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The Impact of Rail Transit Stations on Commercial Real Estate Property Values: Case Study of the PRASA Rail Station in Jeppestown

RESEARCH REPORT

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The Impact of Rail Transit Stations on Commercial Real Estate Property Value: Case Study of the PRASA Rail Station in Jeppestown

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Supervised by Dr Aly Karam

Declaration

I declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Science to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

……Lesley Takunda Mashiri ……

(Signature of Candidate)

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ABSTRACT:

As cities continue to experience rapid urban growth there are opportunities which exist in linking transport planning with dynamic land uses within the city. The main planning approach which stands out in achieving this is transit-oriented development planning. This form of planning is essential as it connects people with services and employment opportunities located in cities and urban areas. Transit-oriented development of a higher quality has the potential to generate revenue which can be used to improve the quality in transit-oriented systems and ultimately boost economic growth and development. Inclusive to this statement is the idea that transit systems are associated with societal benefits; congestion relief, social equity improvement, reductions in dangerous gas emissions and economic development. This study explores the importance of TOD and especially the prescribed linkages between proximity to a railway station and the influence this has on nearby commercial property prices. The study discusses the possible effects of other amenities found around close to the commercial properties and determines. The aim being to find out if these other amenities also have an impact on commercial property values in the study area. This is done through unpacking relatable discourse associated with transit-oriented development and through a research process which investigates whether there are other factors influencing commercial property values around the railway station in Jeppestown. The study will contribute towards the broader body of literature around TOD nodes, rail transit stations and commercial property values by providing empirical evidence provided by a quantitative study. The study uses multiple regression models to determine whether commercial property values are influenced by their proximity to a railway station or by other factors. It was initially expected that proximity would have an impact on commercial property values, but at the same time there was an argument for other factors and conditions located nearby to the commercial properties having an influence too. The empirical evidence collected showed that the proximity to the railway station was not statistically significant. The determinants of commercial property value which were significant were distance to school's property age, retail, industrial and unidentified property. The limited impact of a railway station on commercial property value has been discussed in the analysis section of this thesis. The discussion has shed some light on the gaps associated with the way in which railway stations relate to commercial real estate property values in Metropolitan cities, across the developing world and beyond. The findings of the study will contribute towards better transit oriented development policies to be formulated as well as a better understanding of how public sector investments can help create value for properties.

Key Terms: Bus Rapid Transit System (BRT), Commercial Property, Transit Oriented Development (TOD), Public Transport, National Development Plan (NDP), Urbanisation

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Abbreviation	Meaning
BART	Bay Area Rapid Transit
BRT	Bus Rapid Transit System
BRICS	Brazil, Russia, India, China, South Africa
CBD	Central business district
CPTED	Crime Prevention through Environmental Design
DoT	Department of Transport
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GNP	Gross National Product
IDP	Integrated Development Plan
JDA	Johannesburg Development Agency
Ltd	Limited
MARTA	Metropolitan Atlanta Rapid Transit
MRM	Multiple Regression Models
NLTTA	National Land Transport Transition Act
NDP	National Development Plan
NPV	Net Present Value
OLS	Ordinary Least Squares Regression
PRASA	Passenger Rail Authority of South Africa
PVT	Private
SACN	South African Cities Network
SOEs	State Owned Entities
SPLUMA Act	Spatial Planning and Land Use Management Act
UK	United Kingdom
USA	United States of America

List of Terms

Term	Definition
Agglomeration	A local economy in which several companies, services, and industries exist in close to one another in order to benefit from the cost reductions and gains in efficiency that result from this proximity.
Auto-transit	The use of automobiles to get from place to place
Commercial Property	Real estate property that is used for business activities
Disinvestment	To sell off certain assets such as a manufacturing plant, a division or subsidiary, or product line. Disinvestment is sometimes described as the opposite of capital expenditures.
Externalities	A consequence of an industrial or commercial activity which affects other parties without this being reflected in market prices, such as the pollination of surrounding crops by bees kept for honey.
Empirical Evidence	Information received by means of the senses, particularly by observation and documentation of patterns and behaviour through experimentation.
Hedonic Regression	This is a method used in economics to determine the relative importance of the variables which affect the price of a good or service.
Income capitalisation	Type of real estate appraisal method that allows investors to estimate the value of a property by taking the net operating income of the rent collected and dividing it by the capitalization rate.
Land value creation	Dynamics and processes done on land to increase its value
Periphery	The outer limits or edge of an area
Proximity	Nearness in space, time, or relationship.

Public infrastructure	A term for the basic physical systems of a business or nation — transportation, communication, sewage, water and electric systems
Real estate	Property consisting of land or buildings
Regression	A measure of the relation between the mean value of one variable (e.g. output) and corresponding values of other variables (e.g. time and cost)
Regional Node	Functional areas including the hinterland of a city and the peri-urban-areas with flexible borders depending on local and regional developments
Transit	This is when people are travelling or being taken from one place to another.
Services	A system supplying a public need such as transport, communications, or utilities such as electricity and water
Spatial Constraints	Limitations relating to space
Suburbanisation	The outward growth of urban development which may engulf surrounding villages and towns into a larger urban agglomeration.
Sustainable Urbanism	A form of urban planning that aims to reduce consumption, waste and harmful impacts on people and place while enhancing the overall wellbeing of both people and place.
Sprawling	Spreading out over a large area in an untidy or irregular way
Urban Regeneration	The attempt to reverse that decline by both improving the physical structure, and, more importantly and elusively, the economy of those areas
Value Capture	The process of retaining some percentage of the value provided in every Transaction.
Zoning	Areas of land are divided by appropriate authorities into zones within which various uses are permitted.

Chapter 1: Impact of Railway Stations on Commercial Property prices

1.1 Introduction

The link between rail transit and the urban property market is a significant basis for transit-based development planning yet very few studies have informed on the impact that proximity to railway stations has on commercial property value (Xu, 2016). Railway stations operate as nodes in both transport networks and places in urban environments. The authors (Li and Zhong, 2016) mention that railway transit systems provide access and environmental benefits such as congestion relief, social equity improvement, general improvement of the urban realm and reductions in harmful gas emissions, which contribute to increasing property value (Li, 2016).

Previous studies on the impact of railway stations on commercial property values have been mixed with regards to the magnitude and direction (Fatima Beg, 2014). The findings from these studies indicate that the results range from significant positive or negative effects to even insignificant effects (Debrezion et al, 2003). Based on their findings Debrezion et al (2003) mention that commercial property values enjoy a greater positive impact when situated in proximity to railway stations compared to when situated in proximity to residential properties.

Investing in rail infrastructure has been expected to promote a compact urban structure by providing access to economic opportunities; however previous attempts to determine how this access can be accounted on the form transport costs have been narrow (Debrezion et al ,2003). This study aims to provide more insight on the relationship between the location of railway stations and commercial property values, with an emphasis on retail, office and industrial real estate properties. The bulk of the argument will be constructed through engaging with the literature on commercial property values and literature on the impact of proximity to railway stations.

In previous research it has been argued that commercial properties benefit from accessibility benefits associated with being close to a railway station (Dai, 2014). In other words, there should be some added value for commercial properties located close to railway stations based on the accessibility benefits which come from this relationship (Li, 2016). The literature review will help explain this argument further. The findings and analysis sections will determine whether this is the case with the Jeppestown railway station. The following section of the report gives a background to the Johannesburg inner-city as well as TOD in terms of its origins and policy implications for Johannesburg as a city.

Although the TOD concept is broad and covers both bus and rail this study mainly focused on railway stations. The study has been designed to rationalise a context for TOD and the impact of railway stations on property values in Johannesburg. This is necessary to give the study a point of departure and a basis for the research problem and rationale.

1.2 Background

Similar to other rapidly growing urban agglomerations forces of de-industrialization, decentralization and suburban sprawl have largely reconfigured the urban landscape of the greater Johannesburg Metropolitan area (Dawjee, 2015). This has resulted in the city becoming vast, disjointed and without clearly marked boundaries for its neighbourhoods (Beavon, 2001). The disjointedness provides a challenge for integration of transport systems, which affects people's access to economic opportunities.

The historic downtown core of Johannesburg has been losing its charm as the preferred location for corporate facilities, upscale entertainment spots and high-end retail commerce, catering for affluent customers (Beavon, 2001). This urban decay did not take place overnight; it began during the mid-70s. This was during what was termed "white capital flight" which accelerated during the 1980s and reached a crisis point during the early 1990s (Beavon, 2001). Fight of white capital is the process in which white-owned businesses in the inner-city traded their premises for new facilities close to urbanizing growth points in the north of the city (Beavon, 2001). This process has enabled competitive economic nodes such as Sandton, Rosebank, and Midrand to grow immensely and absorb a large share of capital investments (Beavon 1997; Bremner 1999; Goga 2003; Lipman and Harris 1999, 731-733, Tomlinson 1999a)

The process of white capital flight has left formerly elegant high-rise buildings under-maintained after the owners shifted their capital towards the north (Christopher, 1999). This has caused rental rates for commercial properties to fall in the inner-city. This presented opportunities for enterprising newcomers to fill the void left after the white capital flight. Convenience stores and fast food outlets began to replace upscale restaurants and five-star hotels (Beavon, 2001). There was an increase in low-cost clothing shops run by Africans, Indians and Nigerian/Zambian/Somali foreigners who had arrived from neighbouring African countries. They began to pop up where once affluent customers used to come and purchase goods.

The previously marginalized groups, who were placed on the periphery during apartheid, also began to migrate back into the city (Beavon, 2001). They were seeking better employment opportunities and to be located closer to work so that they could reduce their expenditure on transport.

Given the increased pressure of housing backlogs in the city at the time, the new inner-city residents illegally seized abandoned buildings and warehouses, creating unsanitary living quarters (Beavon, 2001). Due to the lack of investment the living conditions in the inner-city were poor, and this made the city's image became worse. The buildings were marred by graffiti, trash, and broken glass (Schloss, 1993). Finally headlines in the press such as *City in Ruins*; *Entering a city of filth* and *Big Businesses lose out in CBD, have* not helped Johannesburg's image to investors either (Beavon, 2001).

Despite this the Johannesburg inner- city area has relatively remained very accessible to the population in general (Burroco, 2013). This access is an asset, such that the Municipality has been trying to address the disinvestment and urban decay which have occurred in the inner-city during the 1970s, 1980s and early 1990s. They have employed urban regeneration strategies and initiatives during the early 2000s in inner-city neighbourhoods such as Newtown, Braamfontein, and Jeppestown (Mashiri, 2017). These regeneration strategies have changed the perception of the inner-city and stimulating a renewed interest in inner-city real estate property investments, as well as the capitalization of rentals and property prices in the inner-city. There is an assumption that this can solve

the exclusive nature of the apartheid city legacy which is evident in the spatial development of Johannesburg (Burroco 2013).

In recent times the urban regeneration effort has been supported by a public transport strategy implemented by the City of Johannesburg. The democratically elected post-apartheid national government and the city of Johannesburg have both invested in public transport projects such as the BRT project which originated in 2007 (Bickford, 2016). The strategy involves improving rail transit services in order to provide greater access to the city to those previously disadvantaged people living on the periphery of the city in townships (Beg, 2014).

This public transport strategy has been arguably successful intervention in re-configuring Johannesburg's sprawled landscape. The strategy encourages the city to rely less on private vehicles and reduce the importance placed on private vehicle infrastructure which has left most of the city sprawled in the first place. This importance is envisioned in the amount of space allocated for roads and the limited space allocated for the pedestrians in the city. The city's economic centres are very accessible with private vehicles but less so with public transport or non- motorised forms of transport such as walking or cycling. This has left the city with a disintegrated public transport system. The disadvantage of this is that the city becomes more sprawled as the destinations become further away and easier to reach for those with private vehicles. Unfortunately, due to the high inequality gap most of the population rely on public transport to gain access to economic opportunities (Beg, 2014).

The increase in car ownership led to a decline in public transport infrastructure investment which affected the poor previously marginalized groups more. This is because of their dependence on public transport, which provides them with access to economic opportunities within the city (Beg, 2014). However, since 1994 there has been a noticeable deliberate policy shift towards making public transport a national priority (NDP, 2012). This has been complemented by more recent policies such as the National Development Plan, launched in 2012.

The NDP policy is mandated to lower living costs related to transporting costs incurred by poor families living on the fringes of the city (NDP, 2012). This is to reduce the socio-economic pressures they face as well as improve the quality of life of low-income families. This is in line with the New Urban Agenda principle of inclusion for all in cities. The other assumed benefit is to encourage more people to start using transit and other active forms of transport as opposed to motorised forms.

In order to achieve the goal of creating an integrated public transport system, the government has decided to employ a transit-oriented development (TOD) strategy to providing for public transport. This strategy is mainly premised on integrating different modes of transport and functional land use planning to make them viable and sustainable for the city (Banister, 2005). This transport approach aims to bring about positive externalities. It is this line of thought which has contributed towards its introduction into South African cities (Beg, 2014). One such positive externality of using a TOD approach is that through investing in a good public transport system there is a high possibility or likelihood that urban property values will increase in the Jeppestown area (Dai, 2014). The study investigates, analyses, and discusses the accuracy of these assumed benefits of TOD, especially with regards to railway stations.

The main reason for selecting the Jeppestown commuter railway station was its function, it serves as a key arrival point into the city (Valentim, 2017). This railway station is the point where the train stops and therefore connects commuters travelling into the city from the previously marginalized

communities. Once in the city they are also connected with the greater network of transport nodes including taxi ranks and the BRT in Jeppestown and the city (Valentim, 2017).

1.3 Problem Statement and Research Objectives

The motivations behind previous studies on railway accessibility vary. For instance, the focus has largely been on how it is a solution to an increase in traffic congestion, urban sprawl and its ability to give formerly marginalized people ***"a right to their city".***

Presently the literature regarding the impact of railway stations on commercial property values in South African cities is limited. There is limited knowledge of barriers to transit-oriented development (Cevero, 2001). Some of these barriers include the lack of capacity by officials to understand the link between investing in transit stations and the kind of implications this has for commercial property prices. This presents a missed opportunity in terms of how transit-oriented development planning has been understood and subsequently implemented in South Africa (Bickford, 2016).

This is evident with the existing limitations of the BRT transport system implemented in Johannesburg. This is in terms of its integration or rather lack of integration with other transport modes in the city, mainly the minibus taxis (Bickford, 2016). The program "corridors of freedom" is a good example of this. There are gaps in understanding the role transit stations could play with regards to adding financial value to commercial properties within their proximity. This has been a major influence behind this research study. I have also drawn inspiration and interest from my studies in urban planning and real estate development.

According to literature on cities of the north, the impact of a railway stations on a property is typically centred on shorter distances. Therefore, the aim of this study is to explore the relationship between the rail transit station in Jeppestown and values of commercial properties within a 1 km radius, which can be considered as a short distance. The rationale for this study is to contribute towards the body of knowledge which exists on the impact that rail transit stations have on commercial property values in South Africa. In order to do this, **the study has proposed that there is a link between transit stations and their assumed accessibility benefits for commercial properties**. In order to prove this proposition this study aims to determine whether there is a statistically significant correlation between the proximity of a railway station and commercial property values in the study area, or in fact whether the impact is due to other determinants of commercial property value. These other determinants include distance to other commercial centres, schools, and other amenities such as stand size, quality as well as both positive and negative externalities associated with proximity to a railway station (Chiu, 2013).

1.4 Research Question

TOD is an important tool in planning for most cities today, arguably for its assumed positive externalities (Lambert, 2009). This research will discuss the possible impact that proximity to a railway station has on the values of commercial properties close to it. As part of this quantitative study I propose a null hypothesis which will be tested by the results of the regression analysis. The null hypothesis for this research is that the independent variables have no impact on commercial property value, the commercial property values are influenced by proximity to the railway station. To this end the sub-questions have been broken down into two segments which will contribute towards achieving the aims of this study. The question will be answered using a quantitative research method which will look to either accept or reject the null hypothesis. If the research rejects the hypothesis then my initial

proposition would have been true in that there is a link between proximity to a railway station and commercial property values. The results will be presented and discussed in chapter 5. The research question is as follows:

How does proximity to a railway station impact the value of commercial properties in the surrounding community of Jeppestown within a radius of 1km?

In addressing the main question, the following sub-questions are as follows.

- How does proximity to amenities such as commercial centres (CBD), schools and inner-city precincts such as Maboneng impact commercial property values?
- What are the other determinants that influence commercial property value?

1.5 Research Method

The research method used in this study will be quantitative and will make use of secondary data purchased from Lightstone (Pvt) Ltd as well as literature on both TOD and commercial property valuation. The research will also require a multiple regression model in order to determine which factors have a significant impact on the value of commercial properties. The data set purchased includes retail, office, industrial and unidentified properties all within 1 km from the Jeppestown railway station. The full detail of the method is contained in chapter 3.

1.6 Ethical Considerations

This study has adhered to the University of the Witwatersrand research ethics principles in that it will not falsify data or not give a true indication of the results, nor will it contain work from other authors without referencing them. There were no interviews conducted in this study because it employed secondary data purchased from Lightstone (Pvt) Ltd and other secondary sources such as report documents on rail transit stations and commercial properties as well as generating my own multiple regression models to provide data for analysis, results and a conclusion.

1.7 Chapter Summaries

The first chapter of this research report presents the topic and a brief background of the city Johannesburg as a metropolitan area. This has been through discussing some of its historical and current issues with regards to public transport and the nature of its urban decay which has affected the commercial property sector. This chapter also includes the rationale behind the study, problem statement and more importantly the research question. The second chapter presents the literature review section which consists of discussions around the discourse surrounding proximity to railway stations, the value of commercial property, land value capture, and public transport infrastructure investments. The third chapter presents a detailed description of the data collection method and the processes needed to prepare the data for analysis. This chapter also discusses the method in which the study was done. The method was largely quantitative. The fourth chapter presents the case study used to contextualize the environment in which the train station is located. The fifth chapter is a discussion on what the results mean in relation to the literature in chapter 2. This chapter will also aim to set up a discussion which will help to the answer for the research question as well as to provide a basis to either accept or reject the null hypothesis. The last chapter will be the possible planning recommendations and implications of the research based on the analysis and synthesis of information from the research findings.

Chapter 2: The Impact of Railway Stations on Commercial Property Values

2.1 Introduction

This chapter will discuss the relevant literature on the broad topic of TODs in relation to proximity which translates to access to railway stations. The review will also discuss relevant literature on commercial property values to present the arguments and key perspectives from different authors. One of the objectives of this chapter is to define commercial property and the factors which impact its value. This research will however mainly focus on whether railway stations significantly impact the property values of commercial properties within a 1 km radius. This research will look at the different determinants which could affect the values of commercial properties. Lastly, the chapter will provide a conceptual framework which illustrates the relevant concepts discussed in this literature review.

2.2 Transit Oriented Development (TOD)

Streetcar stops is a term no longer used today but was the forerunner to what we now call transit stations today. These were stops in which residential areas were typically developed by one single developer and then connected through transit, to create a link between work in the urban core and residents on the periphery (Carlton, 2007). These stops had small retail clusters which comprised of small shops, hotels, and bars which served the commuters and other residents in the area (Carlton, 2007). These early transit stations provided a strong alignment between public transport systems and urban development patterns, creating a more sustainable and liveable city (Carlton, 2007). In short urban growth in cities was structured to both support and depend on public transport for accessibility and mobility requirements (Carlton, 2007).

However, the period after the Second World War most rail systems were overlooked because cities began favouring bus transit systems instead (Carlton, 2007). This was understandable because buses did carry more passengers than the automobile. They still experienced the same congestion due to them sharing the streets with the automobile (Autler, 2002). During these early days of rail TOD, it was often argued that rail could contribute towards reducing congestion and the emission of pollutants more so than busses could (Sullivan, 2011). This has been the mantra for rail transit planning ever since.

