Use Change, particularly looking at the role of the A Re Yeng BRT as the catalyst for land use changes in the Hatfield. I would like to invite you to participate in the project.

The research is supervised by Mr Uche Ordor from the Department of Construction Economics and Management, contactable on uche.ordor@uct.ac.za

Purpose of the research

The study is intended to investigate the nature of the use of the A Re Yeng BRT service as a catalyst for any land use change in Hatfield. The objectives of the study are;

- To study the concept to land use change.
- To explore the concept of bus-transit-oriented development and how it has evolved in Hatfield.
- To track the presence of transit-oriented development principles in the vicinity of BRT Stations in Hatfield
- To track land use changes in the vicinity of BRT station Hatfield since the introduction of the A Re Yeng BRT service
- To identify the extent to which the users of land in the vicinity of the BRT stations interact with or are affected by the introduction of the BRT service.

Participation is voluntary

Please understand that you are not obligated and do not have to participate in this project. Your participation is entirely voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequences. If you choose to participate but wish to withdraw at any time, you will be free to do so without negative consequences. However, I would be grateful if you would assist me by allowing me to interview you.

Expectations from participations

I will only ask you a few questions regarding the subject matter being researched. This should take 15 to 30 minutes. There is no financial obligation from the project or you as the participant Therefore, there is no payment/reimbursement available.

28 July 2023

Recording of the interview
With your permission, I would like to record this interview so I can refer to it for academic purposes concerned with this project only. If you do not agree that is still acceptable.

Benefits to participants
No direct or indirect harm. I am happy to provide feedback on my findings with you which may assist with planning future planning of transit and land use integration.

Risk of harm to participants
No foreseen or unforeseen risks

Sharing and use of data
Data generated from the interview will be synthesized and used to answer the research questions set for this masters project, it may be presented in conferences and may be published in journals.

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Participant

Date 28 July 2023

Signature of participant .....

Name of participant [redacted]

Organisation of participant [redacted]

Researcher:

Name: Mashudu Sikhwari

Signature: .....

Date: 28 July 2023

APPENDIX C - NVIVO Codebook

Name	Description	Sources	References
BRTOD Characteristics	The common characteristics of a successful BRTOD node incorporating the design principles of walk; cycle; connect; transit; mix; density; compact and shift	4	12
High density development		4	7
Mixed-use development	The creation of a diverse mix of residential and non-residential uses which further limit the need for long commutes to places of activities	1	1
Open spaces		0	0
Pedestrian friendly designs		2	3
Proximity to transit	BRTOD requires the creation of a central node comprising of high density residential and a mixture of commercial uses within walking distance to the transit station	1	1
BRTOD Patterns	The exemplary land use change patterns emerging from BRT investment	5	9
Functional Change	Functional change pattern describes parcels of land where land-use function change is evident without significant alterations to property structures or new developments.	4	5
New Development	New Development pattern is described as originally vacant parcels of land, which are developed with new structures.	0	0
No Change	Within the no-change pattern, the parcel of land where use has remained unchanged since the opening of BRT.	1	1
Structural Change	Structural Change pattern is described as changes within the building or adding new built areas to the existing structure. Land use change may be inferred from observable structural elements in the building.	3	3
Is A Re Yeng BRTOD occurring	The top-level code explores the nature of use of the A Re Yeng BRT service as the catalyst for land use change in the study area as observed by the participants.	7	22
BRTOD is not occurring	A direct link cannot be stablished between the BRT service and land use changes	7	22

Name	Description	Sources	References
Link Established		0	0
Mixed Response (Maybe)	The response is neither a full Yes nor a full No	0	0
Understanding Transit Oriented Development	This top-level code explores the level of understanding of the concept of Transit Oriented Development as a Land Use Change strategy.	7	7
Basic Understanding	The code indicates that the participant has a basic understanding of the concept of TOD as a development strategy	2	2
Deeper Understanding	The code indicates that the participant has a deep understanding of the concept of TOD as a development strategy and may have experience in the implementation thereof.	3	3
No Understanding	The code indicates that the participant has no understanding of the concept of TOD as a development strategy.	2	2

APPENDIX D - Interview Transcripts

Interview Transcript – Academ1

Researcher: As an academic, I'm sure you are familiar with the concept of transit-oriented development.
Academ1: Yes, very familiar with the concept.

Researcher: Yeah great, so my research is specifically focusing on a BRT service as a land use change catalyst because there's been literature largely from the global north or previous research from South America which supports the idea. It is because the BRT service mimics rail so much (with the fixed bus stations and dedicated lanes) that it is believed the service can function as a stimulant as well for land use change.
Academ1: It's an interesting question, so maybe to answer your question let me take a longer path and give you a sense of Pretoria and why it chose the path that it did. It was in the mid-90s or even in the early '90s when planners and government were thinking about how to break the apartheid-era spatial planning structures, you know the structure of separate development. On one hand, you have Mamelodi, on the other you have Pretoria CBD. You have Hatfield on one hand, you Soshanguve on one hand, you have Centurion and all these places, right? So okay, people thought about how we solve this problem. How do we respond to the challenges that apartheid development brought to us?
Some of the people were saying integrated development would be a way in which we move forward, in which we look at the townships and the urban core and look at development in which the urban core would in a way interface and also have positive development spillovers to the Township, and the Township would be able to extract those positive development spinoffs from the urban core. The way that would be done then was integrated development planning, and part of the interventions of achieving that was bus rapid transit, and you know this is where transport planners and other engineers thought about how do we make sure that we bring people closer to town and that they are connected to opportunities, right?
And they tried to answer a question about what you do. Do you bring jobs closer to people or people closer to jobs? They chose the latter, which is to bring people to jobs, and to do so, it's either by train or bus, or minibus taxi. In this instance, the minibus taxi was a really difficult sector to work with. Considering the violence at the time, I remember seeing some articles that President Mandela banned minibus taxis because of how many people were killed. I think it is 1996 or 1997 and he banned them for like a month from operating.
So, then there was this confidence, looking at examples that had happened in Brazil and Curitiba and the successes that BRT had in that city, people had thought that this was the silver bullet. But we then come into 2024 and ask ourselves questions. Did it work? Was the bullet that silver or, was it a different colour, was it rusted, or whatever the case may be?
There was more promise in the 90s, and obviously, we have the benefit of hindsight now, but a much more promising intervention would have been a spatial transformation strategy that looked at things a lot differently. Trying to bring opportunities to obviously where people are, but at the same time looking at connecting people to opportunities.
So, we are now speaking about corridor development to support BRT intervention, which was prioritized by the City of Tshwane Municipality in the early 2000s.
What did it mean? So, building a BRT requires you to ensure that you have sufficient densities to make sure that people can use the service that you're offering. But then the question becomes about when you speak about BRT, the frequency, who you are connecting with, and whether it makes business sense. Is it a reliable service? You know, there are so many of these questions which are not easy to answer.