In trying to respond to the issue of worsening congestion in cities a new generation of rail transit systems was needed. These rail transit systems were planned and built in the USA, in response to the pollution and congestion in their cities after years on automobile dependence (Dai, 2014). These new transit systems were built to reduce congestion and promote rail transit as the main mode of transport. Their funding came directly from the U.S federal government (Autler, 2002).

These new transit systems had a different paradigm, for example, they focused more on reducing congestion. Some prominent examples included the San Francisco Bay Area BARTS system, MARTA in Atlanta and the Metro in Washington D.C which were operational in the 1970s (Carlton, 2007).

Over the years these transit systems have enabled transit stations to perform as regional nodes connecting cities and brining people closer to economic opportunities (Carlton, 2007). Carlton (2007) does however critique these transit systems because they emphasised very little on the immediate surroundings around the transit stations. This philosophy played a role in how these transit stations were designed, they stilled made the automobile a priority (Carlton, 2007). This was evident in the

way most of the investment went towards parking structures as the planners and engineers worked with an assumption that everyone will drive to the station as opposed to walking or cycling (Autler, 2002). These parking structures were barriers between the stations and the community ultimately limiting their access to the station (Carlton, 2007). Duncan (2008) mentioned that providing for pedestrians helps make transit stations attractive environments and this has an influence on property prices around them.

Autler (2002) points out that these early transit systems were not very successful, he explains that these systems fell short in providing all the positive externalities associated with what we consider good public transit today, in terms of the potential benefits they could generates for an area (Autler, 2002). He mentions that land-ownership patterns remained fragmented under these kinds of transit systems due to the lack of integration between land-use and transport planning (Autler, 2002). This poses questions around the assumptions that having the infrastructure in place for transit guarantees its success. Cevero (2014) mentions that the purpose of a transit system must be highlighted in how it will function.

2.2.1 Transit Oriented Development in Recent Times

According to Autler et al (2002); Banister (2005); Lindau, Hidalgo and Facchini (2011) it is generally accepted that rail transit systems can create value for adjacent land. Therefore, real estate agencies and developers alike have the view that owning property around a rail transit station does capture some of this value (Beg, 2014). Beg et al (2014) does mention that the expected returns may not cover the total cost of the initial investment in a rail system. Cevero (2001) then defends investing in rail transit by arguing that when implemented well a rail transit system can bring back returns on its investment. This suggests that rail investments allow land and properties to capture some value, when they are implemented well.

The concept of value capture refers to financial value or sentimental value (McGaffin, 2011). Value capture is a process in which we investigate and determine the additional value which a property gains as a result of public investment for example a public transport system or a school (McGaffin, 2011). It is also a method in which we can extract the value over and above that which the property would have had if the public investment had not taken place. This is just one of the many prescribed benefits of TOD.

According to international experience, TODs benefit communities by increasing ridership (i.e. people who live near stations in California are likely to use the public transport system than those who do not (Dai, 2014).The area with a railway station is likely to experience an improvement in mobility and convenient living environments for people who do not own cars in the area. Rail transit generally improves the attractiveness and vibrancy of places to live, work and play in (Carlton, 2007). They also generate higher and more stable property values in the longer term.

The term TODs originated during the 1980s and comes from Peter Calthorpe who was coincidentally a student of the environmental sustainability movement in the United States. The concept however had been in existence long before then. Calthorpe envisioned TOD to enable sustainable regional growth (Carlton, 2007). It must be noted that within the TOD concept Calthorpe differentiates between urban TODs (located directly on rail transit lines) and neighbourhood TODs (located along local bus lines that feed directly into transit lines (Hess et al, 2004). Calthorpe (2007) mentions that

urban TODs are denser and focus more on employment clustering than neighbourhood TODs which emphasize housing. This study focuses on urban TODs, focusing on railway stations.

The TOD concept enables transit agencies to generate revenues needed to stay operational while providing efficient and affordable public transport services (Bickford, 2016). However, the concept had earlier been introduced by Sir Ebenezer Howard in 1898 when he produced his garden city concept (Carlton, 2007). According to Howard (1898), transit-oriented development is defined as movement centred on satellite cites which are enabled by rail transit access (Carlton, 2007). Howard (1898) explains that his urban planning concept garden city was premised on real estate development using rail as a primary conduit between developed areas. Although Howard's theories and ideas were based on London's social conditions, they have been applicable in other countries including the USA and South America which faced relatively similar social ills associated with the automobile.

For all that TOD is capable of in terms of urban development, the idea of context is contested and debated in literature since these concepts and ideas around TOD are still very new to cities of the south except South American cities such as Curitiba and Bogota and many others.

According to Cervero (2011), transit-oriented development has become a popular and important planning tool for providing sustainable urbanism in most cities all over the world. This is a major step towards building smart efficient cities; however, the nature of TODs needs to be understood in its entirety for it to be implemented successfully in cities. In order to be effective, TODs should capitalize on the synergy which results from a functional integration of land use and transit within a city (Carlton, 2007). This creates a reduced dependency on private vehicles which has benefits the environment by reducing harmful carbon emissions and traffic congestion.

2.2.2 Transit Oriented Development in the South Africa?

According to Wilkinson (2006), South African cities must grapple with distorted settlement patterns associated with segregated spatial planning as a result of apartheid. The transport systems during apartheid era were designed to be very inefficient and deeply divided in order to facilitate segregation and discrimination (Dawjee, 2015). Investment in transport infrastructure was predominantly meant for private vehicles, mainly in the white areas (Bickford, 2016). This has increased the lack of accessibility and mobility in South African cities since the majority of previously marginalized people still live in settlements far from city centres and cannot afford private automobiles (Bickford, 2016). This legacy has stubbornly persisted in the post-apartheid era despite a major transformative policy shift.

Today the South African city context is still characterized by sprawling, relatively low-density, mono-functional developments (driven by both private and public-sector investment), and largely facilitated by privately owned motorized transport (SACN, 2011, Turok, 2012), be it automobile or mini-bus taxis. This can arguably be compared with the similar circumstances for TOD in North America where the auto-oriented transit planning paradigm was very strong (Bickford, 2016). However, in South Africa the impacts of apartheid planning, as well as global market forces, have led to unequal and unsustainable settlement patterns (Bickford, 2016). This and the socio-economic conditions were not similar as South Africa had experienced spatial segregation based on racial lines due to apartheid spatial planning; therefore the applicability of TOD in respect of these contextual elements needs to be considered well (Bickford, 2016).

2.2.3 Transport Policies Related to TOD in South Africa Post-Apartheid

The main overarching policy document which details the functions of the transport sector is the NDP, but this is from a broader scale. In this section of the report, the focus is not the broader nature and relationships between transport and national government but rather how these policies help set up TOD from an institutional perspective. This section will explicitly discuss policies which have been implemented at the local level regarding public transport (Beg, 2014).

During apartheid, the first policy relating to public transport was, unfortunately, one of separate development through locating communities some distances from entertainment, recreation and shopping centres (Walters, 2013). The post-apartheid government has rectified this by introducing policies such as the white paper on national transport policy (1996), the conclusion of interim contracts (1997), the moving South Africa strategy (1998), The Tripartite Heads of Agreement (1999), National Land Transport Transition Act, 2000 (NLTTA) (2000), the national land transport framework 2006-2011 (2006), the public transport strategy documents (2007) , were drafted by the department of transport (DoT) to assist in addressing the social injustice brought on by apartheid spatial planning and an attempt to integrate the transport sector (Walters, 2013). These policies were supported by pieces of legislation such as the National Land Act (2009). In recent times the main legislation governing Land use management is the SPLUMA Act (2013). This new act, together with transport policies and legislation, aim to make public transport more affordable and accessible to those who have been previously marginalized.

2.2.4 Current Debates on the Transport Sector in South Africa

Presently the South African government is struggling to create an integrated public transport system which encompasses all the different modes of public transport and addresses poverty, access and inequality issues (Thomas, 2016). This is alarming considering that 30% of households in South Africa own a car and the other 70% depend on taxis, buses, trains and other non-motorised forms of transport (Mtizi, 2017) . These ratios are strange considering how car friendly South African cities like Johannesburg are. It is also alarming that each mode of transport has its own unique challenges. According to the NHTS, in 2014, 37% of train users were happy with train services. The majority of these users' place importance on punctuality of service, levels of crowding, distance from the station and security (NHTS, 2016).

Creating a safe and affordable public transport system goes a long way into ensuring socio-economic development for cities in South Africa (Beg, 2014). This means that more people will have access to the city and its work opportunities without having to spend a large percentage of their wages on transport. This is especially good for the young employed working class from these formerly disadvantaged communities. (Autler, 2002). This can lead to a positive impact on wages and this has a multiplier effect for property development and for the growth of the country's GDP (Thomas, 2016).

There are three types of systems used in South Africa to provide public transport. These include firstly passenger rail operated by PRASA (Passenger Rail Authority of South Africa) formerly of the METRO rail company, secondly buses most of which are provided at a provincial scale, yet they operate at the metropolitan/municipal level (Mthimkulu, 2017). The last system is the minibuses/taxi systems which operate at a local neighbourhood scale and are provided by different associations with multiple operators (Mthimkulu, 2017). This study focuses on railway transport mode specifically.

One of the challenges facing the transport industry in South Africa is that there are disconnections between the existing and proposed public transport service systems operating in the city especially in Johannesburg. For the average person travelling these challenges mean longer travel times which significantly impacts transport costs (Mtizi, 2017). There is need for a better contextual understanding of the public transport sector in South Africa before introducing new methods (Mthimkulu, 2017). This is where the Integrated Development Plan (IDP) would be useful in analysing the landscape of public transport in South Africa. It would help understand the spatial development patterns in the city and assist in integrating land uses which make public transport viable and affordable by promoting densification along corridors (Fatima Beg, 2014). One of the problems facing South African policy discourse is that public officials have a limited capacity to successfully implement the initiatives of the TOD and therefore there is a missed opportunity which arises from this. (Beg, 2014)

Bickford and Behrens (2016) define and discuss what TOD means in a South African context in the face of an increase in car dependency in South African cities. In their discussion they highlight the effect of apartheid spatial patterns which has persisted in the spatial configuration of the city of Johannesburg (Bickford and Behrens, 2016). The study is a response to the 2012 NDP, which calls for internationally accepted principles of TOD to be employed. The paper also acknowledges that TOD originated in the United States to overcome the predominant use of private vehicles and the inefficiencies of urban sprawl leading to greater distances between places.

The study by Bickford and Behrens (2016) describe the international experience of TODs. They also argue that the implementation of TOD principles often encounters challenges in the South African context. One challenge is the contrasting stakeholder interests which are particularly important to understand. The research was qualitatively based on interviews carried out in Johannesburg, where local TOD stakeholders who comprise of real estate investors and developers, the state which is represented by the local municipality and the public who are the beneficiaries of a transit-oriented system. These stakeholders often have contradictory and competing interests and understandings of what TOD means. This according to the authors poses risks in achieving TOD objectives. As it affects project prioritization and financial budgets needed for the successful implementation of a TOD system.

In their study, Bickford and Behrens (2016) concluded that more research is needed to understand TOD stakeholder dynamics. The authors also recommended that the state provides frameworks and associated strategies through which competing interests can be resolved. The frameworks and policies can be useful in encouraging developers to buy up land and utilize its developmental potential in order to increase the densities needed to have a successful TOD system. In short through understanding the stakeholder dynamics it will be easier to understand the dynamics and mechanisms needed to ensure that TOD around transit stations achieve their objectives as set out by the transport policy in the NDP. This helps the city achieve its goals of reducing the distance between the formerly marginalized and economic opportunities and the reinvestment into the inner-city.

2.3 Availability of Land, Location, Productive and Non- productive Amenities and Infrastructure Development

Every type of economic activity requires land directly or indirectly, the main industries which use land directly are farming and construction. All other industries require land to accommodate workers, equipment and buildings as they must be located somewhere (Nichols et al, 2016). The problem is that land is finite and there is always a growing demand for it. However, following the law of demand

and supply means land's value is expected to increase. The scarcity of land and changes in land prices influences the value of commercial properties. Land also serves as a form of collateral for loans for construction therefore if the land is very expensive there is the likelihood that rentals will be expensive (Nichols et al, 2016).

This section of the literature review discusses the availability or unavailability of land within the inner-city with regards to how this influences TOD development and commercial property developments. It is important to note the availability of land is crucial but so too is the location of the land in terms of the amenities in proximity and the level of infrastructure development available in the area. Therefore, locating commercial property is an important factor if it is to achieve its goal of generating profit (Li, 2016). Marquis (2016) argues that when locating a commercial business the developer must be aware of the land restrictions and controls as they determine whether property developers can adapt to changing neighbourhood dynamics or become obsolete (Fatima Beg, 2014). To compliment this Mourouzi-Sivitanidou Rena (2011) points out that productive amenities for the firm and non-productive amenities for the workers are important in deciding where a commercial firm is to be located. The amenities increase the appeal of the commercial property and possibly allow the owners to demand higher rentals in some cases (Mourouzi-Sivitanidou Rena, 2011). It is also important to note that the quality of the roads, recreational facilities, and other public works greatly influence property values in an area.

It is important to mention that within the land-use dynamic there are institutional factors which determine whether TOD can be successfully implemented. The Institutional factors include the intersection of TOD planning with political systems, human and financial capacity (Beg, 2014). Suzuki et al (2013) argue that it is very common for institutional factors to present large challenges for TOD in the developing countries. One of the challenges facing TOD in developing countries is the assembling of large parcels of land which limits the opportunities for TOD (Fatima Beg, 2014). In South Africa, the question of land reform and expropriation has been raised and does have an impact on whether the property market can sustain new developments.

The economics of Johannesburg is a good indicator of happening in the property market. In 2003 most investors had the view that municipal debt was an inherent risk and that the city would have to work extremely hard to market bond debt at attractive rates (Ngobeni, 2008). This could impact the supply of commercial properties on the market and the prices of properties sold during this period.

2.4 Transport Investments and Land Re-development

An individual's need to travel is influenced by their ability to physically access work opportunities, schools, social and recreational facilities. These needs are defined as the demand for transport in the city (Banister, 2005). This demand is influenced by how we supply transportation services regarding their speed, quality and convenience and financial cost (price) of services. It is also influenced by how the service is perceived in terms of safety, security and environmental effects (Chiu, 2013). In general transport costs do fall as technologies and policies continue to improve. A cause of these improvements is the investment in transport infrastructure and land use development.

Investment is defined as an asset purchased with the intention or assumption that it will generate revenue or appreciate in the future (Staff, 2018). The definition of a transport system is broad because a transport system includes more than just the physical network and vehicles but also institutional settings which enable transportation services to be coordinated (Dai, 2014).

According to Negota, (2001) cities are the engines of economic growth such that most developing countries investing heavily in the urban transport systemsas they are considered a lubricant which keeps these engines going. Pojani and Stead (2015) have a different perspective on investing in transport systems in developed countries. According to their research on "Sustainable Urban Transport in the Developing World: Beyond Megacities", investing in transportation infrastructure including highways, rail, mass transit, and airports tends to generate accessibility, economic, environmental and social benefits for cities. McGaffin (2011) mentions that infrastructure provides access to various economic opportunities for individuals; he views this type of expenditure as an investment and not just access provision. McGaffin (2011) argues that capital expenditure is an investment which tends to lead towards possible value creation and value capture opportunities (McGaffen R., 2011). Investing in transport infrastructure can also be useful in changing the urban shape and in stimulating development and rejuvenation in areas which have undergone decay just as the Johannesburg CBD. Transit stations are very important as transit infrastructure in this regard.

The benefits of investing in public transport infrastructure make a difference in the economies of cities in the developed world. The effect of which has been that more cities have been investing more in transport infrastructure and improvements in transport technologies leading to a decline in transport costs (Pojani, 2015). According to literature, developed countries have in the past invested in transport systems in order to allow for growth and expansion of their cities. This investment was previously aimed towards promoting auto-transit. This brought about a growth in car-based travel which produces longer journeys, increased pollution, and congestion (Banister, 2005). The auto-transit transport system has not the best option for transport as it brings too many negative externalities for cities.

Public transit-oriented systems, on the other hand, were more sustainable and hence require more money for improvements which came in the form of investments. Using transit rail systems enabled cities to avoid creating negative externalities such as pollution, congestion and reduced urban sprawl (Banister, 2005).

The main difference between public transport infrastructure investments in developed countries and developing countries lies in the way transport policies have been drafted and implemented on the ground (Carlton, 2007). In developed countries, money is allocated to the transport sector as it has a bearing on how other sectors perform within the economy. This makes the transport sector integral to the success of other sectors in the economy. This is evident in how much cities spend in terms of expenditure on developing public transport systems and transit stations. Basic land economics explain the importance of transport as it determines where companies will locate in order to maximize profits by cutting costs for transporting raw materials and finished products. These locations become very valuable and as their value increases so too do the rental prices (Beg, 2014).

According to Ajakaiye (2010); Bhatta (2003) and Deng (2013) the impact of investing in transport infrastructure depends on the economic development of a country. However, Ajakaiye (2010) does make the distinction that while public transport infrastructure has made a big contribution in reducing the inequality gap which existed in East and South Asia. The impact of public transport infrastructure investment has been less significant in reducing the inequality gap in sub-Saharan Africa due to the poor quality of the infrastructure. Therefore, level of quality of public transport infrastructure in Africa reflects its development.

It is interesting to note that Bhatta (2003) argues that investing in public transport does have long term economic impacts on the economic development and brings benefits to an area. These benefits include increased productivity; lower production costs; income, property values, employment, and real wages; the rate of return' and non-commercial travel time (Bhatta, 2003). Meanwhile, Deng (2013) conceptualizes the impact of investing in transport differently. Bhatta (2003) acknowledges that investing in transport infrastructure can benefit the city in terms of productivity and economic growth. Deng (2013) points out that some considerations need to be made when measuring the impacts of rail transit infrastructure investment. One would have to measure the transport sector against other sectors, measure the different types of transport infrastructure and their varying quality levels. This enables the researcher to determine specifically how investing in transport can impact an area.

In most developing countries the urban sector contributes significantly towards the gross national product (GNP). Therefore, the assumption is that urban centres are expected to perform economically in a superior fashion as opposed to rural areas (Ajakaiye, 2010). This economic performance is made possible by the efficiency in economic production, which encourages cities and urban centres to spend between 15 - 25% of their annual expenditure on transport (Chuanglin Fanga, 2017). Planning and funding investment into transit stations such as rail stations can be costly yet very beneficial for the surrounding area. This means the city needs to cultivate partnerships such as the joint development approach with the private sector because this is imperative to upgrading transit nodes. The end products of the investments in transport infrastructure must satisfy all stakeholders. The city would want an effective public transport system while the private sector pursues returns in the form of rents for office, shops, and commercial centres which have become integral features adjacent to transit stations (Banister, 2005). Investing in the transit station and ensuring it is pedestrian oriented can ensure this.

According to the Development Research Group (2011), developing countries have a high potential to boost sustainable and inclusive growth through decreasing transportation costs. This potential is however not fully realized because of backlogs to transport infrastructure that exist in both rural and urban areas (Pojani, 2015). There is a lack of supportive transport institutions and governance systems which could ensure that transport policies get implemented effectively on the ground in these developing countries. In their defence the local economic and fiscal impacts of carrying out TOD projects may discourage municipalities from pursuing them. This may present a significant barrier to their successful implementation. This lack of will from the municipality is usually as a result of local officials not having the capacity or understanding required in terms of training or education in both regional and local impacts of TOD.

Now that the literature on TOD has been discussed in detail and it has been indicated that the study is primarily on railway stations and their impact on property value, we will now discuss the link between railway stations and commercial properties.

2.5 Determinants of Commercial Property Value

In the context of this research report the term commercial property refers to an estate[1] ranging from an empty piece of land to an area occupied by all sorts of buildings, intended to generate profit either through capital gain or rental income. It cannot be used for residential purposes (Pejovich, 2018).

Commercial properties include shops, offices, workshops, and factories illustrating their heterogeneous nature as real estate assets. Factors that impact commercial property values are Location, Utility, Scarcity, Effective purchasing power which must all work in tandem in order to generate value for a commercial property (Willmore, 2011). This research will be looking specifically at the office, retail and industrial properties to deduce the assumed link between reinvesting into the inner-city and profitable returns for investors which improve economic development.

According to Fuerst (2007), commercial real estate markets are typically characterized by spatial constraints, extensive product differentiation, and information asymmetries which contribute to a rise in fragmented markets. The argument proposed here is that because commercial markets are differentiated. Therefor it is not a simple matter of picking out a singular factor contributing to a change in their value. There are several factors at play which could determine the value of a commercial building according to Fuerst's (2007) point of view.

The spatial constraints on commercial property values include land costs and economic climate, land restrictions and regulations such as floor area and zoning. However, there is an argument which suggests that this value added comes as a direct consequence of government intervention and not the owner (McGaffin, 2011). Alternatively, there is another argument, that if the owner gets a return on their investment and the state can collect property taxes and it becomes a win-win situation for both parties.

There are other factors important to consider when discussing commercial properties such as distance, size quality and externalities which have an influence on the property prices which are associated with capturing the value of land. One of the theories associated with the value of land in the city is the bid rent theory which can also be a factor impacting the price of property based on the distance to the CDB.

2.5.1 Distance

According to Alonso (1964) and Muth (1969), the basic idea behind the bid-rent theory is that every agent in the city is willing to pay money for land depending on where it is located. The closer the land is to the centre of the city the more the agent is willing to pay rent for the land. The rental gradient declines with distance from the CBD. Therefore, it is more expensive to buy land closer to economic and city cores.

If we follow the bid rent theory as a concept of valuing land and properties located in proximity to railway stations. The argument becomes, properties located close to railway stations should gain from accessibility benefits which can be capitalized on financially (Negota, 2001). This access is attractive to would-be investors or residents, therefore, increasing its value (Bickford, 2016). One of the critiques of this line of thought is that there has been little empirical evidence showing a direct linkage between

1 An extensive area of land in the country, usually with a large house, owned by one person, family, or organization.

accessibility benefits actually being capitalized on and being converted into property values and rents (Li, 2016).

Although several studies have been carried out on the topic of land value capture, this study will look to continue adding to this body of knowledge. I should stress the fact that these studies have largely been on cities in North America and Europe more recently complimented by studies on cities in South America and Asia (McGaffen, 2011). McGaffin (2011) found a positive correlation between public transport infrastructure investment and provision as well as the value accrued by commercial property in proximity to this infrastructure. He did so by using a method called the residual valuation method where two sites where analysed in terms of their history, size, location, layout, infrastructure provision, existing and future developments, demographics and current land uses. The two sites were the Mooki Street BRT Stop in Soweto, Kuyasa Metrorail station in Khayelitsha Cape Town (McGaffin (2011).

There have been similar studies which have indicated that land nearest a commuter railway station is statistically significant to the value of the property which is on it (Damm, 1980). This follows the bid-rent argument that land is expensive the closer it is to a city core. However, the correlation between proximity to a railway station and commercial property values is not always positive as there are some negative externalities associated with having property development near transit. These externalities include crime, and noise pollution.

However, as we mentioned before the results on studies of this nature are mixed. This is due to technological advances. An example of such a technological advance is WIFI which assists companies attract workers and makes them less concerned about railway access.

However, Cervero (1997) mentions that a combination of good transit and good pedestrian access to the transit station has the potential to persuade people to use public transit as an alternative to the auto-mobile which reduces the distances between destinations by providing shorter commutes and the benefits of less congestion and pollution. There are counter arguments which exist in the body of literature regarding the distance to transit stations and commercial property value. These arguments need to be understood and broken down in order to explain some of the opportunities and challenges facing transit stations and the factors needed for them to be efficient.

There have been several studies which have investigated the effect of rail station proximity on commercial property values but very few have gone deeper to assess the underlying factors of this effect. In trying to unpack this effect I have relied on the bid-rent theory as it does explain the economic benefit of nearby parcels of land (Autler, 2002). According to Bowes (2001), two factors have been identified which may increase property values or decrease them. Bowes (2001) mentions that a railway station providing the user with affordable access to economic opportunities , is an example of one of the two factors which may increase property values This makes the proximity to a station a significant factor in property values increasing in the area.

The second factor is that proximity to a train station attracts retail activities which will serve commuters traveling to their respective destinations (Bowes, 2001). This is beneficial for the residents and commercial activities in the area (Carlton, 2007). These two factors can arguably explain the increases in property values in an area which has a nearby a rail transit station. Cevero (2001) argues that proximity to a station does bring with its noise, crime, and pollution which are negative

externalities which can negatively affect the price of property should proximity to a station be significant.

When discussing the impact of crime, it is predominantly due to the access the station will be providing to people who are not part of the community in the area. It is very important to grapple with the roles played by each of the two factors as they have an impact on property values. When these roles are fully comprehended, only then can city planners be able to develop strategies which can maximize the attractiveness of station and in turn reduce automobile-dependency and make cities more sustainable (Fatima Beg, 2014). Within the same body of the literature Armstrong (1993) proposes an interesting argument, he states that if a station has no significant impact or a negative effect on property values then the researcher must investigate the effect of the negative externalities or other determinants of commercial property value. The reason being these determinants could be causing the lack of significance or lack of impact.

According to Ryan's (1999) work on finding the transport-land use connection in relation to property values and transport facilities, there has been four decades of inconsistent empirical evidence on the relationship between transport-land uses and property values. In the findings, she explains that the inconsistency and variation of results of studies on transport facilities and property values come down to how measures of access were specified. This proves that proximity alone without deeper explanatory analysis can be misleading as to how property values are influenced by transit stations (Ryan, 1999). This will be interesting to discuss using the results of this study to back up some of the assumptions. This is to deduce whether external factors such as distance to commercial centres and distance to schools impact the commercial property values. It would be interesting to find out whether these external factors are significant, and the following section of the literature will explore some of the notions and arguments regarding this.

Urban economists and urban planners have been interested in how property value information can be used to measure the benefits of locating near key employment centres, shopping centres or schools (Chor Chin and Foong, 2006) In their research Chor Chin and Foong based on Singapore, they investigated the impact of schools on residential property. In the context of this research It would be important to determine if commercial properties can benefit from this access to schools. The people workering in commercial companies would benefit by having a shorter travel time between school and home (Guntermann and Colwell, 1983).The benefit for commercial businesses is reduced traffic congestion which means more productivity and less time spent on the roads. These are the primary reasons but there are also less obvious reasons such as the ability to monitor and influence their children's educational activities, by arriving home early to assist with homework. This is considered as a non-productive amenity which can indirectly increase the value of a commercial building in an area.

In order to discuss this determinant more, we go back to Foong's (2006) research objectives which were aimed at determining whether parents would pay more for houses situated close to schools. It is reported that in Singapore that following the implementation of an educational policy, proximity to primary schools' grants parent's priority for school registration for their children. This was supported by the results of the study which showed that access to schools is a significant determinant of property values, showing that all else equal individuals are willing to pay more for a property which is closer to a school (Foong, 2006). Therefore, working from this assumption access to a school will be significant to the value of the property because the literature mentions schools are an important non-productive

amenity for the workers working in commercial buildings. However, it is important to mention that schools do not impact the value of property unless they are accompanied with incentives.

2.5.2 Quality

TOD as a planning tool aims to reduce our dependency on automobiles and promote increased use of public transit and non-motorized transport. This is done through promoting high densities and mixed-use developments which are environmentally friendly in urban areas within walking distances to transit stations (Chiu, 2013). TOD planning makes use of urban design concepts such as walkability, which is a measure of how friendly an area is for walking. This means that streets surrounding a transit-oriented development have wide pavements, engaging street edges, street furniture and activities which invite people to stay and linger. This provides pedestrians with the opportunity to either actively or in a passively participate in the street activities. The literature on the impacts of TODs does mention that urban design criteria and pedestrian-friendly designs do reduce automobile use and increase pedestrian access to transit transport (Chiu, 2013). According to Kim (2013), it is assumed that walkability can add economic value to the built environment of an area. It is important to acknowledge that walkability plays an important role in creating urban land use efficiency. This is usually due to walkability offering access and providing an alternative to driving which increases travel times between destinations leading to less productivity (Kim, 2013).

The design features which promote walking include wide well-connected pavements, clear street signage, and active transport options such as cycling or Tuk Tuks. These features do however require space and the Cadastral size of a property plays a part in ensuring their realisation. This is because walkability encourages people to actively participate in their local economies. This can be by simply walking to the supermarket in a convenient manner which boosts property values (Sohn, Moudon and Lee 2012, 116). This research will explore the level of influence that design concepts such as walkability, clear signage, traffic calming measures and a good public realm have on the value of commercial properties close to railway stations.

According to Boyar (2018), walkable areas are some of the most desired urban locations by residents and employees looking for convenience, access to amenities and reasons to explore the city. Boyar (2018) goes onto argue that improving the walk score of an area strongly correlates with a rise in property values, rentals, retail sales, tenure, absorption and price elasticity in economic downturns. In support of this argument a study conducted by HR&A advisors (Pvt) Ltd commissioned by the NoMa Business Improvement District in Washington, D.C., confirmed that mixed-use developments outperform single-use properties in both CBD and suburban settings alike. This is also coupled by companies using walkability and strong amenities to attract highly skilled workers, with promotional adverts such as *"Great office space within a 5 min walking distance to public transport*". These firms are willing to pay a rent premium for a highly walkable area. They are working on the basis that there is a direct correlation between increased walkability and price appreciation (Rodriguez, 2018). As for this research, Rodriguez supports that increased foot traffic also leads to increased retail sales.

This research study will analyse how other building attributes contribute towards the quality of a commercial building. These attributes are property age, property class, and type as well as the utility the property provides. These attributes assist in determining whether proximity to a transit station is the only significant factor influencing commercial property values (Fuerst, 2007).

Property age is linked to the character of a neighbourhood in which the property is located. Studies by Han et al. (2002), Kauko (2003) revealed that most homebuyers preferred to buy property located in neighbourhoods characterised by pleasant features such as modern building designs, and good roads. These properties are considered more valuable according to Iroham et al (2014). This is not different for commercial properties as they too benefit from clean trustworthy environments because they impact the perception of customers and would be investors. The literature mentions that new buildings are associated with security features that contribute towards their value increasing in an area. This is supported by Owusu-Ansah (2012) who mentions that the age and condition of a property will influence the price which is to be paid for the property. Keeping in line with the same trend of thought, Sirmans et al (2005) established that age of commercial property usually influences its value in a negative direction. This should not be a surprise because the older a commercial property gets the more its economic value decreases. Therefore, the utility derived from the said property decreases. This is because owners must spend more money on maintenance. It will be interesting to find out how the age affects commercial property values in my study, will it support the existing literature or provide some new insights. This will be investigated in chapter 4.

When it comes to office buildings there are some determinants which contribute to their quality and this increases their value. Fuerst (2007) mentions the existing literature on commercial property value covers a range of important factors which explain the variation in office rental rates. Among them are age, size and access to multiple modes of transport. At the same time there are arguments that state that the relative weight of rent determinants could possibly change over time favouring buildings with certain features over others (Fuerst, 2007). However, this also depends on many factors including the position of the property in the real estate cycle, for example, given the shifting in preference for more sustainable buildings over regular buildings. The rental prices for so-called green buildings have been on the increase because they influence the employees and customers' perception of the quality of the building. Office properties are classified according to grades and these are described below.

In terms of classification, office spaces are usually classified as either Premium (P) grade, A grade, B grade or C grade. Premium grade offices are usually observable by their top-quality offices with modern space which helps them achieve high rentals. This grade includes the latest technology and building services, ample parking, a prestige lobby finish and good views (Mourouzi-Sivitanidou, (2013).

The A grade, on the other hand, is generally new and not older than 10 years unless renovated (Mourouzi-Sivitanidou, 2013). These offices are in prime locations and provide high-quality finishes, on-site parking, and air-conditioning. An A grade office building will typically accommodate financial service activities and rely on agglomeration provided by large retail nodes. An A grade office building is affected less by rental expenses but more so by the relevance of image and prestige factors of tenants, for example, a worker will boast about working at a building and this boosts its image and creates a positive perception. According to CoStar (2007), A grade office properties are investment grade offices which are well located, above average maintenance and quality in terms of amenities and features. It can be argued that most inner-city buildings in Johannesburg were A grade before the flight of capital in the 1970s, which lead to finance institutions leaving their old offices and relocating to Sandton.

The B grade offices typically offer functional space with no special features and have ordinary designs. These buildings typically have good maintenance, management, and tenants (Fuerst, 2007). The B grade buildings are usually between 10 to 20 years old unless renovated. Accommodation is modern,

situated in good locations and provides on-site parking and air-conditioning (Fuerst, 2007). B grade offices typically accommodate government institutional and small businesses. These offices are usually located in the vicinity of smaller retail centres and in CBD's (Mourouzi-Sivitanidou, (2013).

Lastly, the class C and D are older buildings which offer basic space and command lower rents and sales prices. These buildings usually have very sub-standard maintenance and management, and could have mixed or low tenant prestige, inferior elevators (Fuerst, 2007). These offices generally accommodate government institutions, small businesses and activities related to industrial uses, and are typically located in older CBD's. Due to them having low tenant prestige these buildings must rely on a lower price to attract tenants and investors.

Having discussed offices commercial property building typologies the literature review now shifts its focus to retail properties. Retail buildings typically house convenience goods, shoppers' goods and personal and specialized services (Jihye et al 2014). Their quality is ensured by their location which influences their ability to attract new customers or retain old customers.

According to Jongeun Lee et al (2008) who analysed data gathered from 16 cities around the provinces in Korea,the general rent determinants of retail properties are building coverage, floor area ratio, rentable space, land value, the number of stories, the distance of the subway station from the store, the width of the road the store bordered on, and the direction of the windows. Jihye et al (2014) suggest that the impact of conditions of a specific location and building characteristics on rent differs from place to place, for example in Korea retail buildings located close to a transit station are affected in terms of their value.

2.5.3 Externalities

Research studies on transit and property prices usually discuss how the station has two effects on property. Firstly, they offer access to services and economic activities and secondly, they act as node for the area. It is also understood that property values are affected by positive or negative externalities (Debrezion, et al, 2004). The external amenities which affect property come from the physical environment as well as the type of activities which take place on or within the property. Locations that are immediate to the train station are expected to have higher effects than locations further away. At the same time increased population movement gives rise to retail development and these retail activities may sometimes attract crime (Bowes and Ihlanfeldt 2001). According to Debrezion, et al (2004) the impact of railway stations on property values becomes less significant as one goes farther away from the station. However negative externalities such as noise pollution influence properties located along the railway line.

From an urban economics perspective, public infrastructure is an area of interest when evaluating a city's economic potential. In major city's mass transit plays an important role in economic development since it is the most basic means of connecting individuals and businesses together. Although there are assumed benefits that are discussed within the literature on TODs there are some arguments that suggest that TOD does more harm than good. For example Baum-Snow and Kahn (2005), argue that there is not enough evidence to suggest that pollution and congestion which are the most common negative externalities associated with vehicular transit decrease due to rail transit use. Other studies suggest that urban rail transit systems may lead to increased centralization of poverty in cities (Edward Glaeser, Matthew Kahn, and Jordan Rappaport (2008). Diaz (1993) argues that some of the negative externalities of rail include noise, perceptions of crime and visual intrusion

which could deter residents or companies from locating near a transit station. The focus of my study is not residential properties; therefore, we will investigate how such externalities impact commercial properties.

Crime as an externality is unique in the context of this study because it has dominated several debates over the years. The early 1990s saw a dramatic increase in the crime levels recorded in South Africa and this trend has continued even after democracy came in 1994 (Kruger and & Landman, 2007). What is of concern is the high prevalence of violent crimes such as murder, rape, and assault. South Africa has one of the highest murder incident rates in the world (Kruger and & Landman, 2007). The study area is known as a crime hot spot and this could be an important negative externality to the results.

2.6 Conceptual Framework

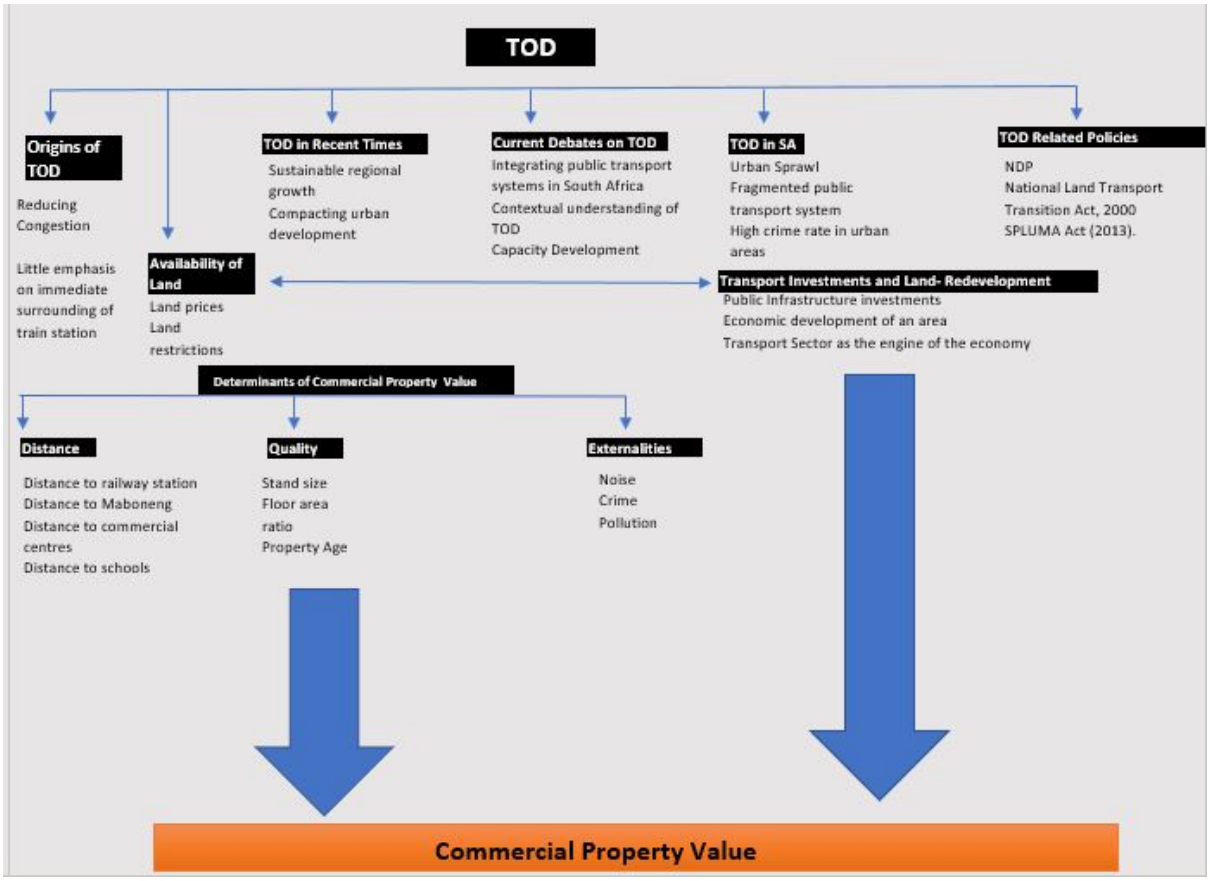


Fig 40 Showing the conceptual framework followed by this research.