When you start with the service and then hope that, under the umbrella of the reconstruction and the building of a new country, everyone will come on board, and everyone will do their part. But it does not always materialize.
So the understanding should have been, as the city we will do our part and provide this service BRT, and then hopefully the provincial and national government will build housing along this strip that we've identified as a corridor and they would put people closer to those corridors to ensure that they have easy access to the BRT service. But what we understand is that there's a plethora of research in Tshwane about where these new housing developments will be placed. Many of them were placed in the peripheral areas of Tshwane. So now, which again makes you wonder...why the mismatch? Why do you put a BRT service in CBD and Hatfield but then also densify at the periphery where the bus is not running? What are you trying to do, where is the logic there?
And you find that there is no logic you know, so it is fragmented. It is a fragmented approach to reconstructing and rebuilding a country.
So, when you ask the question about whether the BRT has influenced density and land use in Hatfield? Is it a difficult one because here in Hatfield we are seeing a lot of densifications happening along… let me just say, Lynwood Rd. It is a very, very important strip economic strip, and there are a lot of densifications that occur here. However, it was dense before the BRT service was introduced. Why is the densification happening? Is it happening to fulfil the corridor development mandate or is it occurring for different reasons? Before we answer that question, we need to answer the most crucial question. Who owns land in Hatfield, right? Before we get to the question of the BRT corridor development in Hatfield, you have to answer that question.

Researcher: It is the University of Pretoria, right?
Academ 1: Yes, the University of Pretoria owns a lot of land. I don't want to quote the wrong numbers yet, but I think they own the majority stake.

Researcher: So, what does that mean?
Academ 1: It means that the University is the main driver of land development. If you look at the old maps in Tshwane, in the late 90s, you realize that much of Hatfield was suburban and the University was just there. Over time, from the 2000s, then they started redeveloping the suburban properties and putting in student housing. They're bringing a lot of student housing, which is expensive.
Remember the intervention of BRT was to solve an apartheid spatial crisis, but when you have a situation where along the corridor by which you have prioritized, say, Lynnwood, you realize now that, okay, the majority of the developments in this area, because this is prime land, are not targeting your mixing in terms of income categories. They're just high-end accommodations, you know, even for students, you know, most students can't afford the prices there. For example, I'm working, but I can't afford any accommodation along Lynnwood Rd.
So, what is the point of having the BRT service on the ground here when it is neither providing access to jobs nor supporting the land use activity around it? Yes, densification is happening, but it is happening for other people for other reasons.
So, the government and planners get a different idea in terms of transportation planning versus land use planning. You know which one follows the other, you know? Which one is the head, which one is the tail, and when does the head start biting the tail is another question? So, by that, I mean when does land use activities start capitalizing from the intervention of transport planning? I think this may be a case where, because the land use alongside these corridors is not necessarily always compatible, you get a problem. If you look at student housing, how much do the students need to use the BRT bus, for example, you know very little. They don't normally use the BRT bus service.

The bus service that they use, if ever, is the Gautrain Bus Service, which they use for other reasons. Now, if you're speaking about A Re Yeng BRT service, who uses it? It's typically workers of the university; it's typically workers who work in the service industry here in Hatfield. They take the BRT bus and go to CBD and then from CBD, and then they take a taxi to Mamelodi. You see what I'm saying, or to Soshanguve or whatever?
It's such a difficult thing, man. Then the question says, you know, does the action of retrofitting land use end up benefiting or causing a reaction in the utility of the A Re Yeng bus service? Maybe not, because…again, you're trying to answer very difficult questions, again about how these transport planners saw the potential of what was happening in Curitiba and why that worked versus what they thought could work in South Africa.
Another difficulty here…the taxis, now we have Ubers, which makes it a lot more difficult, for people to use the BRT service. And safety is a concern. So, if you're gonna have a bus service and say you're trying to fix and sort out this broken spatial structure problem, then mobility needs of the community also to be geared towards that kind of intervention for maximum potential. Some stakeholders proposed and said that the service needs to be free then, you need to make the movement free. But then how do you make that plausible and possible? You know, there's no free lunch. You know someone is gonna have to pay. So then do you raise the rates and taxes of the city and all those questions, which becomes a very, very difficult thing? Those who do not use the service end up paying for it and all of that you know. But I'm just trying to point out that I don't think the question is as clear-cut in terms of the connection between land use and the BRT. What is happening in Tshwane is the BRT is all around areas that are experiencing or have high economic development like Hatfield connecting to the CBD.
Then you ask, so where do people live? You know who uses the bus is another question. Would you ever see a rich person using a bus? Yes, they do, but those who use a bus typically use the Gautrain and get off from the Gautrain station to the Gautrain bus service. Do you see what I'm saying? So, they don't use it because A Re Yeng is less predictable than the Gautrain bus.
I'm speaking a lot and giving a lecture so maybe I should just stop right there.