The conceptual framework (Fig 40) illustrates how TOD is a broader context in which my research on proximity to railway stations is situated. In this review I have mentioned the origins of TOD and how in particular railway stations act as regional nodes in urban areas, contributing to the value of commercial property. It was necessary to begin with the broader TOD concept because it has been a useful planning tool that has been implemented in cities of the developing world. This chapter has

discussed the opportunities of TOD and its challenges with the aim of relating some of this in a more specific manner when it comes to railway stations.

The framework also includes some determinants of commercial properties which may or may not have an influence on their value. These will be the independent variables to be measured in the study. These independent variables include the quality of a commercial property which includes the stand size, floor area ratio and property age which all have an influence on the price of the property. The distance to the station can directly or indirectly influence the values of the properties. as Also, the existence of both positive and negative externalities including crime and noise, increased walkability and an improved public realm.

2.8 Conclusion

This section of the report discusses key concepts and arguments with regards to research on the impact of railway stations on commercial property value. The conceptual framework has presented TOD as a broader context in order to set up a discussion on the impact that railway stations have on surrounding properties. The chapter does this by engaging with past and present debates on TOD and its ability to create value on land in proximity to railway stations. The chapter has discussed issues around commercial property values with regards to their determinants and the impact of being close to railway stations. The chapter has also identified the challenges, opportunities, strengths and weaknesses and priorities in relation to how cities have employed TOD as a tool in achieving development, and how railway stations play a role in the value capture of commercial properties.

The chapter has also discussed some of these challenges faced by the Post-apartheid government in its attempt to employ rail and BRT systems to restructure the modern day the South African city which has been fragmented by years of apartheid spatial planning. The discussions have drawn on the bid-rent theory which explains why land gains value the closer it is to the city core, as well as Ebenezer Howard's garden city concept. The literature review has argued that a good pedestrian environment is critical for railway stations to have any meaningful impact on commercial property values. The next chapter will discuss the research method used in this study and how the data used in the study was collected and analysed.

Chapter 3: Measuring the Impact of a Railway Station on Surrounding Commercial Property values

3.1 Introduction

This chapter details the method used to carry out this study in terms of how the data was collected and analysed. This section will describe both the dependent variable and independent variables used in this study; this will be both in a listed format and using the descriptive statistics of the variables.

The study also makes use of a case study on Jeppestown in relation to the railway stations origin and implication of its current context. The study will use secondary data bought from Lightstone (Pvt) Ltd, based on the record of sales transactions of commercial properties located within a 1 km radius of the railway station. The purpose of choosing properties within this radius was to determine whether proximity to the transit station has an impact their value. It had been mentioned in the literature that the proximity to railway stations is usually measured in shorter distances, which justifies using 1km as a measured distance. This study will require a multiple regression model to analyse the data provided that all the necessary data is available.

The study is quantitative and will rely on using statistical data classified into four asset classes of commercial real estate properties which are office, Industrial, retail and unidentified properties. They will be analysed using a multiple regression model based on the attributes and factors identified in the conceptual framework. The attributes to be measured against the value of commercial property are quality, size, externalities, and distance.

The literature mentions that commercial buildings are extremely heterogeneous. There could be other determinants besides those mentioned above which could have an impact the property values. The results of the regression model will help explain whether proximity to a railway station impacts commercial property values, or if these other determinants do.

3.2 The Case Study Approach

This is a research approach which is usually used in the social sciences. According to Crow et al (2011), the case study approach is very useful in situations where it is necessary to gain an in-depth understanding of an issue, event or phenomenon of interest in its real-life context. The case study approach enables the researcher to explore and understand complex issues. The role of the case study approach becomes more important when there are issues regarding poverty, unemployment, illiteracy, and crime in the context of a study. (Johnson, 2006).

3.3 Multiple Regression Model (MRM)

Multiple regression models are one of the most widely used econometric techniques to analyse how different independent variables influence the dependent variable in a quantitative study (Fuerst, 2007). In this study, a multiple regression model was used to analyse the data obtained from Lightstone (Pvt) Ltd.

The independent variables were plot sizes, floor area, and ages of buildings, proximity to other commercial centres, and proximity to the railway station. The dependent variable was the property values which include sales between 2005 and 2015. This method of regression analysis was advantageous as it enabled subject matter which is normally measured qualitatively to be measured quantitatively.

Regression modelling has become the standard tool in examining price determinants in real estate research (Fuerst, 2007). The Multiple Regression Model technique has been used widely in studies to distinguish the impact of public infrastructure investments on property values from other factors (Cervero, 2004; Mohammad et al., 2013; Rosen, 1974). The main goal when generating a regression model is to create a model that accurately measures impacts of independent variables on the value of a property.

It is important to use the appropriate regression model when carrying out the study. In this study, I designed a multiple regression model run using Microsoft Excel software. A multiple regression model was useful in this study because of its ability to investigate multiple variables at the same time unlike the least squares' ordinary regression or the bivariate regression model, which do not give enough information about the kind of relationship between multiple independent variables and the dependent variable.

3.4 Data Collection

The Data used in this study was empirical in nature and was purchased from Lightstone (Pvt) Ltd. The Lightstone (Pvt) Ltd Company was founded in 2005 to assist in developing tools that help mortgage lenders better manage risk. The company is also responsible for providing support and data to insurers, estate agents, municipalities and other professionals in the property industry. The data purchased for this study data consists of sales, rentals, plot sizes, floor area, age of buildings and distance from the Jeppestown railway station. The data covers the study period from 2005 to 2015. The data consists of recorded transactions of individual commercial properties within a 1km radius of the Jeppestown train station.

The study will make use of a multiple regression model to determine the statistical significance which will determine the impact of proximity to a railway station. This impact is to be measured in relation to the values of commercial property located within a 1 km radius. Within the literature, it is mentioned that commercial properties are heterogeneous therefore the study will also assess other factors associated with commercial property values. In order to control for other amenities each of the properties have been aggregated by distances to Maboneng, the Carlton centre shopping complex in the CBD and the nearest schools.

The study uses the ANOVA table to test for variance between the groups of means of each variable and this will help determine whether the independent variables are significant to the value of commercial property. In order to understand exactly how proximity to railway station impacts property values I controlled for other access factors using dummy variables and have applied them to the models.

3.5 The Dependent Variable

The commercial property value was the dependent variable in this study. This value in the context of the study refers to the recorded price that the commercial property was sold for. The sale price was chosen because it captures the true valuation of all the commercial properties external and physical characteristics, measured in Rands, the South African currency. The prices have been adjusted to the base year 2005.

3.6 The Independent Variables

An independent variable affects the value of a dependent variable (Johnson 2014). In other words, independent variables are the factors which could possibly influence the dependent variable, in other words the value of commercial properties contained in the data set.

3.6.1 The Distance to the Railway Station

Distance is the independent variable measured between the railway station and the commercial properties in the study area. This variable was used to measure whether proximity to nodes such as railway stations has an impact on the value associated with the commercial property. In this study, the distance to the railway station was measured in meters and provided by Lightstone (Pvt) Ltd. The distances to other commercial centres, Maboneng and schools was measured using the Google earth point to point measuring tool. This was done using the coordinates of the individual properties and was also in meters.

The distance was measured using the straight-line method along the road, which is a good proxy for distance unless there are physical features such as lakes, rivers, mountains and the wilderness, for which Jeppestown does not have it is a built-up urban area. However due to the sprawled nature of Johannesburg which is a direct result of the apartheid spatial planning policies which promoted separate development, most spatial scales such as schools, parks, and shopping centre usually means people travel by private vehicles, busses and minibus taxis. I chose to use the straight-line method because very few people enjoy walking around the CBD due to its perceived dangers related to crime and urban decay. Yet I also acknowledge that people of low-income status do not have much of a choice but to pay taxi fares to travel between points where they do not feel safe.

3.6.2 Property Age

Older properties can either have a negative or positive impact on commercial property value depending on their functional use. The property age and aesthetic features are characteristics which are used to value a property. The properties used in this study were all located in Jeppestown which has suffered from the urban decay and the disinvestment that occurred during the flight of capital during the mid-70s. This has left the neighbourhood with several old dilapidated buildings, most of which have not been renovated or upgraded since then.

The normal service life of a building is 60 years according to Dias (2013). If a building goes beyond 60 years it will need considerable renovations due to some utilities such as elevators becoming out-dated and dangerous to use. It is also important to note that most buildings which use concrete have an average life span of 50- 60 years before they start to have structural problems (Dias, 2013). This is relevant because the oldest building from the data set is 81 years old, meaning there are buildings way beyond their service years which has an impact on their value. This supports the earlier comment with regards to the fall in value of commercial properties in the property market during the mid-70s due to poor maintenance, resulting from the flight of capital to the northern suburbs (Beavon 2001). The data on the property of the buildings was also obtained from the data set purchased from Lightstone (Pvt) Ltd.

3.6.3 Property Size/Floor Area Ratio (Sq. meters) and Cadastral Size of Property

Floor Area Ratio (FAR) is the ratio of a building's total area in relation to the size of the erf on which it has been built. It is measured by dividing the total area of a building with the cadastral size it sits on. During this study, I did not have to physically measure this independent variable as it was also part of the secondary data supplied by Lightstone (Pvt) Ltd in square meters. The cadastral size of a property is what the owner can use, including the built-up and non-built up area in accordance with the title deed. It is custom that property with a greater cadastral size sells for a higher value.

The cadastral size of a property is measured in square meters. It is common for cadastral sizes to be smaller, closer to city centres and larger as you move further from city centres. This is following the ideas of Howard in his garden city concept and the Bid-rent theory (Carlton 2007)

3.6.4 Classification of Commercial Buildings in the Study

Retail buildings are used to sell products such as clothing, phones, and other electronic gadgets, books and computer games. As such retail properties are responsive to consumer spending patterns and will locate where there are considerable pedestrian flows. In this data set, more than 50% of the buildings are retail which makes it a very important variable. However, due to the high crime in the area, it will be interesting to see what effect the retail use variable has on the property values in the area. The Office property types are buildings that house businesses and other business-related activities. In Johannesburg, the trend is that office buildings are now being designed to hold multiple firms making use of locational advantages found in the areas they are situated. The Industrial property class refers to factories and other premises used for manufacturing, altering, repairing, cleaning, washing, breaking-up, adapting or processing any article; generating power or slaughtering livestock. Finally, with regards to the unidentified properties some were bought and changed in terms of their functionality, others were hijacked buildings, and a few were buildings under construction.

3.6.5 Tenure Typologies

The term tenure refers to the various ways that an individual can own a property. In this study, I obtained two tenure types from the data which were either rented or owned. The rented properties were listed with their prices per month while the owned properties were listed with the listed prices they were sold for.

3.7 External Factors

These were the independent variables affecting the commercial properties indirectly and therefore needed to be controlled for as they could possibly alter the results of the regression. The external variables in this study were distances to newly developed nodes, schools, commercial centres, presence of highways or other public transport routes. The highways could be competing with the railway for accessibility benefits mentioned before.

3.7.1 Distance to Maboneng

The Maboneng Precinct is a fairly recent development in the inner-city having been established by Jonathan Lieberman and Propertuity in 2012. It is one of the trendiest tourist destinations in the inner city offering the middle to upper classes an urban living experience. The precinct has several coffee shops and trendy restaurants and food markets for the urban explorer. It is one of the urban regeneration projects undertaken by private developers with institutional support from the city of Johannesburg. Due to it being a mere walking distance from the railway station it must be controlled for as a variable as it could have an impact on the value of commercial properties in the study area.

3.7.2 Distance to Other Commercial Centres

Proximity to other commercial centres could arguably also have an impact on the value of commercial properties in an urban area. The nearest major commercial centre to the study area is the Carlton Centre located in the CBD and therefore it was important to add it as a variable and to control for its external impact on the 87 properties selected for the study.

3.7.3 Distance to Schools (Non-productive amenities)

The literature on real estate properties does mention that there is a link between schools being in proximity to a commercial property and an increase in the value of the property. There have been Studies in South Africa by Mhlanga (2014) which support this finding. The study area is close to 3 schools which are the Jules high school, John Mitchell School and the Dominican Convent School.

3.7.4 Date of Purchase, Number of Sales and Dummy Variable for the Year of Purchase

These variables were included in order to provide information regarding these properties were purchased. The number of sales describes the number of times a property was sold between the period 2005 and 2015 which could influence the value of the property. This variable helps determine the impact of the investment PRASA made when they took over the commuter rail service in Jeppestown in 2005.

3.8 Descriptive Statistics

This section of the chapter gives a summary of the descriptive statistics for the variables used in the study. The variables are Commercial Property Value, Distance, Property Age, and Property Size/Floor Area Ratio (Sq. meters) and Cadastral Size variables. This data covers a 10-year period between the year 2005 and 2015. This is significant because according to the JLL report on "Commercial real estate transactions review in South Africa", reported that that transactions actually slowed down between 2006 and 2009 there was a property boom towards the end of 2010 leading to 2014 which could have influenced the property prices. In the study the most (27) transactions were recorded in 2005, (22) in 2014, (16) in 2008 and (7) in 2010.

When carrying out regression and correlation analysis the raw variables do not necessarily need to be normally distributed. However, they do need to be symmetrically distributed. This improves the reliability of the results for the analysis. In this section the descriptive statistics of the raw data were used to measure the level of skewness of the data and the possible impact this could have on the results for the study. In order to do this the median and the mode values of the raw data were compared. The reason for using the median and not the mean is that the median is a better measure when describing data with outliers, this data had outliers. In this section I will describe the statistics of the dependent variable and independent variables.

3.8.1 Commercial Property Value

The maximum value for which a commercial property was sold for between 2005 and 2015 was R 7 106 667 while the minimum value was R 22 000 and the mean was R 1 170 717.12. The large difference between the maximum and minimum values did indicate that there was a spread of the data about the mean. The skewness indicates asymmetry in a statistical distribution and can define just how much a distribution varies from a normal distribution. According to a general rule of thumb if skewness is less than -1 or greater than 1 then the distribution is highly skewed. If the skewness is between -1 and -0.5 or 0.5 and 1 then the distribution is moderately skewed. If skewness is between - 0.5 and 0.5 then the distribution is approximately symmetric. The value for commercial property variable had a skewness of 2.33 which shows that the data was highly skewed. This is due to outliers which drive the mean upward but do not really affect the median of the data (see Fig 16).

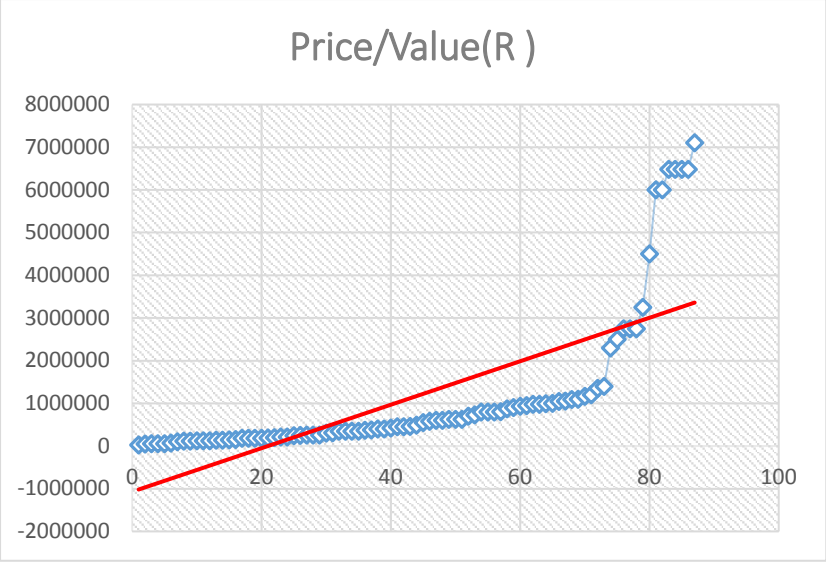


Fig 16 Graph for Commercial Property Value statistics

3.8.2 Distance to the Jeppestown Railway Station

The maximum distance from Jeppestown railway station was 806.89 meters and a minimum distance was 76.47 meters. The median distance was 443.98 meters which is considerably less that the mode which was 677.05 meters. When the median is less than the mode this means that the data is skewed towards the left. This is supported by the skewness value of -0.098. This has the potential to affect the results of the regression analysis by violating the following assumptions of a multiple regression:

1) There is a linear relationship between the outcome variable and the independent variables
2) Multivariate normality because multiple regressions assume that the residuals are normally distributed.
3) No multicollinearity, multiple regressions assume that the independent variables are not highly correlated with each other.
4) No autocorrelation

Multivariate normality means that regression requires all its variables to be normal. By having skewed data, we violate the assumption of normality. The violation can lead to a disproportionate influence on the parameter estimates also known as coefficients in the regression analysis table. Secondly the skewness of data can impact the confidence intervals by making them too wide or too narrow. This can affect which variables prove to be significant in the study. Based on that explanation the distance to the Jeppestown commuter rail station data has shown that it is not normally distributed and has skewed data.

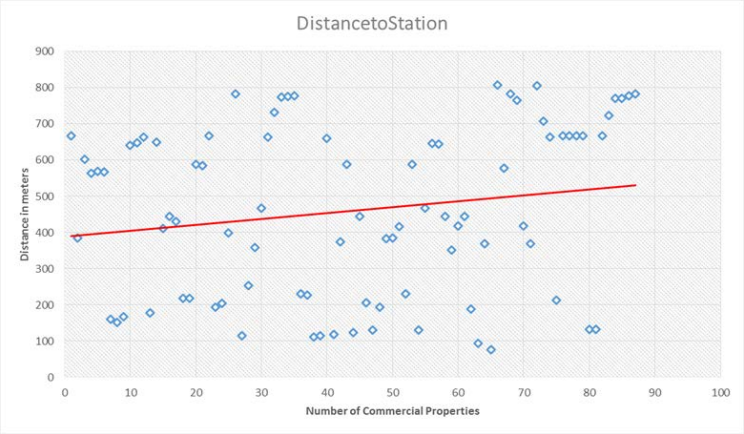


Fig 17 Graph for Distance to Jeppestown Railway Station

3.8.3 Distance to Maboneng

According to the data presented in the graph 18, the maximum distance between a commercial property used in this study and the precinct was 1400 meters while the minimum distance was 218 meters. The median distance was 426 meters which is greater than the mode which was 292 meters. When the mode is less than the median as shown in this instance this means the data is skewed to the right. This is supported by the skewness value of the variable which is 1.580539 which is significantly more than 1.0, which could be an acceptable level of skewness. Any value above means that the data is very far from being symmetrical or normally distributed. The graph 18, shows the existence of outliers which may have contributed to the high skewness value in the variable. This has an impact on the results as discussed before the skewness violates the assumptions on a multiple regression. This impacts the results when the variable is run in a multiple regression model.

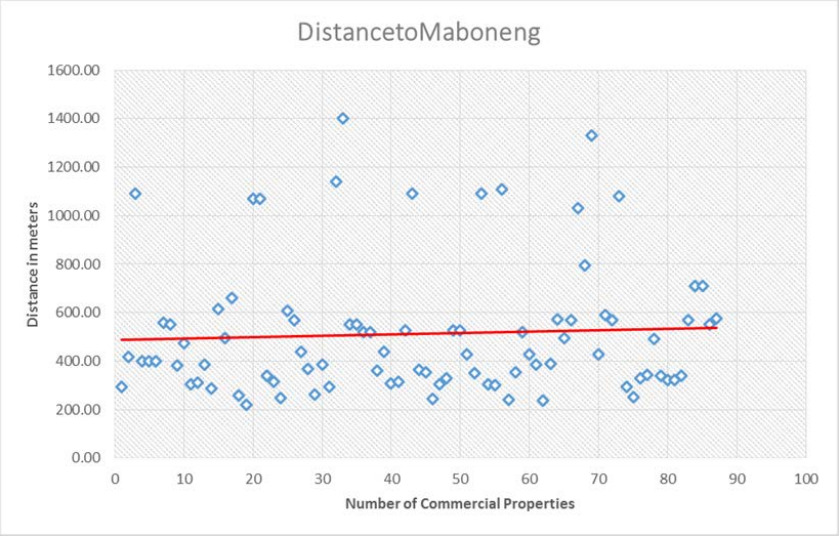


Fig 18, Graph for Distance to Maboneng

3.8.4 Distance to the Carlton Centre

The maximum distance was 2590 meters and the minimum distance was 660 meters. The median distance was 1490 and the modal distance was also 1490. In instances where the median and the mode are equal this means that the data of that variable is approximately symmetrical. The graph in fig 19 as well as a low skewness value of 0.358 supports this. The graph shows that the two sides almost mirror each other.

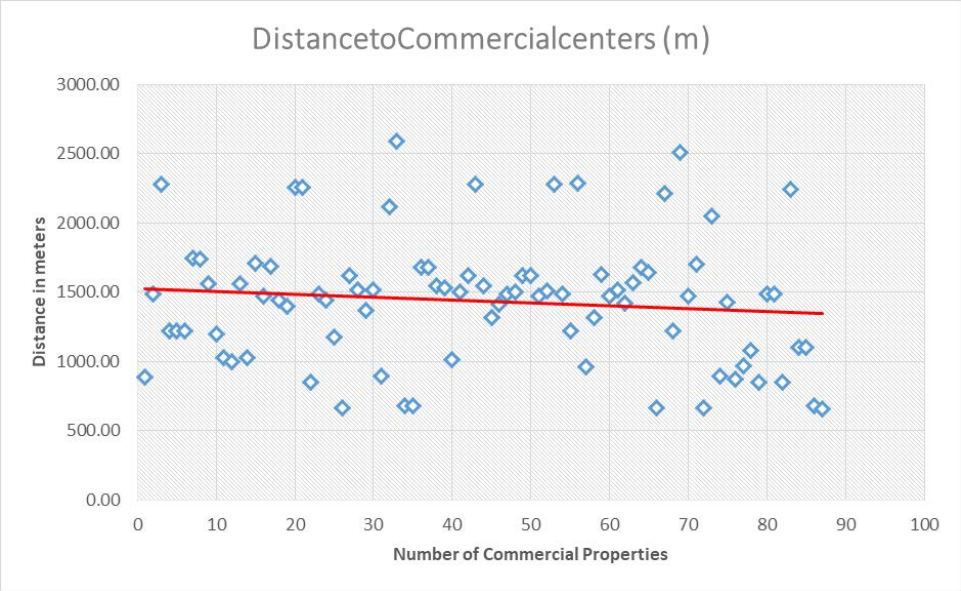


Fig 19 Graph for Distance to other Commercial Centres

3.8.5 Distance to Schools

The maximum distance between the furthest commercial property and nearby schools was 1450 meters while the minimum distance between the closest commercial property and nearby schools was 208 meters. The median distance 863 meters was less than the modal distance of 1410 meters as mentioned before when the median is less than the mode the data is skewed to the left. The skewness negative value of -0.16552 supports this. However, the skewness lies between -0.5 and 0.5 which the measure for moderate skewness and where the data is approximately symmetrical. This means that the data does not violate the assumptions of the multiple regressions as much as other variables which have more skewed data.

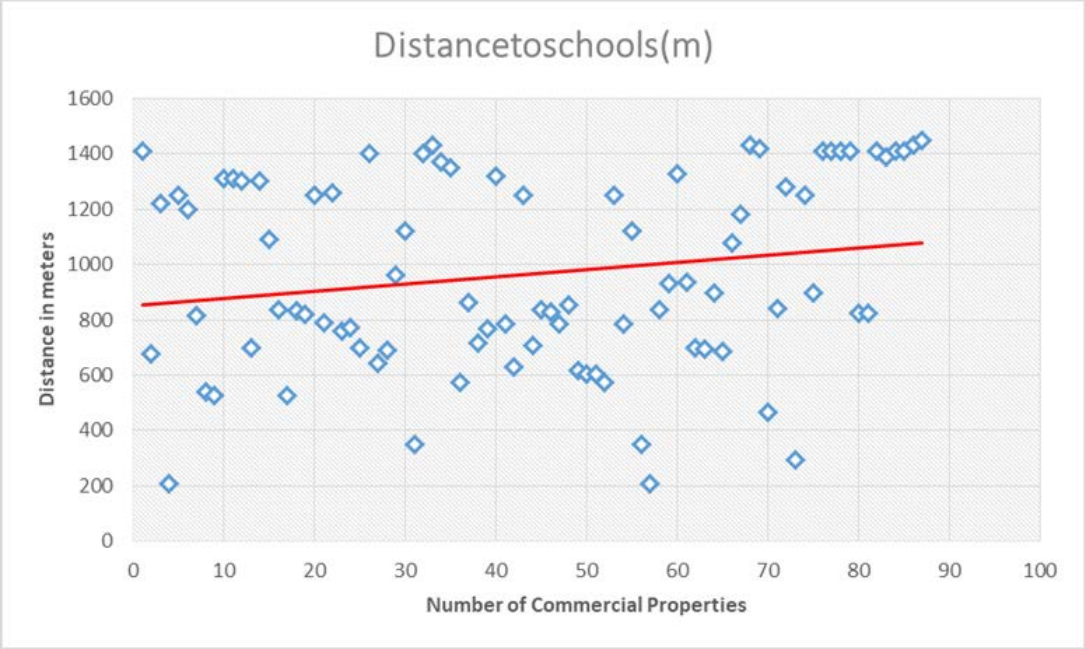


Fig 20 Graph for Distance to Schools

3.8.6 Property Age

According to the data the maximum age was 81.58 years while the minimum age was 2.08 years. The median 29.17 years was greater than the mode meaning the data is skewed to the right. However, the data is also moderately symmetrical because the skewness value of the variable was 0.4000 which also lies between -0.5 and 0.5. Fig 21 shows that the data is approximately symmetrical as the two sides almost mirror each other. This means that the data does not violate the assumptions of the multiple regressions as much as other variables which have more skewed data.

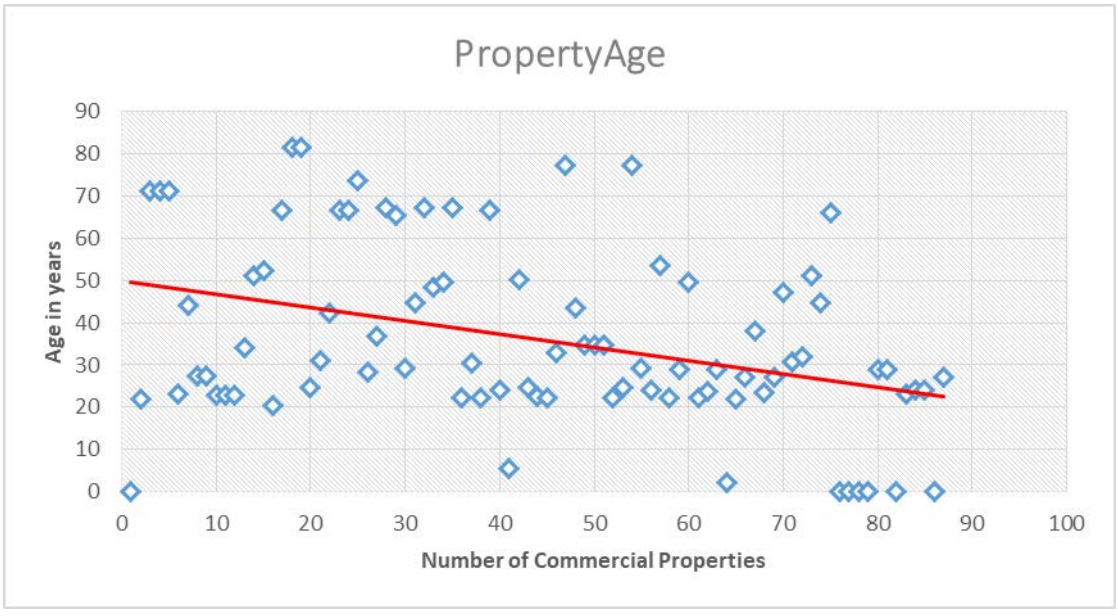


Fig 21 Graph for Property Age

3.8.7 What the Descriptive Statistics Reveal about the Data of the Variables

As mentioned in the beginning of this section of the report it is important to note that when carrying out regression and correlation analysis the raw variables do not necessarily need to be normally distributed. Although they do need to be symmetrically distributed as this improves the reliability of the results for the analysis. The descriptive statistics of the distance to the Jeppestown railway station show that the data is not distributed normally due to the existence of outliers which lead to skewness. This affects the results of the regression because having skewed data violates some assumptions of a multiple regression analysis. The statistics for the data regarding the distance to Maboneng variable are also not normally distributed due to the existence of outliers which lead to skewness. The statistics for the data regarding the distance to Commercial Centres was a bit different in that it was approximately symmetrical. This affects the results of the multiple regression but less so than the first two variables would. The same can be said about the data regarding the distance to schools and property age variables. These statistics are important as they have an impact on the multiple regression model selected to test the Null Hypothesis in this study.

3.9 Selecting a Model

In the sample of commercial property market transactions, it is possible to use econometrics to separate out the implicit value of attributes which can be determined by the parameter estimates also known as the coefficients in the regression analysis table. The basics of this method involve measuring the property value against a set of independent variables measuring quality, access while controlling for area effects and external factors. I ran several models in order to arrive at the final model, this was to also test the validity of my results because the final model should be one that can be used repeatedly to produce the same results each time. This section details how I arrived at the final model used in this study. The model selection was informed by the descriptive statistics section. The multiple regression function takes the following form:

$V = f(S, D, A, N) + \varepsilon$

Where,

V is the Value of commercial property

A is the property age

D: is Distance

N is the number of times sold

S is size of commercial property

Where the value is a function of the commercial property's structural or physical characteristics (parking, size in square meters, number of floors etc.) ε is the error term. The commercial property value is therefore a function of all the attributes relating to the commercial property. The resulting coefficients are the marginal implicit impacts of the attributes. To get a more detailed explanation of multiple regression models see Gibbons and Machin (2008)

The first model I ran had a total of 308 0bservations. The set of variables I measured using this model included the following; distance to railway station, distance to Maboneng, distance to commercial centres, and distance to schools, the dummy variable for before and after the establishment of Maboneng, Property age, Property size and the cadastral size. However due to the outliers in the data of each independent variable this produced skewness. The skewness affected the significance of the variables in this model resulting in no variables being significant. This was despite it producing an

adjustable R square value of 35.6%. None of the variables were significant in this first model as they were greater than the measure of significance which was 0.05. The lack of significance was a result of the skewness in the dependent variable data, the distance data and the property age data as mentioned in the descriptive statistics section of the report. I adjusted for skewness by removing outliers before running this model.

1st Multiple Regression Model

Commercial Property Value = β_0+B_1 Dist_Station +B_2 Dist_Maboneng + β_3Dist_CommercialCenters + β_4 Dist_Schools+β_5 BeforeandafterMaboneng+β_6 Property Age+ β_7PropertySizeSqm+ β_8 +β_14Cadastral Size +ε

To improve the validity of the results for the model I removed outliers from the dependent variable (value) and from the distance variables as well as the property age variable. In this model, I logged to the base 10 the distance variable and property age data in order to reduce the effect of the skewed data on the results of the model. The model had 242 observations the number dropped after removing outliers. This time the model produced an R squared of 3.17% which was way too low. There was only one factor was significant which the logged distance to commercial centres was; therefore, I rejected this model as it did not help in answering the research question.

2nd Multiple Regression Model

Commercial Property Value = β_0+B_1Log_distance to station

+B_2Log_Distance to Maboneng + β_3 + β_4 Log Distance to Schools +β_5 BeforeandafterMaboneng+β_6 Property Age+ β_7PropertySizeSqm+ β_8 +β_14Cadastral Size +ε

A third Model was run to resolve some of the issues encountered with the previous two models. To improve the adjusted R square value in a regression I included more independent variables to be measured, these variables included; distances to railway station, Maboneng, commercial centres, schools and the property age all logged to base 10. I also used the dummy variables for before and after the establishment of Maboneng, property size, cadastral size, and retail property type, industrial property type, unidentified property type, date of purchase, number of sales and the dummy variable for the year of purchase.

Through the descriptive statistics section it was determined that data from some variables was skewed. This influenced the distribution of the data and violated the assumptions of a multiple regression analysis. To mitigate the effect of the skewed data I transformed the data from the variables which had skewed data using the log-base 10 to improve the validity and reliability of the results.

The variables which were logged to base 10 included the distance variables and the property age variable as previously done before however this time properties which had incomplete data were removed which left the total number of observations in this model at 87. The justification for this major reduction in number of observations was supported by literature on degrees of freedom, which stated that the absolute minimum number of observations should be at least five times the number of factors to be correlated. In this study, there are 10 factors to be correlated excluding the dummy variables used. The 10 variables give 50 as the minimum number of observations and a degree of freedom of 37 which is tight but can vary reasonably in the analysis without breaking any constraints. The multiple regression model was then run to determine the impact of the following variables on the dependent variable which is the value of commercial properties in Rands.

3rd and final Multiple Regression Model

Commercial Property Value = β_0+B_1Log10_Dis_to_train

+B_2 Log10_Dist_to_Maboneng+β_3 Log10_Dist_to_CommercialCenters + β_4 Log10_ Dist_to_Schools + β_5 Log10_Propertyage + β_6Before_and_after_Maboneng β_7 Property size/floor area ratio + β_8stand size + β_10 Retail + β_11 Industrial + β_12 Unidentified +β_13 Date of purchase +β_14Number of Sales +β_14 Dummy year of Purchase + ε

Where:

Log10_Dist_to_train = Distance to Train Station

Log10_Dist_to_Maboneng = Distance to Maboneng

Log10_Dist_to_CommercialCenters = Distance to Commercial Centres

Log10_Dist_totSchools = Distance to schools

BeforeandafterMaboneng = before and after the Maboneng Precinct (Timeline)

Log10_PropertyAge = Property age

PropertySizeSqm = Property size in square meters

Retail = Retail property

Industrial = Industrial property

Unidentified= unknown property

Stand size = Size of Cadastral

Date of Purchase = Date of actual Purchase

Number of Sales = Number of times a property was sold

Dummy year of Purchase = the year in which the property was purchased

This model had more significant variables which it was used to test the null hypothesis and answer the research question. I will report on the variables which were significant in the findings section.

3.10 Limitations of the Study

According to Saunders et al. (2009), a research methodology is the spine of a research study. In every study, the methodology consists of two phases firstly planning and then the execution. It is very normal to have limitations beyond our control in both these phases (Simon, 2011). This study has taken a case study approach and is quantitative in nature. This section of the report aims to discuss some of the possible limitations associated with conducting a similar study.

The biggest limitation when it comes to planning for quantitative research is data, after acquiring the data the researcher must ensure that the data has been checked for errors before any research can be done. It is important to know that when dealing with quantitative data is that it is very expensive and time-consuming. This type of research requires careful planning; in order to achieve complete randomisation and the correct designation of control groups (Morgan 1980). In terms of execution, the quantitative approach may also give the researcher difficulties in data analysis as it requires an

extensive statistical analysis, which can be difficult if the researcher does not have a statistics background. Performing a quantitative study can also require the use of extra resources to analyse the results, in this study we will use Microsoft Excel mainly. The above mentioned are some of the more general limitations associated with planning and executing quantitative research.

Although a 1km radius may be narrow an area to test the hypothesis I must stress that the cost of acquiring the data and the spatial configuration of the area was a limitation to this study. The cost limited the use of a larger area and the sample of commercial properties analysed. The study area does offer other modes of transport which offer people access to economic opportunities as well. This could have an impact on the demand for rail transit, which in turn affects the possible impact of the railway station on commercial properties (Shires, Ojeda-Cabral and Wardman, 2018).

3.11 Empirical Issues Associated with using a Multiple Regression Model

A major limitation involving the multiple regression model is the choice of the functional form, for example the linear, semi-log and log forms which can be applied to the regression model. Choosing the wrong functional form can result in inconsistent estimates (Bloomquist & Worley 1981; Goodman 1978). According to Butler (1982); Halvorsen &Pollakowski (1981) the discourse on regression models gives little guidance on the choice of the proper functional form to use.

Another limitation associated with the multiple regression model is the misspecification of variables. This is when an irrelevant independent variable is included (over specification) or when a relevant independent variable is left out (under-specification) (Diewert, 2003). The issue here is that multiple regression model deals with implicit values of quantities of attributes of a product it is only inevitable that misspecification of variables happens. Another common limitation of multiple regression model is incomplete data; this can be problematic for the researcher in that it can lead to misleading conclusions and unreliable results.

3.12 Validity and Reliability of Data

According to Messick (1989) validity refers to the extent to which an instrument or tool used in research purports to measure what it is meant to measure. In the same instance, Heale and Twycross (2015) describe validity as the extent to which a concept is accurately measured in a quantitative study. There are three forms of validity and these are namely content validity, construct validity and criterion validity.

Content validity refers to how adequately a tool or instrument is used in the quantitative study to cover all the content that it needs to regarding the variable being measured. Construct validity refers to the extent to which a research tool measures the intended construct (Heale and Twycross, 2015). In this study, this would relate to how well the regression model measures the intended construct of the study which is the relationship between independent variables and property values. Lastly, criterion validity refers to the extent to which a research tool or instrument used is related to other tools which measure the same variable.

There is one important aspect of validity useful in this quantitative study and this is internal validity. Internal validity refers to how well an experiment has been carried out especially when it involves more than one variable acting at the same time. In other words, internal validity is the extent to which a piece of research allows the researcher to choose among alternate explanations for a finding (Heale and Twycross, 2015). In this study, this could be the case depending on the findings.

To summarise, validity is the extent to which inferences made about the results of an assessment are appropriate to the study. Messick (1989) goes on to say that it is a matter of degree and not a specific

value. In his view validity is applied to a specific purpose and therefore cannot be employed for all purposes.

Reliability refers to the extent that the research study produces stable and consistent results. A study is considered reliable if it can be performed by several different researchers and produce consistent results; this is because reliability reflects consistency and replicability over time. Reliability is the point to which a test is free from measurement inaccuracies. The more measurement inaccuracies that exist the less reliable a test or research method is (Fraenkel & Wallen, 2003; McMillan & Schumacher, 2001, 2006; Moss, 1994; Neuman, 2003). This study will ensure that the data is reliable by carefully sorting and arranging the data before using it in the regression model. The data is coming from Lightstone (Pvt) Ltd which is a reputable and reliable data source.