Researcher: I think I've let you speakers well without interrupting because you have preempted some of my follow-up questions. Just so I'm clear and to be more specific to Hatfield, what land use changes have you observed inside the node, and what role do you think the A Re Yeng BRT service is playing as a catalyst in those land use changes?
Academ1: Yeah, maybe just to be more specific to your question, the land use changes scene. Previously I was told that there used to be a place called The Square where students went and had a good time on a Monday. But then again, because the University of Pretoria owns that much land, they just bought the businesses that were there, and then they put in student accommodation. Alright, so the biggest driver of development land use development in Hatfield is the University of Pretoria.
Yeah, we have an accommodation crisis. We need to get more accommodation so that we can accommodate more students who are coming in, that's what I think is driving it. So, I wouldn't say that the A Re Yeng BRT is a catalyst for anything related to that matter.
But even, A Re Yeng, has a constraint I would imagine, because there's a road we call Burnett Street. It is the most active short piece of a street that we have in Hatfield, but it is one way, especially where it is most active around The Square. Even though the A Re Yeng bus service does travel there, it can only do so one way. So, the function then, when asked some of the transport engineers have said that it would be a bit of an impossibility to make it a two-way street because of some code that exists.
But you ask yourself about the functioning utility of a street, you know of a BRT corridor. It's an activity corridor; it's not just a place where buses stop and go and drop off people. If there's an activity that happens then you want to ensure that you harness it and you make sure that you get the most benefit out of that activity that occurs along that strip.

So, I see A Re Yeng following the patterns and trends dictated by the kinds of land use developments that are happening, not necessarily that it is a catalyst to a particular kind of language change. You know, I have not seen it ever since I got here.
So, they tried to follow the fashions and see where people are and then you know, use that route for the BRT, but even then, they are still being beaten in my view, by the Gautrain bus service. I think that service is used a lot more and you know but used by people who work in the university and the government buildings and all of those places. So, I think it's a missed opportunity by the city. You know, it means that there was an opportunity for them to enter that space and take a leading role, but because they left the gap in the markets, then you know a private player entered that space.

Researcher: Are there any nodes in South Africa where you feel TOD using BRT is being executed particularly well?
Academ 1: No, no, I think it's a dismal failure. I mean, if you look at the City of Johannesburg, I don't think they've ever used leveraged those stations that they built there. They look quite beautiful, but you know I've never seen them being used for more than just for transport.
I haven't seen it in Cape Town, but mostly in South Africa, I don't think it works.

Researcher: Where do you think the disconnect is coming from?

Academ 1: So, I'm gonna be very biased, you're gonna have to forgive me. I think it's laziness to move out of the thinking in the 90s, which was influenced again by what was happening in Brazil, Curitiba, and the success of their people. I think we misread what was happening in Curitiba and what was the cause of the success of those engineers there.
This success was not its BRT system, you get me, the success was something else. The success was the function of the city. How do we retrofit the functioning of a city? How do we make sure that in our building codes, the distance between a building and the property edge is determined and it's an X number of meters? That we're not going to allow vehicles to drive along this piece of strip, that it's just going to be purely buses.
You see all those interventions led to what we saw in Curitiba in the 80s, and not just that, not just the design and the infrastructure, it was also the type of leadership that is required to make these things work.
You see? So, it's not just something that you can copy-paste and put in every Spatial Development Framework as you will rightly point out, it requires a lot more work to make it work. I do believe that where we are in South Africa now, it is a costly intervention that is unnecessary because it doesn't want to address the serious problem. The serious problem is the apartheid spatial structure. What TOD does; is maintain the structure as it is.
Think about it. So, if you if you remove the TOD then you will be stuck with apartheid 101 again. How do we solve it? Do you see what I'm saying?
So, the question even from the user's perspective, the question is not about how I move from point A to point B. The deeper question is how we heal the wounds of the old settlement typology and we do not do so through transport. Everything is telling us that, Hatfield is a prime example of that.
So, then it means for you to make the city work, for you to address the undying special logic, you need to address the prime and first vision which is designing a city for the car. Then you know you need to start thinking about what you design, for post-apartheid for people.
What does that mean? Don't people drive cars...and then what is the car?
Further, the location of opportunity changes quite a lot more still, and wherever this future leads us is gonna look drastically different. So, if you're gonna propose again and say we need to make our BRT service work, well you're gonna need to provide a proper, enviable plan and way by which that can happen, you know, and thinking about where the future is going.

But I'm just, you know, hesitant to go down that path again because it's gonna be too costly and it's, it's everyone's question whether that can work and whether everyone is an appetite to afford, you know, whether such a service is of benefit and use of value to the city.

Researcher: Alright I hear you; I think we have covered what I wanted to ask you, thank you once again for making time to answer my questions and provide your insight.

Academ 1: Right, I'm glad that I'm glad that you know to be of some service.

Interview Transcript – Academ2

Researcher: My research is looking at the use of BRT service as a stimulant for land use change. It follows the literature which states that because BRT mimics rail, it can also adopt the characteristics of stimulating associated land use changes. Does this make sense?
Academ2: Yes, it's worth appraising. It almost sounds like you are appraising the promises of the intermodal mass transit system and if it has translated into this so-called stimulation of land use change or intensification of land use change along this infrastructure.

Researcher: Yes, correct.
Academ 2: Yeah, it's worth reviewing. And if I have to say upfront, I will say no, it hasn't happened in South Africa. The initial work has been done, but in my assessment, it hasn't happened, and I think we can get into that.