3.13 Conclusion

In conclusion this chapter has described in detail the method of research used for this study. This is in relation to the way in which the data was purchased, arranged and run in the multiple regression model. The chapter also described the statistics behind the variables and how they could have an impact on the type of model used and therefore the results of the regression analysis. The chapter has also highlighted the advantages of using a multiple regression model in carrying out quantitative analysis as it enables the researcher to draw out a correlation between the independent variables and the dependent variable. This has been done in order to set up the analysis and discussion which will follow in chapter 5. In the latter section of the chapter there was a discussion around some of the possible limitations of a quantitative study and the pitfalls that researchers could fall into. The next chapter is a case study section which will be important to illustrate what constitutes of the study area and how it has or hasn't changed over the time since 1886.

Chapter 4: The Case Study

The drive for public transport infrastructure investment in South Africa has largely been supported by global government intervention models (Dawjee, 2015). It is important to note that South Africa has a total of 22 298 km routes of rail infrastructure. It is the 11th largest rail network in the world and the largest in southern Africa.

In its bid to achieve its core competency of contributing towards the establishment of a developmental state, the South African government decided to establish state-owned enterprises which are companies that provide financial, organizational and an oversight function for the state's infrastructure projects (Mnyaka, 2014). PRASA is an example of one such SOE used in providing rail transport services (Mnyaka, 2014). PRASA was established in 2009 to position and promote rail as the preferred mode of travel along high density and high-volume corridors in South African cities including Johannesburg. Since its inception, PRASA transports around 560 million passengers annually with 53% in Gauteng, 30 % from Cape Town, 13% from Durban and 4% from the Eastern Cape (Mnyaka, 2014).

After it was established PRASA took over 317 stations of the 468 stations Metrorail operates (Mnyaka, 2014). To this end since taking over, PRASA provides commuter rail service on 3180 kilometres of the track of which it owns 2228 kilometres. The significance of this for the study is that the Jeppestown Train station is one of these 317 stations owned by PRASA (Mnyaka, 2014). They have invested in rail infrastructure with a mandate to provide rail commuter services for the Republic which are also within the public's interests. This is according to the principles set up in section 4 of the national land transport transition Act, 2000 (Ayandibu, 2010). PRASA is authorised by the government to play an essential role in the development of social and economic infrastructure in a post-apartheid South Africa.

The company has several divisions but the PRASA Corporate Real Estate Solutions division (CRES) is responsible for real estate asset management, facilities management, and property development. They also have a subsidiary company Autopax which provides a bus feeder service for their customers (Mnyaka, 2014).

4.1 The History of Jeppestown Rail Transit

Jeppestown is one of Johannesburg's oldest neighbourhoods, established in 1886 as a result of the Gold Rush mania which had gripped Johannesburg during this period (Beavon, 2001). The area used to employ racial occupancy classes as lease agreements. This meant that people of certain groups, mostly non-whites could not settle in certain parts of this neighbourhood (Beavon, 2001). This could be argued to have been the forerunner for the apartheid system which followed. The racial zoning had a profound effect on how people of colour accessed Jeppestown during this time (Beavon, 2001). However for people of European descent the town was busy and vibrant filled with traders, shopkeepers, farmers and prospectors all coming together to interact, sell, buy their products or just have a cold beverage; Jeppestown was certainly the place to be (Beavon, 2001)(See fig 3).

Fig 3 an image depicting the sort of scene one would have witnessed in Jeppestown during the late 1800s. Adapted from Some African Recollections South (Phillips, 1899)

The town developed rapidly partly due to the need to transport gold down to the Cape for export and a transport option for the increasing population of immigrant workers looking for a brighter future (Beavon, 2001). This was the case such that by 1888 rail was the mode of transport being used more frequently to import food and other provisions for the workers living and working in the town at the time (Beavon, 2001).

As is often the case with transport nodes the public spaces around this first station became areas of trade and entertainment for commuters and residents alike (Valentim, 2017). The town began to grow in prominence such that by 1896 the Jeppe boys and Girls schools, the first public library the historical post office, fire station and the original station next to the grand central hotel had all been built (Valentim, 2017). The original station (see fig 4) as mentioned before was built in 1896 in order to accommodate the railway line established along Main Street (Christopher, 1999). This station enabled Jeppe to become an important arrival point for many businessmen dealing with gold. In the process becoming the second busiest railway station after Park Station (Beavon, 2001).

Fig 4 Image showing the first station in Jeppestown in 1896. Adapted from Some African Recollections South (Phillips, 1899)

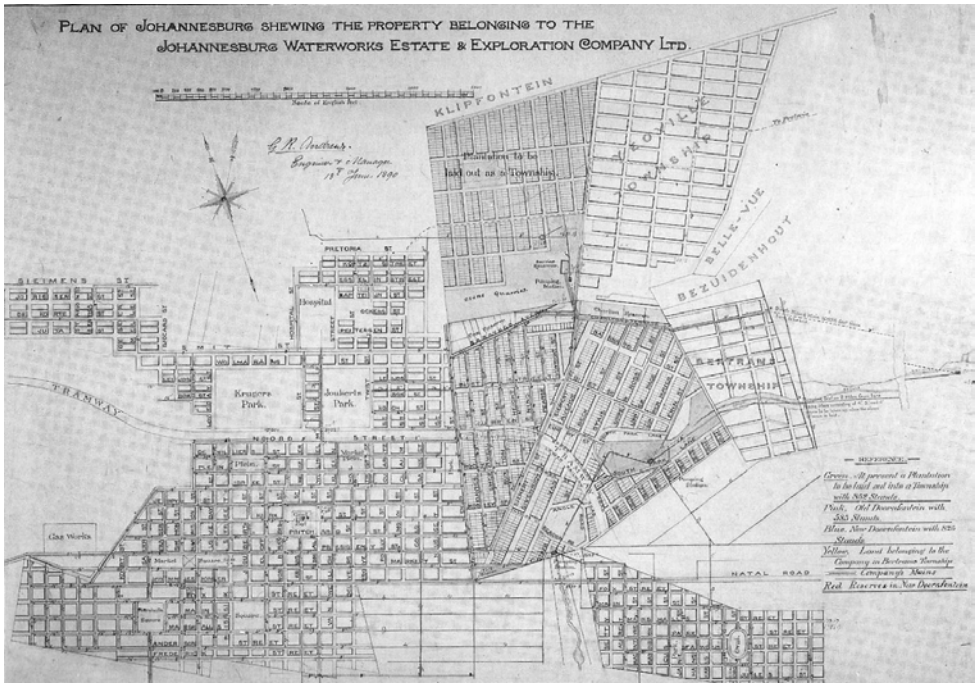


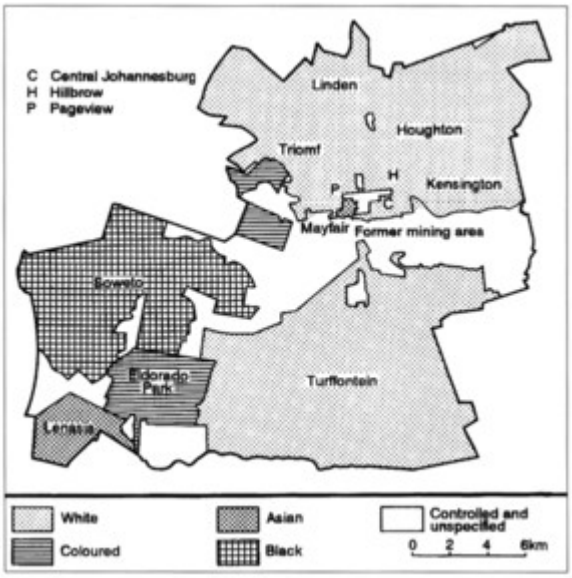
Fig 5 Image showing the change in the grid layout after 1890 before the railway line. Adapted from the Johannesburg 1912 World Press – Suburb by Suburb Research)

By 1896 the railway line had reconstructed and placed below street level which caused a major change in the towns' original grid layout just after 6 years (see Fig 5) (Beavon, 2001). The original train station was later demolished and replaced by the now familiar Jeppe railway station we see today (see fig 6). The railway station has an interesting origin and it is interesting to note that the 120 km of surface rail is as old as the city of Johannesburg itself (Beavon, 2001).

Fig 6 showing the change in the layout after 1896. Adapted from the Johannesburg 1912 World Press[2] – Suburb by Suburb Research

During days of racial zoning the built environment was an essential and conspicuous element of the compartmentalisation that colonialism brought to African cities, Johannesburg included (Christopher, 1999). This type of land use zoning meant that people could only own property or settle in areas designated for them according to a racial hierarchy which usually placed whites on top and people of colour below them (Christopher, 1999). This did not change because after the colonial city model came the apartheid city model which was spatially organised along the same racial lines and premised on segregation. The apartheid city model had oppressive legislation such as the 1950s group areas act and the black communities' development act 4 of 1984 supporting it. The extent of this segregation was that between 1950 and 1991 over a million hectares of urban land was zoned in racial terms. This was very inequitable given the population demographics in South Africa with 21 ha per 1000 coloured people and 183 hectors per 1000 white people (see table 1 and Fig 7). The direct effect on access to cities for the previously marginalized and still impacts them today as previously mentioned in the background.

2 https://johannesburg1912.wordpress.com/2013/07/06/jeppestown-belgravia-pt-3/ (Accessed 24/12/2018)



Group	Area (000 ha)	Population (000s)	Area (ha) per 1000 people
African	147	6 963	21
Asian	53	808	66
Coloured	110	2 380	46
White	752	4 100	183
Total	1062	14 252	74

Fig 7 and table 1 above show the spatial inequality in urban areas due to the racial segregation imposed first during the colonial times and the reinforced by apartheid spatial planning

4.2 The Current Context of Jeppestown and the Commuter Railway Station

Jeppestown is in Johannesburg which is one of the two metropolitan areas in the Gauteng province (see Fig 9). The western section of Jeppestown is where the study area is located and was originally zoned industrial but has gradually been used for low-income housing (Dawjee, 2015). In terms of accessibility, Jeppestown can be accessed by two major roads, Commissioner Street and Jules street. When travelling from Jeppestown, Commissioner Street which provides access to Kensington, Jan Smuts Airport and the East Rand; Jules Street which provides access to Malvern, Germiston and the East Rand (Mashiri, 2017).

The study area is also well connected by a rail network line stretching from Germiston right through to the Johannesburg Park station, providing an important link for people to access economic opportunities located in the CBD.

The neighbourhood is divided into two sections, Jeppe east and Jeppe west. Jeppe east comprises of semi-detached and detached housing while Jeppe west consists of Industries, factories, and warehouses. The area falls under ward 61 of Johannesburg Metropolitan Municipality has a total area of 2.6 square kilometres and a population of 16 971, 60 % are males working in factories. Then there are 8.9% of the total population who use the train, according to the 2011 census (Valentim, 2017). The average annual income is R14 600. The area's unemployment stands at 23.3% while the whole Metropolitan area stands at 26.7%. There are approximately 27.9% of households with no income which affects commercial activities, especially in the retail sector. The area has two major public transport routes as well as a Metropolitan road (see Fig 13). It is a low-income neighbourhood with

many of the old factories having been illegally occupied by residents without rezoning applications sent to the city (Beavon, 2001). Proximity to a railway station is of higher value to low-income residential neighbourhoods than to high-income residential neighbourhoods (Nelson 1998; Bowes and Ihlanfeldt 2001).

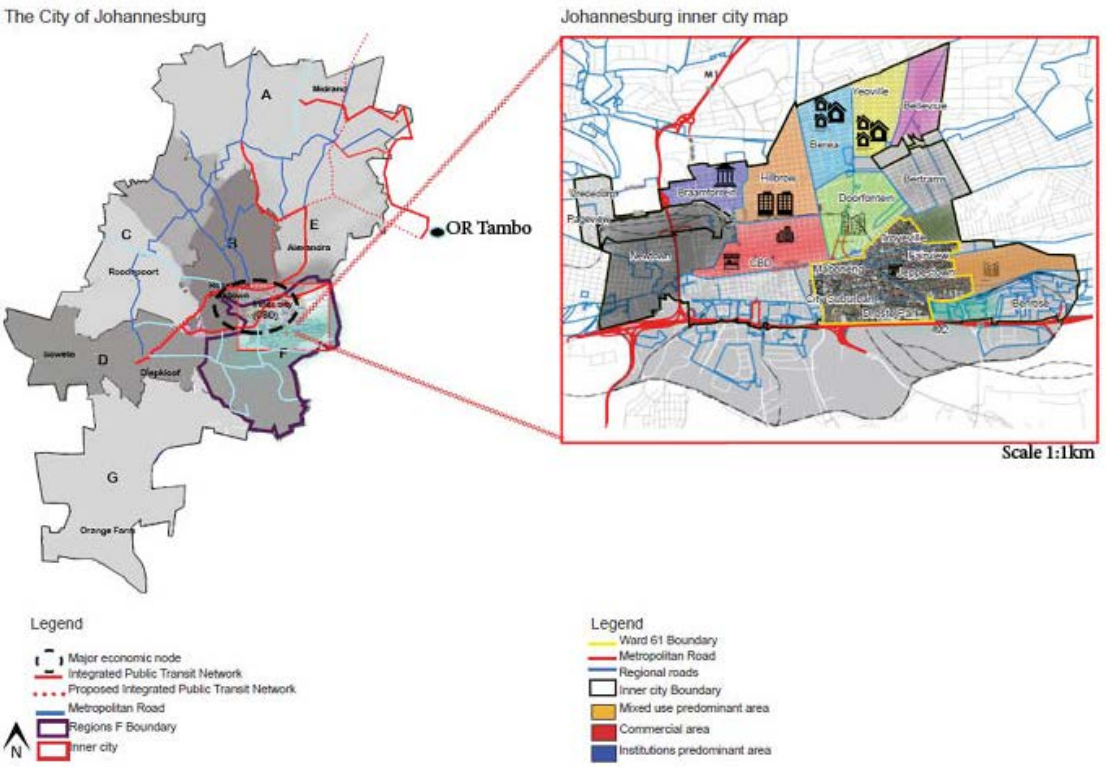


Fig 9 Map oh Johannesburg Source: (J Nethenzheni 2017)

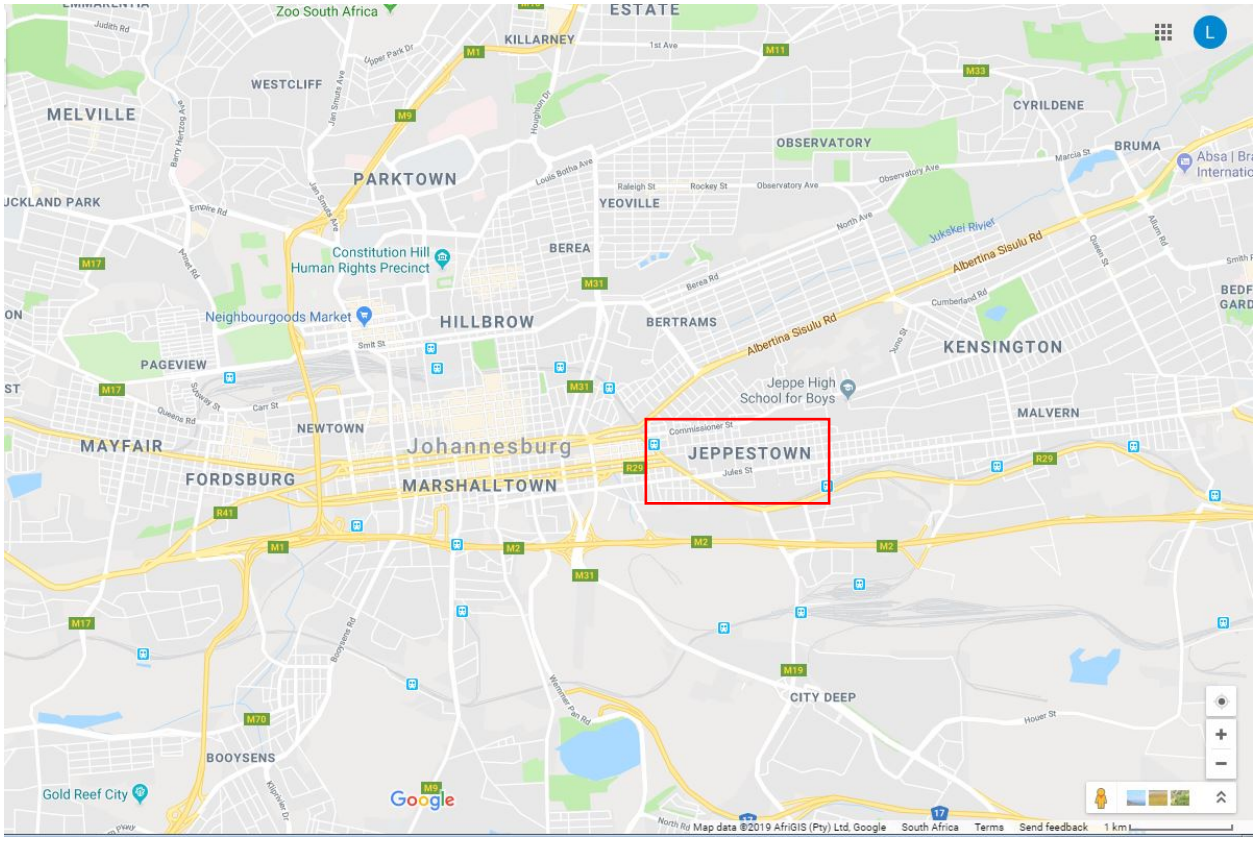


Fig 10 Map of the Johannesburg inner- city area

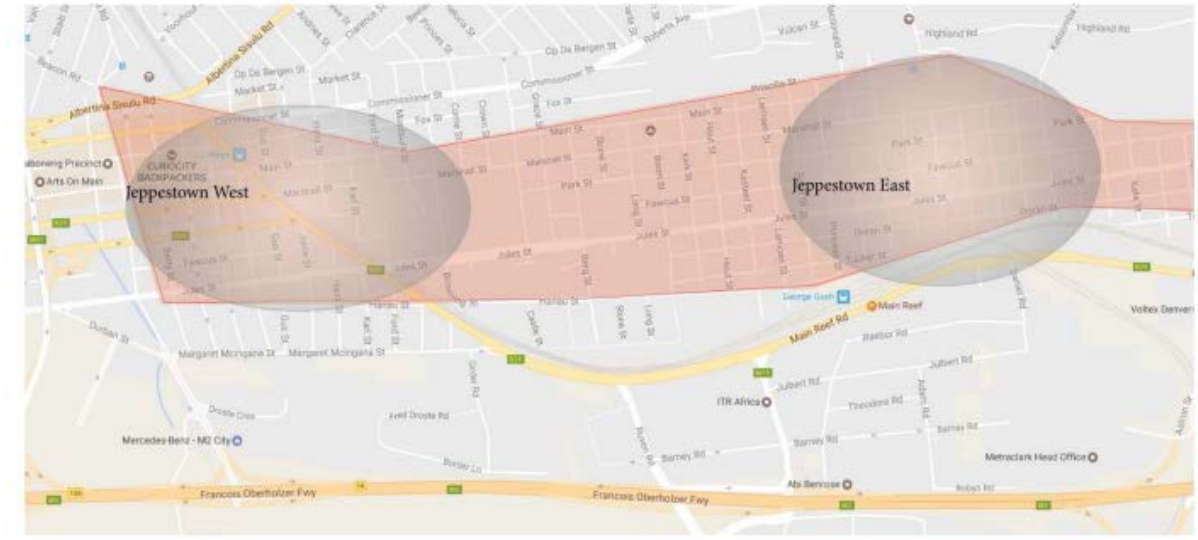


Fig 11 Map of Jeppestown West and East (Source: Google Maps 2019)

Fig 12 Map showing the location of the train station and the 1 km study area

Fig 13 an image showing how some of the buildings in the area have maintained their architecture and aesthetic from the earlier days.