Researcher: What did you think is hindering it from happening because they're speaking about it so prominently? And if you look at Johannesburg, for example, they've got themes like the corridors or freedom between BRT stations, transit-oriented development is detailed in spatial development frameworks of today, so where do you think the disconnect is coming in?
Academ2: There are various levels to this problem, and you would have to break it down into specific contexts. For example, you are looking at the BRT, if you look at those stations, those stations are buy and large and located in an area where within its immediate surroundings you can't do much because the space is already restricted. It's surrounded by your you know old style housing product or housing infrastructure that has been there for years. They are not necessarily located in an area where you can intensify the land use changes. So, for you to intensify that land use, you must buy people out. You have to give people a choice whether you can buy them out, and you can't just buy one person out. So that's why those stations have just remained transport infrastructure and that is it today.
The other dimension in the Township that you must understand, is that townships were never developed in a way that they provided what you would call both economic and social life to its inhabitants. I'll try and explain what I mean by that. You, who is a typical middle-class person, if let's say you work in Rosebank, your connectivity to home is so expansive. It's so widely available that you can afford to do hop and hop, and on and off, on and off on a public transport system, as long as it can ultimately take you home. For a typical person in Soweto, those options do not exist because why?
For example, if you are coming from, let's say Senaone and Tshiawelo, and you are working in Randburg or Fourways, the amount of time it takes for you to get from point A to point B is so much that you have got no time anymore to be wasting it on, hoping on and off you know, to socialize here and there to have to grab a cup of coffee here to go and shop into this shop, you simply do not have time. A typical BRT user doesn't have the luxury of time.
You leave home at 4:00 AM, you come back at 7:00 PM. But a person who stays in Fourways for example, you can take a BRT from Rosebank and you get off at Rivonia you do what you're doing, you catch another one and you go to Fourways. This space and time allow you to do all those things, but the person who is on the periphery and uses the BRT doesn't have that luxury of time. That's why the infrastructure has remained the same. That is why this infrastructure has remained so monofunctional, they just become transport infrastructure and that is it.

Researcher: What about a concern where our planning departments don't have the right skills internally to implement the strategy of TOD?
Academ 2: I don't think it's a problem. When there is no skill, when the private sector sees the opportunity it will go for it, and it will deploy its own skills. That leads me to this specific area where I

think the problem lies, the problem lies with the institutional weakness that is there, both in local government and transit itself.
This institutional weakness is to not see, and maybe broadly speak to the skills issue, to not see and leverage the marriage between the infrastructure agents that are there. This is to say how can we partner together with local government and BRT, which is an agency of government, to make further investments and leverage this BRT investment to diversify you know the opportunities around those areas.
I think that is where the problem is, so it's not so much the skill as a technical skill to interpret the plans and make them operationalized, because the private sector can do that. Why are government institutions not coming together to see these opportunities and leverage them?
If you look at Gautrain, in Marlboro or your Midrand is one of the dullest stations you'll ever find yet it's located closer to one of the most vibrant middle-class segments in the country. I can't even meet my friends there to have coffee. Why doesn't Midrand have the diversification of land uses around it doesn't make sense.

Researcher: Thank you, and If I were to then look at Hatfield specifically, have you noticed any land use changes that have occurred since the introduction of the A Re Yeng BRT service?
Academ2: Yes I have but the problem with Hatfield is that it's not a place where one can simply just speculate, and I'll tell you why. It has characteristics that few other places do not have, and therefore one needs to be careful in terms of whether you can attribute those changes to the public transit system alone.
You cannot, and let me tell you why, Hatfield exhibits certain characteristics that many other stations do not have. You know what that is? Hatfield is a student town, and it's already very dense. I don't know any other station that has a university precinct around it. Now with that alone, you cannot only attribute the land use changes to the investment in BRT.
And the other thing that has come up in the last 10 years is that they have had a huge investment in student accommodation, there are also offices and Hatfield Plaza already. That is what I'm saying, Hatfield has characteristics that cannot allow you to speculate. In that sense, you cannot attribute it only to BRT.
I studied at the University of Pretoria myself many years ago and certainly, Hatfield has seen changes. But again, those changes cannot only be easily attributed to one factor.
Researcher: Alright I got you. Thank you once again for taking the time to answer my questions. I highly appreciate it.
Academ 2: No problem

Interview Transcript – HCID

Researcher: How long have you been with the CID?
HCID: I'm just about seven years old now.

Researcher: Alright. And then what are the geographical limitations of the CID?
HCID: All right, so we are an area of about 2 kilometers, about 2 kilometers in and around the University of Pretoria, the main campus. There's the University of Tourism's Main campus and then the CBD area of Hatfield as well. So, the boundaries stretch right up to Francis Baard St in the North, then it comes down past the train station right up into Harold, right down into Lynnwood, back into the university.
Researcher: 3. Does the CID have a view into the building land use applications that get submitted to the City of Tshwane which specifically lie within the Hatfield Node?

HCID: No, not at all. The only thing that we've done is a precinct plan for Hatfield. And in this precinct plan, there's a, there's a lot of stuff that we talk about. How do we see things develop and the kind of image that we want to create? Transport systems are probably one of the trickiest things that we had to deal with because in our experience, transport engineers…they are a different bunch. I tell you what, every one of them has got a different opinion, all right.
The councilor would have sanctioned our report a long time ago, but the Transport Department has again come back and said that some of the projects that we are proposing are not supported. It's the likes of building some connections, east/west, north/south connections which will alleviate traffic congestion in a big, big, big way.
Then there was another suggestion around Park Street, also a bridge over the railway line, but the traffic engineers are saying to us, if you consider the financial situation of the City of Tshwane at the moment, we'll never get the money for that. So, they recommend that go and look for smaller projects that will bring solutions in the short term, which we will look at. Examples of that would be looking at a solution for taxi drop-and-go areas in Hatfield. Alright, so that's a very practical thing. It's something that we've worked on that we're with the taxi associations already and they like it.
Then there was, out of University Road, actually out of Bennett St when you turn right into Festival Street, that causes a lot of congestion. So, they're proposing that it should only be a left turn so that we take the traffic out of the area so that we can do traffic calming and also reduce the noise pollution in and around the residences.
I'm happy to talk about the practical stuff that will make a difference in the people of Hatfield immediately. So, we're going to revisit that thing with our consultants.
In saying this, you have to understand that we are looking at a 50-year view, and it's good to have a long-term view and a long-term vision to create sustainability.