The railway station is in the heart of Jeppestown enabling it to serve as an arrival point into the city (see Fig 12). It is bounded by the Doornfontein hostels towards the south and Maboneng towards the East. The commuter station primarily operates to connect the city centre and middle to outer suburbs. The station is used by low-income people travelling from township areas located on the fringe of the city (Nelson, 1998). These are people travelling to work, school and do their shopping in the area filled with small retail businesses (Nkoane, 2016). The users also influence the commuter patterns around the station, for example most low- income people cannot afford private vehicles, so they need to walk to and from the station(Nelson, 1998). They are walking to small retail shops, commercial buildings where they possibly work and the informal and formal traders which surround the precinct where the station is located. The users are also walking towards the taxi rank which is located close to the station which can then connect them with the rest of the city and its employment and economic opportunities. The users define the overall walking patterns in the area where the station is located, and they are in danger of crime as the area is a well-known crime hotspot.

This proximity and the stated high unemployment figures then enable the researcher to begin to discuss the possible benefits of the deliberate transport policy shift by the post-apartheid government. The main objectives of the transport policy shift were to help people who had been previously left out of the economy. This means giving them access to the city in a safe and reliable way. This shift was championed by the City of Johannesburg's former Mayor Parks Tau (2011-2016) who along with his administration worked tirelessly to encourage a change in the behaviour of people in Johannesburg. They tried to get people to move from relying heavily on private vehicles towards using public transit initiatives such as the BRT (2012) and the facilitation of better passenger rail services.

The study area is ideally located close to the job and economic opportunities (approximately 3 kilometres from the CBD) sort after by the formerly marginalized groups during apartheid (Patel, 2008). The area has been chosen in order to help discuss some of the key issues that arose in previous research done on the inner city. There have been studies which found that investment has been withdrawn from the inner-city due to the flight of capital during the late 1980s as well as the existence of crime and grime. (See Fig 15)

Fig 14 an image of a commercial building abandoned in the inner-city after the flight of capital
Source: Johannesburg's Inner City Blues blog by Victor Dlamini

Previous researchers indicated that the crime and grime has been a nuisance which has deterred investors from buying property in the inner-city, even though there was good transport infrastructure in place in the city at the time (Beg, 2014). The crime has not reduced in Jeppestown according to reports in 2017 there was a record high 124 murders, an increase of 40% from the previous year. The area has several hostels which house male migrants looking for a better life in Johannesburg and these are the usual victims of the crimes. According to some of the residents “Police don’t want to confront their friends, the criminals” also the level of crime is due to the high unemployment in the area as mentioned before. (Saturday Star, 2018)

4.3 The Study Site through Time (2001-2015)

The site has not changed much in this period of the investigation except for some new additions in land uses and has parking notably from 2005 with the Jozi Mall Mosque being built opposite the station. This will be visible in the series of orthophotos to be presented in the annexures. The SOE PRASA took over management of the train station in 2006 and in 2008 City of Johannesburg in partnership with PRASA built up a car park which has street trader stalls on the outside as well. There are also flea markets and a meat market right by the train station which from the evidence of the orthophotos began around 2007 as well. The other notable change is the regeneration efforts by the city of Johannesburg and property developers which resulted in the Maboneng precinct (2012) and other inner-city renewal projects. This section of the chapter presents a locality map for the study illustrating how the area has evolved through a series of orthophotos taken from Google Earth pro between the periods 2001, 2005 and 2015 (see Appendix).

Chapter 5: Discussing the Results and Conclusion

5.1 Results and Discussion of the Model

According to the fig 22 the F ratio was 3.809748987. This is a rather large value and supports the rejection of the Null hypothesis as this value is not close enough to 1.0 which would have been expected if the Null hypothesis were true. This means that the variation among the group means is more than I expected to see by chance. The f test value supports this as it suggests that there was a relationship between the dependent and independent variables. In the fig 23 showing the table with a summary of the regression, the R-squared (0.4255) and adjusted R-squared (0.30) illustrate the strength of this relationship between the independent and dependent variables. However, the adjusted R-square is a better measure as it has been adjusted for the number of predictors in the model. The adjusted R square shows that the significant independent variables have a 30% impact on the dependent variable. In terms of the probability value it was expected that if the p value was less or equal to the level significance of o.o5, then the null hypothesis is to be rejected. This means that in this study there is a relationship between the independent variables and the dependent variable which is the value of commercial property.

	df	*SS*	*MS*	*F*	*Significance F*
Regression	15	1.1226E+14	7.48403E+12	3.809748987	6.372E-05
Residual	72	1.51543E+14	2.10476E+12		
Total	87	2.63803E+14			

Fig 22 ANOVA Table

Regression Statistics	
Multiple R	0.652339148
R Square	0.425546364
Adjusted R Square	0.299958157
Standard Error	1450778.624
Observations	87

Fig 22 Summary output of 3rd Regression Model

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	5850713.59	6144508.47	0.95218578	0.344188438
Log10_Dis_to_train station	-830704.33	986866.1159	-0.841759907	0.402709594
Log10_dis_to_Maboneng	2024132.278	1330476.736	1.52135864	0.132549729
Log10_dist_to_commercial Centers	-2668199.98	1741525.031	-1.532105443	0.129878782
Log10_dist_to_schools	2268852.051	1012749.544	2.240289383	0.028158912
Log10_Propertyage	-1234475.807	448167.6323	-2.754495679	0.007438045
BeforeandafterMaboneng	-42533.79304	412278.9486	-0.103167511	0.918116841
Property Size/Floor Area Ratio (Sq.m)	-237.6020514	514.0031503	-0.462257967	0.645290208
StandSize	-56.25554688	97.98950287	-0.574097686	0.567690938
Retail	-1717958.565	457059.3073	-3.758721324	0.00034437
Industrial	-2058483.263	549507.8899	-3.746048603	0.000359228
Unidentified	-2454989.194	864501.2014	-2.839775341	0.005864744
Date of Purchase	-72.25077754	47.17683934	-1.531488301	0.130030999
Number of Sales	-43373.98976	167550.5876	-0.25887101	0.796473425
Dummyfor year of purchase	15909.51581	76778.84627	0.207212228	0.836429051

Fig 23 MRM per variable

After selecting the model to be used to test the hypothesis through the model selection phase of the study I ran this model to measure the impact on commercial property values coming from the following variables; distance to railway station, Maboneng, commercial centres, schools, the property age, dummy variable for before and after the establishment of Maboneng, Property size, cadastral size, and retail property type, industrial property type, unidentified property type, date of purchase, number of sales and the dummy variable for the year of purchase between 2005 and 2015. The findings of which have will be discussed in this section of the report.

The model produced an adjusted R-square of 0.30 which means that this model explains 30 percent in the variation of the value of commercial properties in the study area. This is an acceptable percentage (Frost, 2018). The summary of the multiple regression per variable table shows that with this model there were 5 independent variables which were statistically significant.

The adjusted R square value 0.30 did prove that the independent variables are correlated with the dependent variable, however it does not fully explain the variance in the dependent variable. This was very useful in my attempt to understand and illustrate the need for a linkage between proximity to a railway station and commercial property value, using the data available. It was necessary for this study to investigate how rail transit stations interact with the urban commercial property market (Frost, 2018). I will now explain the findings in relation to the independent variables measured by this model.

5.1.1 Distance to Jeppestown Railway Station

The distance to the railway station was not significant because the probability value from the model was 0.4027, which is greater than the significance level of 0.05 used as the measure of statistical correlation in this study. This means proximity to a railway station did not impact the value of commercial properties within 1km of its location. It is also important to note the coefficient as this determines what effect the independent variables have on the dependent variables in cases when they are significant. The coefficient for the distance to the Jeppestown railway station was negative meaning that as you move further from the railway station the value of the commercial properties decreases.

According to Armstrong (1993) this finding is not all bad as it provided an opportunity to use a different perspective on the study. Armstrong (1993) argues that if a railway station is in a study area and has no significant impact or has a negative impact on property values. It means the researcher should consider looking into other determinants considered when valuing commercial buildings this was the case with this study. It is possible that the railway station is not significant to the study because there could be other determinants influencing the value of the commercial property. In the literature review such determinants have been discussed. These determinants are quality, existence of other access points into the study area, non- productive amenities as well as the proximity to other nearby amenities.

There has been extensive cover of literature on European cities which has reported occasions when there was no apparent impact before and after a railway station has been established (Forester et al, 1996). This could be a result of externalities of other factors. In addition, Debrezion et al. (2007) performed a meta-analysis of 57 hedonic studies of railway stations. In some hedonic studies there were very high positive impacts for properties near railway stations, while others found that new lines had negative or no effects. This could be a result of externalities which result from having the railway station in close proximity.

The positive externalities are usually in the form of lower transport costs, safety, reduced travel times and overall efficiency. While the negative externalities are crime and noise. These negative externalities could possibly negate access to the railway station making it a less desirable attribute.

The Jeppestown area is known as a crime hotspot within the Johannesburg CBD area as mentioned in its brief context. This does support the arguments proposed by Armstrong (1993) and Bowes (2001), which stress that crime is an important contributing factor to the insignificance of proximity to railway station, especially for a commuter railway station where most users walk to their intended destination after disembarking from the train.

The literature on the proximity to railway stations mentions that there are other contributing factors which should accompany proximity. In his study Aterkawi (1991) proposed an important argument in support of this line of thought. He argued that the overall impact or benefit from proximity to a station can depend on the characteristics of the railway station, average income of the neighbourhood in which the commercial properties are located as well as the distance between the railway station and the CBD. Although this may be true, Duncan (2008) argues that for a railway station to have a significant impact on the value of commercial properties it must be complimented by a very well-designed pedestrian-oriented environment. This improves access, functionality, safety and aesthetic of the area (Bickford, 2016). Consequently, it also improves the perception of the area where the railway station is located and only then crime might become less of a factor (Carlton 2007).

5.1.2 Distance to Maboneng

In South African literature on Johannesburg many researchers including Cabaret (2014) have been quoted saying that, “Nobody walks in Johannesburg”, “We can only walk in malls”. Or even, “there are no streets in Johannesburg”. This is due to the perception of urban decay, trash, graffiti, congestion and crime which have persisted in the inner-city as a result of disinvestment in properties within the CBD which began during the mid-1970s and accelerated in the early 1990s. Peyroux (2002) and Cabaret (2012) do mention that the City of Johannesburg’s has made considerable efforts through its recent policies and partnerships with the private sector (property owners and developers) including the urban regeneration initiatives and continued establishment of special ratings areas (formerly known as CIDs) to bring investors and people back to the city and to improve the pedestrian flows.

Within the literature Tibbalds (2001) argues that the public realm or environment is an important place in a city as it is where most human contact and interaction take place. He mentions that the public realm extends from streets to parks, squares, porches outside buildings and even public transport stops. In his book “Making People-Friendly Towns: Improving the Public Environment in Towns and Cities” he critiqued urban planners and accused the profession of concentrating more on individual buildings and vehicular movement when it is the places in the public realm which matter more. This is how the city of Johannesburg had previously been planned under apartheid and during the automobile era. However, through urban regeneration efforts this is not the case in Maboneng because the pedestrian realm does accommodate pedestrian traffic. This theory seems to suggest that areas which have undergone urban regeneration have a significant but debatable impact on property prices.

However, the findings in this study are contradictory to such arguments in the literature because the distance to the Maboneng variable when measured was not statistically significant. This was because it had a p-value of 0.1325 which is greater than the significance level of 0.05 used as the measure of

statistical significance in this study. Although the coefficient is positive it has no impact as the p value is greater than the significance level of 0.05. This is not surprising because the precinct is positioned as an island within the inner-city Jeppestown area with no connection with the rest of the streets in Jeppestown (see Fig 23). That is to say that the people who come to visit the precinct do not cross over from its safe "invisible walls" into the other streets in Jeppestown.

The reason being the prevalence of high crime in Jeppestown (see appendix), and this is probably as a result of the high violent crime in the area which is supported by a well documented 40 % increase in murders from 2017. The high crime comes from the fact that many young adults are excluded from the economy in Johannesburg with a high unemployment rate of 23% (Peyroux (2002) and Cabaret (2014). It is important that the city does not replicate Islands such as Maboneng, but rather actively link nodes together using the anchoring of nodes as a strategy. Islands such as Maboneng do not help reduce unemployment or crime they merely hide it behind the invisible barriers of social and economic exclusion (Peyroux, 2002). There is a need for more inclusive and integrated streets in Jeppestown in order to encourage people to walk and use them to access the railway station. This can help improve the perception of the Jeppestown neighbourhood and possibly attract new people as well as property investors back to the Johannesburg inner-city.

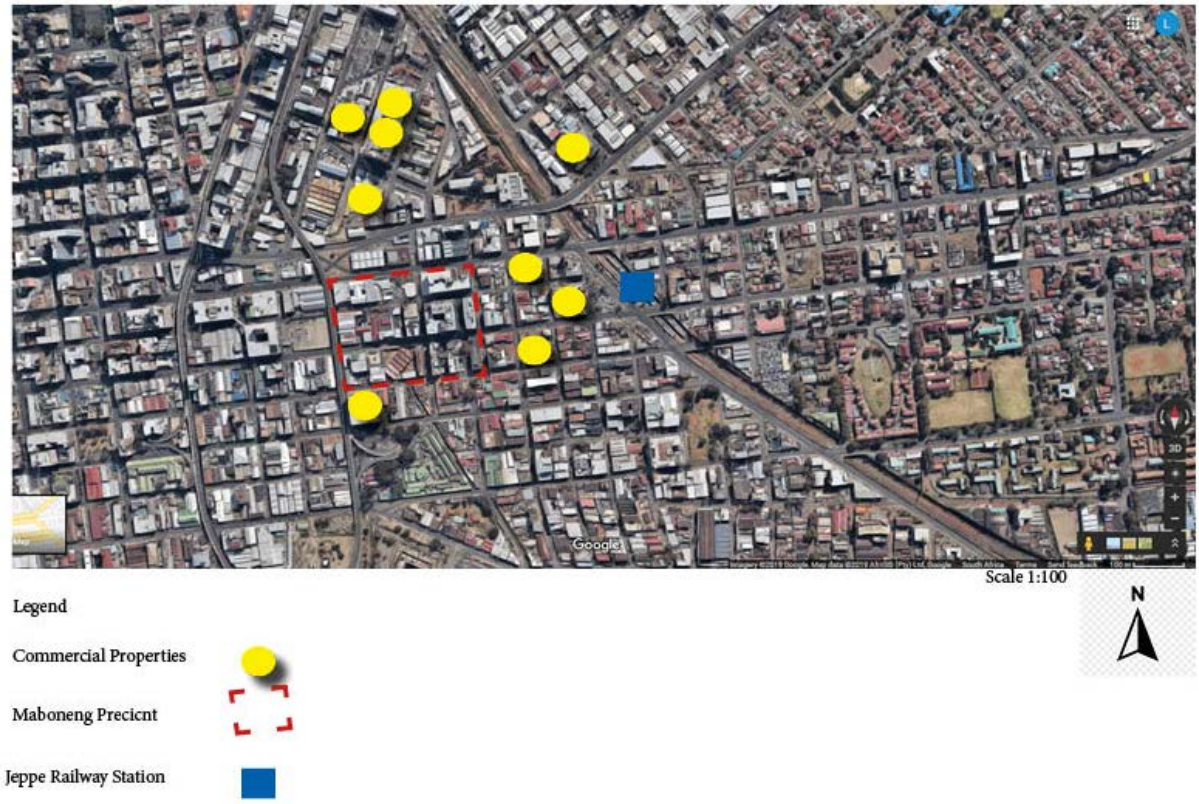


Fig 24, a Map showing how close Maboneng is to some of the commercial properties, yet still there is no significant impact

5.1.3 Distance to Commercial Centres

The distance to commercial centres variable was not statistically significant to the commercial property prices as it had a p- value of 0.1298. This value is greater than the significance level of 0.05 used as the measure of statistical significance in this study. Again, the coefficient here is negative but has no effect due to the p-value value not being significant. This is possibly because the Carlton centre

is too far from the commercial properties investigated in this study and requires walking through unsafe streets due to crime (see Fig 25). This could be one of the reasons it does not significantly impact the price/value of commercial properties analysed in this study. This is interesting because the literature on proximity to commercial centres does argue that proximity to shopping centres is significant and outweighs the dis-amenities of traffic, noise and pollution.

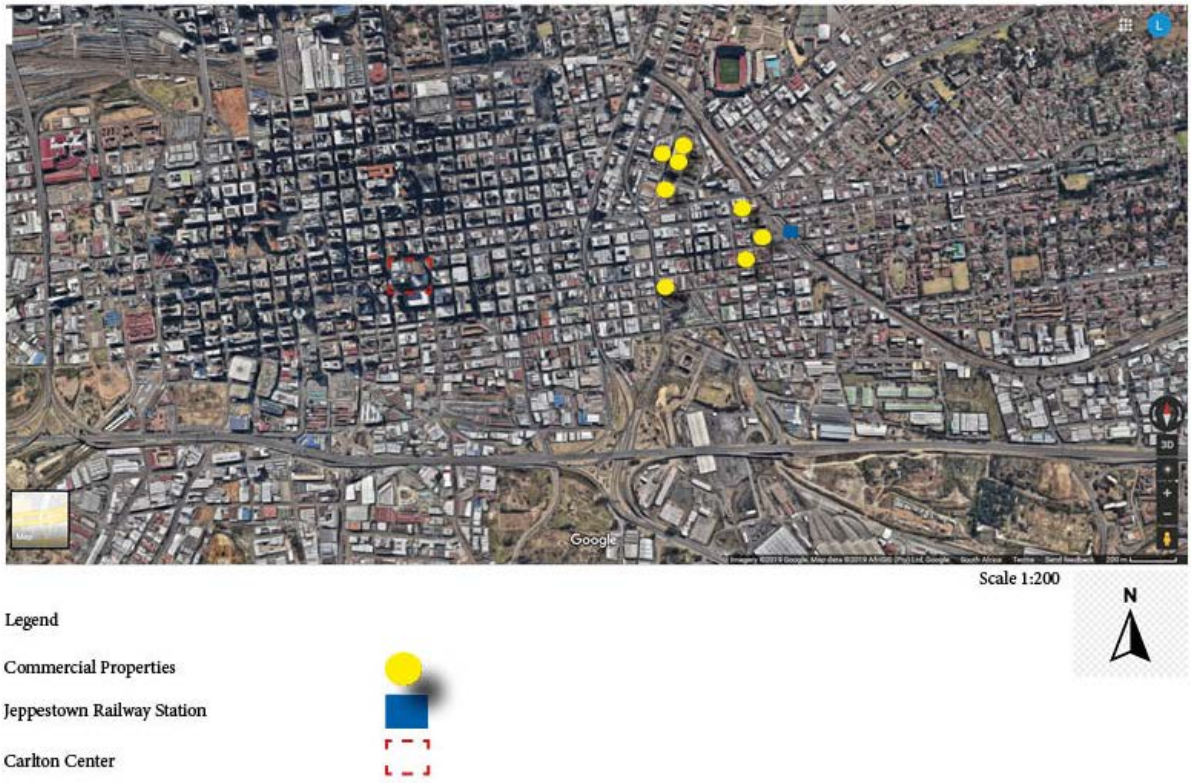


Fig 25 showing how far the Carlton centre is from the station and the commercial properties

5.1.4 Distance to Schools

The distance to commercial centres variable was statistically significant to the commercial property prices as it had a p- value of 0.0281. This value is less that the significance level of 0.05 used in this study proving the significance of the variable. The coefficient for this variable is positive meaning that the closer a commercial property is to a school the more its value increases.