Researcher: Yeah. Yeah. Since you've been with the CID, have you noticed any changes to how parcels of land are used in Hatfield Node? - If yes, to what extent would you attribute those land use changes to the introduction of the A Re Yeng BRT service?

HCID: Yes, I have absolutely. One of the things that happened in quite a significant way in and around the University is that a lot of land was bought up and student residential properties were put up. So much so that we have about 15,000 students now staying in private residences, so that was a significant move in terms of land use, which also brought a lot of densification into the area.
So, definitely a move towards privately owned student residential land use with almost all of them having a small element of retail. Sort of ground floor retail and then student accommodation upstairs. I don't know how successful that is because you know if I'm a student and I wanna study and there's a club at the bottom on the 1st floor, I don't know if I'm going to be happy with that music in my ears all the time, you know?

So, one of the things that we're saying to people who develop properties in our areas is how are you going to deal with soundproofing and that sort of stuff to ensure that students get a fair chance to pass, you know? Yeah, so I did the calculation the other day, the densification that happened in Hatfield over the last five years….more than 700%.
There are seven times more people, seven times more people in Hatfield than there were five years ago, 700% I promise you. So, you can imagine just from urban management and a safety and security perspective what the challenge is.
Researcher: Those land use changes that you're speaking of, to what extent would you attribute those to the presence of the BRT service?

HCID: Alright. So let me say this. I don't think that Hatfield has harnessed the potential of having a BRT or Gautrain station yet. I know that developers are looking at doing some developments to the North, but it's in the planning Phase. I think we're lagging from that perspective. If I look at what's happening in Sandton and what's happened in Rosebank, they have jumped on it to harness what is happening with that opportunity.
The A Re Yeng service and its potential have been downplayed in Hatfield. Honestly, I must be honest with you, so much so that we've asked the University professor to look at an integrated public transport solution for us in Hatfield. For instance, we all get annoyed with taxis when they don't stop at the red lights because we think they are going to kill people. But we can find a system that all the left lanes are public transport lanes for instance.

Researcher: It's quite interesting that you are having those conversations about leveraging the presence of transit services. So, it's also something I wanted to ask you how familiar you are with the concept of transit-oriented development?

HCID: Transport services are one of the things that we have delved into when we did the precinct plan. One of the recommendations about the precinct plan is that we need to create a transit or a transport node in that field that combines all parts, and all kinds of transport. So, if we say how transit will be the central piece of it, can we link taxis to that? Can we link buses onto that and any other related transport mechanisms? One of the big things that we're looking at is non-motorized transport. If you consider that we are a student suburb, and a lot of people are walking all right.

But, if you look at Hatfield the development now has been done for cars and not for people, and if you think about it from a planning perspective, I think we have done it the wrong way around. We didn't have the foresight to say guys, but you know, they'll come to a point that there is going to be so many people that they should walk and that we give preference in the planning phases that you know, walkways are more important than roads.

But we yeah, these people get very upset when you talk about these things, but it's a reality.
Well, like all, all use Taxis as an example, everybody thought taxis would be a nuisance that would go away over time. More than 70% of the population uses taxis. We don't have drop-and-go zones in Hatfield. We currently talking about it, yes we are. But to convince the Transport Department that we need to take up some part of the road reserve and build 8 to 10 drop-and-go areas so that we can manage the noise pollution and flow more effectively…so that is something easy for transport engineers to understand. I just think that sometimes we are out of feeling and out of sync with the reality of the environment. We need to look at the characteristics of the environment and then design the road systems and traffic systems around that making it as safe and convenient as possible.

Researcher: If you look at Hatfield CBD for example, is already a very dense area with a whole mixture of users. So, is it now a case of more retrofitting accessibility into Hatfield that needs to be done?

HCID: I think so and I think…I mean Jan Shoba Street is our main artery that's the North-South connection, but there's no East-West connection. It is not congruent and does not support accessibility, and there's a lot of talk now. A lot of noise and very little to do.

Researcher: Like it's perfect in planning?
HCID: Yeah it looks good on plan, but we need action.

Researcher: What would you say is the primary draw card of property owners and businesses who come to be in Hatfield?
HCID: I think the University of Pretoria. I think that's the anchor institution by far. You know, 55,000 students and the top five universities in South Africa. From a property value escalation perspective, your property value will go up in Hatfield because students aren't going to go away. University is not going to go away. The need for education I education is not going to go away. And if you look at the way that we manage it and look at it, the chances of you, you are making money on your property over time…the probability of that's very good.
Looks like everybody's jumping on this bandwagon of student accommodation. I think a weakness from a land use perspective is young families, the need for young families. I'll give you an example of why I'm saying this. So, the proximity to the train is very important, but do you know that the sports campus of the University of Pretoria is the best in Africa? Based on sports campuses in Africa the Europeans all come in their winter season come here to train. There's a high-performance center at the University of Pretoria that is for sure a draw card. So, what we're saying is I think there's an opportunity for that kind of thing.

Researcher: If I were to ask you, using a rating from 1 to 10, with 1 being not important and 10 being extremely important, how would you rate the presence of the following in Hatfield;

1. Presence of the University

HCID: That's a 10, 11, or 12… it's more!

2. Presence of Gautrain

HCID: Absolute 10.

3. Presence of A Re Yeng BRT

HCID: I would say 6.

4. Mixture of users / Dense environment.

HCID: The mixture of land use, I think, is critically important in Hatfield. I would say 8 or 9.

Researcher: If I asked you to imagine that the A Re Yeng BRT service was not available in this location, what impact would that have on the accessibility of the node?

HCID: I don't think so at all, Taxes are applying for are far bigger role. I don't think it would have a big impact whatsoever.

Interview Transcript – PropDev2

Researcher: Concerning your property currently being developed in Hatfield, what were some motivations and or considerations that led you to develop in that location?
PropDev2: There aren't a lot of properties around the university currently. We spent some time with the previous owner, and it was in close proximity to the University. I think it is around 700 to 800m from the main campus gate. So obviously our main driver was the University as we are building student accommodation. And then of course the price of the acquisition of the piece of land was another.
The way the structure of the building is set up currently it facilitates a student accommodation. You have a couple of various avenues in terms of redeveloping a current building, it's a donut shape with light coming from the ATM inside. So, I think the building facilitates the student document accommodation very well.

Researcher: There is a BRT station just outside your building, did proximity to the BRT station play a role whatsoever in making the location decision?
PropDev2: Might be a 1% role, but not that much. We didn't take cognizance of that BRT route. It became apparent when we were there that the bus route was just around the corner. I did not have an effect on us purchasing the building.

Researcher: Alright I see. I ask because that is the angle that my research is focusing on, proximity to transit being a catalyst for land use change. Are you familiar with the concept of transit-oriented development?
PropDev2: No, not that much. Our focus was the student accommodation. The majority of our students are NFSAS students who don't own a car. So, walking distance to the varsity is very important for us, and I think the students as well. You know, they can't afford to spend transport money to go from where they stay. There are a lot of students who need accommodation, and I mean, if they have accommodation that's within 800 to max, maybe 900 meters away from varsity, that's the sweet spot.

Researcher: One last question, what other land use changes have you personally seen taking place in the area?
PropDev2: Look, there's a lot of student accommodation that is currently developed in the area, high-rise buildings, so that location was chosen because of the University. Most are converting to student accommodation. And I think when the whole NSFAS movement was on free education, and well not free education but giving opportunities for the previously disadvantaged community. That fund that has been developed by the government facilitates this, I think a lot of developers are identifying student housing opportunities around the varsity.

Interview Transcript – PropDev1

Researcher: How familiar are you with the concept of Transit-oriented Development?
PropDev1: This is my first time hearing about it from you. I couldn't make a mistake and say I've heard it before because it makes sense. It intuitively makes sense, right? But definitely a first as a development strategy or a concept.
When I was a property development manager, we didn't consider it as a strategy, though you know the market research studies that we commission would look at transport nodes in terms of how close our property is to a major transport node, and even those that feed that transit node, etc. We would look at such things yeah.

Researcher: For your project, did the proximity to the transit station influence the location decision?
Prod Dev1: Our tenant there is the Department of Labour, and they wanted to create a one-stop shop with the UIF Compensation Fund because they complement each other in those departments. The clients that those departments are serving are your ordinary people. In front of the site is a feeder taxi rank which takes people from there to a major transport node, so that is already a plus because the clients would have a way to get to the facility. So, what we did as part of the development team, was to try and engulf this taxi rank and make it bigger, renovate it, and make it look like it was a part of our development. That's as far as we went in terms of considering a transit node. It just so happened coincidentally that the piece of land had the BRT station just outside, so the transit station was not considered as anything, as a stimulant, to develop.
Once we started looking at the profile of the people who will be using our facility, it then clicked that we were in the right place.

Researcher: I see, understood. If I were to ask you what your thoughts are generally on BRT being used as a catalyst for land use change from a developer perspective, what would you say?
PropDev1: When I think of BRT I have a picture of it within a city already, running around, but it makes sense that on its route, if there are stations there, it would make sense to bring people closer and develop around those stations. I can see how it can make sense and how for example if it's closer to a residential development, it can spur some sort of demand.
People might be coming from rural areas and migrating into the city. They are not going to live in the rural areas, they are going to live in the outskirts, so along that route in can see it developing and stimulating land use changes.

Researcher: I see, understood. Is there anything else maybe on the topic that you would like to add?
PropDev1: It's an interesting concept, if you look at the work we are doing in Dubai now along the monorail, there's a green line and a red line. It was retrofitted and built at the same time as the city. But around those stations here in Dubai, you have a lot of properties, activities, residential around…but as soon as you sort of go more inland and away from the transit station then there's less and less and less development going on and that's why I think now they are planning a new line to go more inland and I'm sure there will be more development inland around those nodes, they going to be developing around those nodes as well or maybe that line going inland will pass will sort of retrofit itself passing already developed communities and you know.
You know obviously that MyCity also started in the Cape Town CBD, right? And then it you know; it grew and grew and grew. I wonder because it was, it was going into developed routes already. I wonder if some routes, which were you know sort of less developed areas, I wonder if it's sparked anything there. I mean on routes that were less developed, it'll be interesting to see what has happened.

Researcher: Yes that is very true. Thank you very much for your time and for participating in the research, I appreciate your assistance.

Interview Transcript – PropVal

Researcher: How familiar are you with the concept of Transit-oriented Development?
PropVal: I have heard about it Yes. Let me give you some of the findings from the research that I did. BRT is in the metros, and it creates havoc with traffic flow simply because you don't have the cross-flow across from one side to the other. Either gotta go around the block and then take the next lane next to the BRT on that side, or be on this side, or be willing to drive a four-by-four over the hump. And you're going to measure again, we have to look at what came first, the BRT or the change of land use in the CBD, you know, the CBD standing vacant that converted, converted more and more old B&C grade offices into residential accommodation and they obviously started at the convenient places being along the BRT routes and then branched out there from there.
So, the BRT corridor development has been part of the part of the catalytic yeah process to change the landform or give an alternate use to the properties around it.
OK, so you will see properties where we have small retail on the ground floor and residential accommodation on the upper floors, I mean that you can go into the CBD anywhere and take a photograph in any block around a BRT route, you're going to find that and that's the positive view. OK, the negative view is on the traffic flow. Alright, I mean that's a given. What I have found in Pretoria, I don't know if you are familiar with the development of Rainbow Junction.

Researcher: Yes I am, in Pretoria
PropVal: Yes, that BRT route extension to the Annlin area, that route has prompted change the developers to buy a plan for residential development in and around that area over there, and the positive is that land the increase in land value went from R500 a square meter to R700 a square meter, an increase of circa R150 to R200 per square meter so it increased the desirability and developable demand in that area, so that's a positive.
Ekurhuleni has done a Bus Route by the golf course in Kempton Park, and that's a prime example of a negative effect. Ekuhuleni doesn't have buses, so the route is now being used by informal taxis and the like. But because of the barrier on the road, the Engen filling station has halved its output because half of the traffic can't get there now without going around.
Residents living in that area are up in arms because, the traffic flow has been reduced by two lanes, one on either side and they're now congested, and cannot get out of their suburbs easily.
Guys will be slotting to say time to move time to get out of here because simply it's unsustainable to try and drive out of the areas and get into the workplace from there. Residents are saying "Time to move", "Time to get out of here" because it is not sustainable to drive out of the area and go to work, etc.
So that's a negative effect, yeah.

Researcher: That is quite interesting because one of the reasons that the municipalities want to implement BRT service is because they want to get people out of their cars and use the bus service.
PropVal: Not, not in that note. So, as it's just very nodal, it's very it's almost like a case-by-case basis. You know, I've seen a lot of positives. I've got those in Cape Town along the fountains area over there where land use changes, across the road from the station, we use changes from offices to residential and people wanna be there. Businesses are booming and they are building student accommodation across the road from that station.
The units on Park on station in Cape Town where the whole node suddenly became more vibrant, if you go up Cape Town into up to green Market Square area where the BRT is there that's where they are putting social housing now even to develop to right next to the bus route so the guys can out of the house into the bus to my workplace you know so that's a positive development.

Researcher: So, I'm trying to see if BRT is the stimulant for the land use changes. Do you think those land use changes where still be there whether the BRT service was there or not?

PropVal: Look on the one hand I don't think the land use changes would have happened without the extension of the road and the infrastructure. That would not have happened. The catalyst was the expansion of the road, the mass of intersections being placed over there. Without that, that development would have been pushed back 15 to 20 years, so that one is a definite given. Cape Town on the one hand had a functional public transport system and I'm not talking about taxes and all that I'm talking about formal transport systems, so what we did see were conversions to higher-grade residential accommodation before the BRT was there.
Old Mutual has good flats over there selling R2, 3, 4 million whereas the residential units along Fountain there closer to R1million Rand you know for the more affordable housing and they came post to the BRT route being put in there.
So, the BRT route was initially installed, before the World Cup 2010 World Cup. But then when the World Cup left, that's when the development of some of those buildings that had been standing vacant for an extended period, started developing and started changing the use from B and C-grade offices to residential accommodation.
Here are positives but yeah, you're gonna have to weigh each one up, you know, on its own-on-own merit. I mean, if you look at Modderfontein, there were the Gautrain route runs, they've got the station earmarked, they've got the platforms built and ready to create a station, but nothing's happening in around it, so there's no, no development happening around, it's so there's no reason for them to put the station over there I valued that station in 2012 and that that platform was already there and you'd expect it in the last 12 years as the catalyst was there, it should have promoted development in that area. So, it's very, very nodal.

Researcher: Looking at Hatfield specifically, are you familiar with the land use changes in that node?
PropVal 1: Hatfield is a positive example of the demand for development. In and around the Gautrain station there's been quite a few developments taking place over there. We have a few clients who are developing high-density residential there, but no one can link those land use changes to the BRT service.
It's a case of a student saying "I wanna go to University, I don't have a car, Mom and Dad can only afford these flats over here, how am I gonna get to university" They will look at an alternate place where the is the convenience of me getting from here to there. Students need to get to University and walking is not an option, informal public transport is not an option so they will look to where formal public transport is an option.
Researcher: Alright I hear you. I think that's it. Thank you very much for your time.

Interview Transcript – TownPL

Researcher: How familiar you are with the concept of transit-oriented development?
TownPl: Umm, very familiar.

I've been working on transit-oriented development for the past 25 years, and various corridor studies throughout South Africa, mostly rail-based. We were also involved in the planning of the BRT routes, the initial alignment, and the identification of the routes for the city of Tshwane as well as Ekurhuleni.
And then I don't know whether you know about the built environment performance plan.
But in essence, these BRT routes were bought off a network that is intended to actually fulfill the national priority of spatial transformation inside South Africa, because that's why we have the BRT routes. The intention is that you should initiate land use change along those corridors and those routes and regulations, densification, etc.

I'm actually working on the Ekurhuleni Special development framework right at the moment, we've been appointed to that, and so transit-oriented development is exactly what we are doing.

And yeah, my office is here in Hatfield. The BRT runs one block to the South of my office. When I look out of my window, I see the street.
When the Tshwane BRT system was planned, we did the precinct plan for Hatfield, it was part of that study you know.

Researcher: Since the introduction of the BRT, what land use changes have you noticed happening in Hatfield, and in the vicinity of BRT station

TownPl: Well, not significant land use changes because the section of the BRT route running through Hatfield was already mostly office developments along the alignment up to the BRT station because it links into the Gautrain station. So, when the Gautrain was built, you know, some redevelopments took place in the immediately adjacent area.

But the BRT section running through Hatfield did not change because obviously I mean the office already existed along the route that was selected.

So, some of the offices are now changing into student accommodation because of the need for student accommodation. And what's very helpful is the fact that the city of Tshwane initiated the parking reduction policy. So, for any land use changes within 500 meters on both sides of the BRT route, they allow developers there a lower parking area ratio to the number of units than they would normally because the intention is to promote development redevelopment, and densification along the BRT route.
And the argument is, for instance, if you have 60 or 80 student units instead of 20 offices, you don't need to provide 60 or 80 parking lots, because if a student lives within walking distance from the BRT, he will have access to public transport which links him to all the major nodes of business and entertainment, etc in the city.
So that's one way of actually putting your money where your mouth is for the municipality to say, but we will as an incentive, we will allow a reduction in our requirements in terms of parking bays for developments along the corridor. Our office, some developers were interested in converting it into student units earlier this year, and so that was definitely seen as a huge benefit because they could fit in more units if they didn't need to reserve as much land for parking. But in the rest of Hatfield at the moment, not really based on the BRT because, as I say, it was already fairly intensively developed.

But from here to Menlyn, as you drive along Lynwood and then Atterbury Road, there's a lot of single residential units that are now being converted into townhouse complexes and flats three and four and five Storeys. The developers took on the benefits associated with the BRT route running through there and the relaxation in the parking requirements of the city of Tshwane.

So, there are a number of new developments along this section through Menlyn which happened over the past two 3-4 years, which I think is positive in terms of the BRT.

Researcher: I think with that you've just actually answered my next question because I was going to ask you how you see the BRT stimulating land use change.
TownPl: Yeah, I think it's important for the council to, it's not only about the BRT service, but I also mean the council needs to provide some incentives to the developers and something. So, what they could do is to say OK, we have a little bulk spare capacity for infrastructure. We reserve the bulk for developments within 500 meters, so they get priority in terms of allocation of bulk for instance. And then the other one like reduction in parking requirements. Initially when I made that proposal with the traffic engineers were not very happy because they liked to keep their standards in terms of parking requirements. But what I said to them was that you can't have your cake and eat… if you are serious about providing a public transport service that will be successful, then you must be able to lower your parking standards, which actually cater to private vehicles and the developer will take the risk. They were initially resistant but later then they accepted it, and they have a formal policy now where they allowed in significantly lower standards in terms of parking.
So that made a huge contribution towards residential densification along the section of the BRT Corridor.
Researcher: My next question was really about parking and traffic patterns, and I think you've just covered that as well.
TownPl: No, but that's a very important one, the parking requirements.
It's very also symbolic to show that the Council believes in public transport and therefore, they will forfeit one of the key requirements or relax it at least if you develop then within walking distance from the BRT route.
And that it's a very important one, that makes the difference between a viable and a nonviable project in many cases for developers.

Researcher: So, if I must ask you to give an importance rating from one to 10, right, one being not important and 10 being extremely important;
Presence of the university
TownPl: Well, Hatfield is about the university. It is 10
Presence of Gautrain Station.

TownPl: The presence of the Gautrain station is also very important - 8. Although it hasn't had the prominence of, for instance, the Sandton station, you know, but it's coming along gradually.
Most play a significant role further on in the future, and when office space is being sold it's a big selling point. The fact that you were within walking distance of the station, is a key element.

Researcher: Presence of the BRT station.

TownPl: The presence of the BRT at this stage, Is not as prominent as it should be, hopefully, it will enhance further in the future, but umm at the moment.
The role it plays in the broader Hatfield environment, I would say about the 6 at most, it's not as strong as it can be, but obviously, all of this is these are processes you don't just switch the switch on and off.

So, it takes time, it might take ten, 15, 20 years. And you know all the major nodes in Sandton and all of those developed throughout 50, 40 years. So the energy is just a little lower in Hatfield at this stage in terms of business, and you know the dominant trend right now is for student accommodation,

Researcher: And the presence of a mixture of uses?
TownPl: Hatfield used to be a residential area with the university. The residential component, in terms of single residential houses, is gradually being demolished and then redeveloped as student accommodation blocks. The commercial land use is mainly still consolidated in the Hatfield Shopping Center and along Burnett Street. So, Burnett Street is the major business street, and then also Jan Shoba Street, those are the true main activity spines in Hatfield with a mixture of land uses, while Arcadia Street is the BRT route, which is just one block away to the north.

Researcher: And then hypothetically, if I were to ask you to imagine that the BRT service was not available in Hatfield, what impact do you think that would have on the node?

TownPl: At this stage, at this stage, not much. It's in the infant stage.
Unfortunately, the city of Tshwane lost a large part of its bus market over the years, unfortunately, the bus and the train, lost to the taxi market. But it's a countrywide issue. I mean, the trains made the biggest loss, but even, even the bus service. When I compare it to when I started working to how full the busses were compared to now, gradually people just moved away to alternatives because of poor service reliability. Whether the bus will end up at the same time and then you have strikes from time to time and like just don't, don't drive.

So, there's a lot to be done to improve and to convince the public again that it's a reliable service and then for people to come back to using public transport, unfortunately, that's how things have fiddled out over the past 15,20 years, we still work on hope.
I was in Europe about a month ago, and when I came back, I said to my daughter I saw everything that I've been proposing in the reports being implemented overseas. I saw that what we preach here is correct, technically it's correct, It's the implementation that we are struggling with in South Africa.

The theory is 100% correct, I saw there how seamless integration between different modes of transport bus, taxis, trains, and trams could work, and I saw the impact of such a system being efficient on land uses.

I actually took some nice photographs to show the linear development of three stories four stories walk-up residential units all along these priority public transport routes and how it impacted the land use response. The transport route needs to be in, and it needs to be successful and convenient, and then reliable, and then the land uses change gradually. Intensifies all along, but if it's not reliable, you know the land uses won't respond, so it's important to put the infrastructure in place and get the service running and operational, and gradually land uses will change over time as the public gains confidence in the reliability and the permanence of the public transport service along that route.
Researcher: Yeah, it's a similar theme I'm finding as well when I'm reading the literature, you know, so yeah, you just echoing that as well.

Thank you, I appreciate your time.