There are 3 recognized schools in the study area; John Mitchell primary school, St James primary school and the Dominican Republic school (see Fig 26). I used the distance to the first two schools as they were the nearest to the railway station in the area which were within the 1 km radius of the study area. Schools contribute towards increases in pedestrian traffic and activity around an area. This is due to their population of teenagers who frequently visit retail shops and linger around public transport nodes after school (LaGrange, 1999). This does support Foong's (2006) argument that investors are willing to invest on commercial properties that are located close to schools. The reason being commercial centres do locate where there is increased traffic flow.

The proximity of schools and other institutional buildings in an area has the potential to increase the value of commercial properties in an area (Cervero and Duncan, 2002) Schools also attract residents and workers into an area which does benefit commercial activities in an area. This idea of having schools close to working places does reduce traffic in that kids can walk across to their parents'

workplaces which reduces the number of trips made. It does require well designed streets with traffic calming measures and safe pedestrian crossways, which contributes to improving the quality of life in the area. The improvement of quality of life can also be referred to as liveability in this context.

The concept of mixed-use areas i.e. having schools close to workplaces complimented by calm streets supports the concept of liveability which is argued for when TOD planning approaches are thought of and implemented in an area. The concept of liveability first emerged in the 1950s and has since become an important concept in the field of planning. The concept resulted from the growing concern that cities were too congested and that there was a need to preserve green spaces and to pursue smart growth strategies. In 1981 after Donald Appleyard published his book on liveable streets since then the concept has been recognized more and more by urban designers in relation to streetscapes and transportation. Appleyard (1981) argued that people living in cities preferred to live closer to their places of work than far away, as this significantly reduces the distances they travel as well as the costs therefore making it convenient. According to AARP (2005) a liveable community is one which has affordable and appropriate housing, supporting community features and services (i.e. employment opportunities and schools) and adequate transport options (Lewis 2017).

In my view commercial properties can benefit from being in such a community in terms of their value. The only drawback would be the high crime rate in the area which could discourage people from walking around and force them to resort to using private vehicles which takes us back to the issue of congestion and pollution.

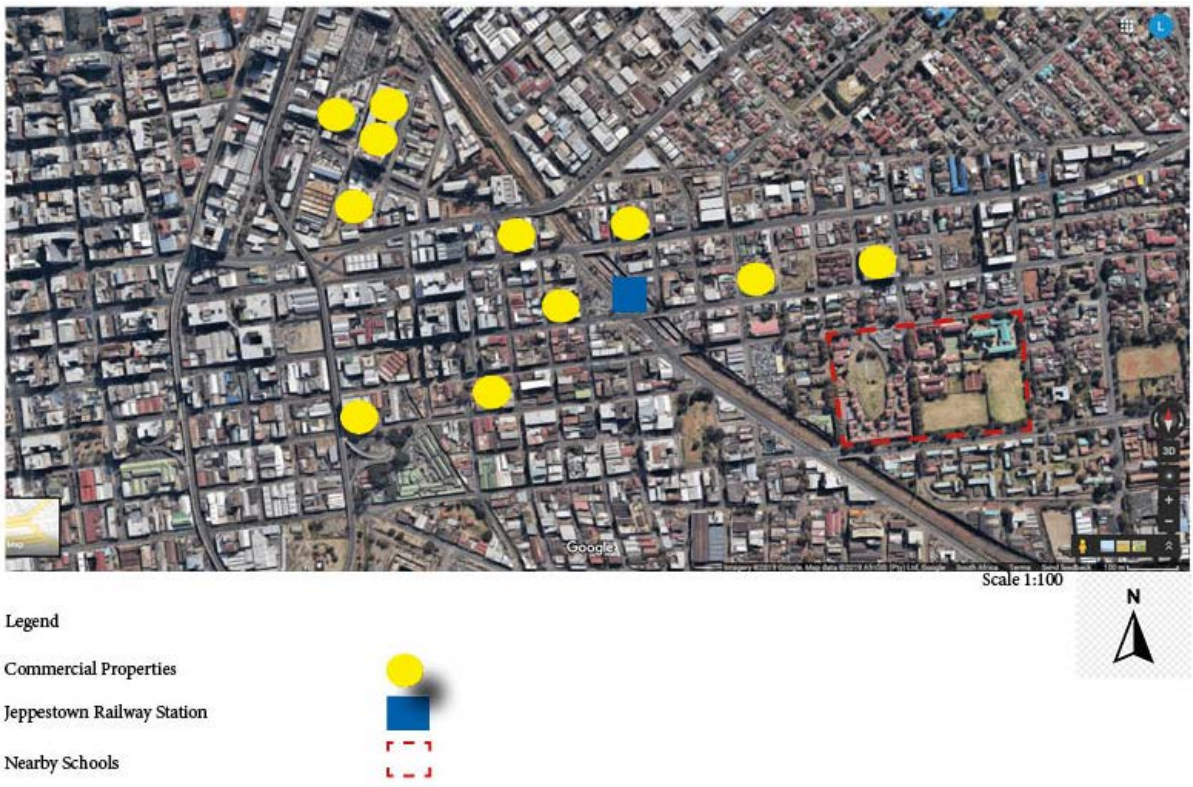


Fig 26 showing the location of the nearest schools in the study area.

5.1.5 Property Age

The property age variable was statistically significant to the commercial property prices because it had a p- value of 0.0074. This value is less that the significance level of 0.05 used as the measure of statistical significance in this study proving the significance of the variable. The coefficient for this variable is negative meaning that the older a commercial building becomes the more its value decreases. The perception of a place concept helps us better understand why people buy properties in certain locations. It is a concept which has an impact on the value of such properties. The property age and maintenance are important determinants in the value of a commercial building in this regard.

Iroham et al (2014) suggest that neighbourhoods with modern building designs, good roads and general aesthetics are more valuable. The age of the property indicates when a building was first built; older commercial properties have a negative impact on value. The environment in which a property is located and how the building has been utilized must be considered. The commercial properties used in this study were all located in Jeppestown which suffered from the urban decay and the disinvestment that occurred during the flight of capital and some of the buildings may not have been renovated or upgraded since then. This is especially problematic because property owners are understandably hesitant when it comes to investing in an area known for decay and related to crime out of fear of not maximizing on returns.

5.1.6 Property Size and Stand Size

The property size and stand size variables were both not statistically significant to the commercial property prices because they had p- values of 0.645 and 0.567 respectively. These two values are greater than the significance level of 0.05 used as the measure of statistical significance in this study. The coefficients for these two variables were both negative but again this had no effect as the two variables were not significant.

I found this result to be interesting because from the literature review the arguments are that stand size is an important determinant of commercial property let alone property value. A larger stand size increases the value of a property by providing more rentable space. In the literature authors, Sohn, Moudon and Lee (2012) all argue that in order to create walkable environments more cadastral space is required. It was initially assumed before carrying out the MRM, that the cadastral size would be one of the significant factors for commercial property value. This is because the cadastral size has the potential to stimulate expansion of properties. However, building and development restrictions could be externalities impacting the relationship between stand size, property size and the price of commercial properties (Yang et al, 2016).

5.1.7 Retail

This variable refers to all properties which are used to sell goods through stores, kiosks or the internet. This variable was found to be statistically significant to the price of commercial properties with a p-value of 0.000344. This value is less than the significance level of 0.05 used as the measure of statistical significance in this study. The coefficient for this variable was negative, possible due to the perception of crime and high rentals in the area.

Jeppestown is like most neighbourhoods located in the inner-city area in that it has a mixed retail environment although predominantly for low-cost goods. This is a stark contrast to what the area used to be during the days of apartheid (Beavon 2001). In Jeppestown there are streets such as Main where one can appreciate the vibrancy offered by mixed retail environment and can visibly see the

agglomeration of small Somalian businesses which service the low-income residents of Jeppestown. The literature does document that most neighbourhoods with transit are mixed use in nature and this is not different with Jeppestown with regards to retail activities (Schuetz, 2014). The ground floor is mostly shopping and the second and third floors consists of low-income accommodation. The MRM results show that the retail properties are statistically significant. However, the significance can be attributed to the nature of the properties, crime and economic conditions in South Africa.

5.1.8 Industrial

The Industrial variable describes all commercial properties in the study being used for industrial purposes, this includes factories and warehouses which are a common feature in East Jeppestown. The variable was found to be statistically significant to the price of commercial properties with a p-value of 0.000359. This value is less than the significance level of 0.05 used as the measure of statistical significance in this study. The coefficient for this variable was also negative citing similar challenges as the commercial retail property type.

According to the literature commercial properties are usually valued based on their utility and industrial buildings gain value based on their functional use. A possible reason for this is the age and the linkage with maintenance of machinery such as elevators which may increase operational costs. The older an industrial building is the lower its utility and function which means its value will not be as it used to be. Industrial buildings which are newer can attract higher rental incomes and yields (Gilmour, 2016). Industrial properties are usually valued in relation to square meters available and can possibly offer rental yields of up to 8% compared to the 4%-5% on a house (Gilmour, 2016).

5.1.9 Unidentified Property

The variable for the unidentified properties was found to be statistically significant to the price of commercial properties with a p-value of 0. 0058. This value is almost equal to the significance level of 0.05 used as the measure of statistical significance in this study. The coefficient of this variable was negative, and this could be attributed to the lack of maintenance of the properties due to the capital flight which took place during the 1970s.

The data purchased from Lightstone (Pvt) Ltd had a peculiar property use classification and that was the unidentified properties. This property class was statistically significant with a p-value of 0.00586. I investigated further about some of these so-called unidentified properties and found some where being used as storage warehouses but had recently been constructed, others where buildings under renovations. There were some which were abandoned /hijacked buildings which had litter and grime on their facades (see Fig 29 and 30)

Fig 29 an image showing the state of some of the commercial properties which have been hijacked in the inner-city. Source the Mail and Guardian (2015)

Fig 30 showing the decay and dilapidation facing commercial buildings which have been hijacked in the inner city. Source Business Live (2018)

5.1.10 Date of Purchase

The date of purchase variable was not statistically significant to the price of commercial properties with its p-value of 0.1300. This value is larger than the significance level of 0.05 used as the measure of statistical significance in this study.

This variable had to be included in the model as a measurable variable because lease contracts for commercial properties are consistently longer than those of residential properties. The reason being that commercial tenants usually stay longer than 5 years or so. This has an impact on the supply of commercial properties being sold on the market, which can affect their prices. Alternatively, commercial properties can remain unoccupied for long periods especially in uncertain economic times. According to Beavon (2001) this can help explain the high vacancies rates in the CBD.

5.1.11 Dummy variables for Year of Purchase, before and after Maboneng was Established

The Dummy variable for year of purchase was not statistically significant to the price of commercial properties with its p-value of 0.836. The before and after Maboneng dummy variable was not statistically significant to the commercial property prices as it had a p- value of 0. 918. Both values are greater than the significance level of 0.05 used as the measure of statistical significance in this study. The dummy variable before and after Maboneng was used to distinguish between properties sold before Maboneng precinct was developed in 2012 and after it had been in place. In regression analysis like this study dummy variables are used to sort data into mutually exclusive categories (such as smoker, non-smoker). This was necessary to control for the effect the Maboneng timeline had on commercial property prices.

5.1.12 Conclusion

In conclusion, the multiple regression model did find that the proximity to the railway station was not significant to the value of commercial properties. In doing so the model proved that the null hypothesis was incorrect and that there was a relationship between 5 independent variables and the dependent variable. Armstrong mentions that this result is not entirely bad, the discussion of the results of each variable based on sub-questions supports this. Armstrong mentions that if proximity is not a significant factor in determining the price then there could be other determinants of commercial property prices which exist. When measured using the MRM, the determinants which proved significant were the distance to schools, property age, retail, Industrial properties, and unidentified properties. The discussion in this chapter provided some insight as to why this was the case. The next chapter will provide a comprehensive answer to the research question and sub-questions as well as provide some planning recommendations.

5.2 Final thoughts on the impact of proximity of a railway station on commercial property values

The impact of a railway station on commercial property value has received relatively little attention from both TOD literature and commercial real estate property literature. This value is thought to be attributed to accessibility benefits could be capitalized on by property developers. The aim of this study was to determine whether proximity to a railway station had a significant impact on commercial property values within a 1 km radius of the railway station, or if there were other factors influencing the value of commercial properties. The existing literature that I did come across during this study was largely on how TOD, rail transit in terms of how it offers access to employment areas to those seeking

employment and how it affects residential property prices. This chapter aims to answer this question and provide some planning recommendations for the study area

The Jeppestown railway station is relatively well positioned as a gateway into the city which has been under urban decay. This has prompted me to ask the question: **How does proximity to a railway station impact the value of commercial properties in the surrounding community of Jeppestown?**

The question was broken down into the two sub questions below.

- How does proximity to amenities such as Commercial centres (CBD), schools and inner-city precincts such as Maboneng impact commercial property values?
- What are the other determinants that influence commercial property value?

Firstly, it was interesting to note that the proximity of the railway station was not statistically significant according to the results of the MRM and hence had no impact on the price of commercial properties sold between 2005 and 2015. The literature does justify the results of my study in that it did provide evidence of similar studies, where they found that a railway station had an impact and others where it did not have an impact. The literature also mentions that commercial properties do not gain value by virtue being close to railway stations there are other factors that must compliment the proximity to a railway station. Duncan (2008) supports this argument by stating that for a station to have a significant effect on the prices of commercial properties, it must be complimented by a very well-designed pedestrian-oriented environment. This was especially important as this does increase ridership and improve the perception of crime and grime associated with the Johannesburg inner city.

The results were mixed in terms of the proximity to amenities such as Commercial centres (CBD), schools and inner-city precincts such as Maboneng and their impact on commercial properties. The results proved the proximity to schools was statistically significant due to the increased pedestrian activity they bring to the area. Also, they make the neighbourhood attractive to new residents who will also want to live close to work and have an eye on their children's academic development. When it came to the proximity between the Maboneng precinct and commercial properties in the study area, the Maboneng precinct was not statistically significant. This was a surprise as Maboneng precinct is the closest inner-city regenerated precinct, other than Newtown, but it presently operates as an enclave with invisible walls which segregate people along socio-economic lines. The residents of Jeppestown do not identify with it and those who visit the precinct do not venture beyond its invisible walls or towards the Jeppestown railway station. This is in my view a missed opportunity as the urban regeneration efforts could be very beneficial for the commercial property market in the study area by linking Maboneng and the railway station.

The results did show that there were other determinants which influence commercial property value. The results proved that the property age was statistically significant to the commercial property prices. The property size and stand sizes were the attributes arguably mentioned in the literature to have significant impacts on property prices. In this study, this was not the case, and this was supported by other studies conducted by Sohn, Moudon, and Lee (2012), who argued that this attribute alone does not impact property prices. According to their research more cadastral space (stand size) is needed to create a walkable and pedestrian friendly environment

The results from the property classification variable proved very interesting as the retail, industrial and unidentified groups were all significant to the commercial property prices. In terms of retail the

literature supported its significance in that areas where TOD is implemented retail land uses are prominent. While the industrial was supported by the fact that the area did have more industrial zoned properties their function can be argued to give an edge in terms of property prices.

The results did provide a very different perspective on the research from the previous assumptions and findings from the previous research on the topic. This research showed how externalities such as crime globally and especially in a South African context can be influential to property prices. The results also proved that the property age also impacts the property prices and the use of the properties is also very important. In the next section I will detail some planning interventions regarding the results of the study.

Chapter 6: Planning Recommendations and Implications of the Study

6.1 Planning Recommendations

The results of the multiple regression model revealed that the property age was significant to a commercial property's value. There were several properties in the neighbourhood above 60 years old. They have a certain aesthetic to them which influences people's perception of the neighbourhood. For the property age to have a positive impact I recommend that we adapt and rehabilitate these existing old buildings. The reason being it is more sustainable for the built environment and cheaper to renovate than it is to demolish and rebuild. This intervention focuses on the ability to reuse buildings which have an aesthetic value as they help maintain a certain character to a neighbourhood like Jeppestown. This can help the city boost inner-city tourism because the railway station has been around for a long time much like the old buildings.

This intervention can be enhanced through urban design by linking the streets of Jeppestown that lead to the station with the buildings in Maboneng in an urban framework. The idea is to also integrate the streets of the "Island" which is Maboneng with the rest of Jeppestown. This is to allow the expansion of the precinct and significantly improve the area. A greater significance is to be placed on upgrading the pedestrian realm with improved access and walkability in order to encourage active modes of travel such as walking and cycling. This offers improved access to many low-income people who rely on walking to get to their destinations after arriving on the train.

The second variable which was significant in the study was the distance to schools. This variable is interesting given that the literature mentions that it has the potential to increase the value of commercial properties in an area. It is no secret that the streets of Jeppestown are unsafe given their high crime prevalence. One way to mitigate this is to design for walkable streets which connect land uses and institutions such as schools to transit and public transport which the urban framework would enable. Specifically, this can be done by designing pathways which expose students and pedestrians to different yet interesting views and pathways as they walk to school. These pathways must be continuous, safe with little or no obstacles. The pathways should be comfortable with a good ratio of street furniture and street lighting. These are interventions which can physically change the physical form of the street. There are also programs which can encourage active transport for the people using the streets of Jeppestown.

Active transport is the use of non-motorised transport nodes such as cycling and walking. Jeppestown already has a grid layout which is efficient for walking.

I recommend that the city initiates neighbourhood walking programs on weekends and get both parents and students to be involved. The provision of maps, security and walking guides can help people feel safer and give them an opportunity to walk from the station to their destinations. It is imperative that we offer a walk which is both good and interesting to the pedestrian. The main idea behind giving people an opportunity to walk is that it includes people in the city and can increase passive surveillance which can reduce crime as well. Jeff Speck (2017) says *"Every transit begins with a walk therefore we must remember to build walkability around our transit stations"* and in this case public institutions such as schools.

Fig 31 of walkability and walking infrastructure and an active environment in Singapore

http://wrirosscities.org/our-work/topics/sustainable-urban-mobility (Accessed 14/04/2019)

Fig 32 showing secondary seating on streets which enables passive surveillance (Portland, Oregon)

http://www.accidentalurbanist.com/designing-for-people/want-community-build-walkability/

(Accessed 14/04/2019)

6.2 The Implications of this Research

Improving the walkability will reduce traffic congestion, air and noise pollution, the maintenance costs of roads and the number of automobile injuries. It will also persuade city officials to rethink how they envision Johannesburg as a "world class '" city. This research argues strongly for the use of rail transit and more active modes of transport such as walking and cycling within the city.

This research began with a focus of determining whether proximity to a railway station has an impact on commercial property values in Jeppestown. The findings proved that railway stations located in neighbourhoods which have high crime and experienced urban decay, there is no significant impact. However, the literature does justify the findings by stating that proximity alone does not guarantee an impact on commercial property values.

This research has discussed TOD as a broad planning tool but focused specifically on urban rail emphasising its importance and high potential for improving an area. However, there is a need to compliment proximity to a railway station with a well-designed pedestrian oriented urban area. This

has largely informed my planning recommendations for a proposed urban framework which provides guidelines on how to revitalize urban areas experiencing urban decay and high crime rates. Therefor this research study aims to increase awareness and highlight the importance of conserving inner-city commercial buildings and creating safe, pedestrian friendly, highly active streets which are linked to public transit nodes as they provide access to the Johannesburg inner- city area. This is an area for considerable further research and one which has major policy implications which can reshape the way we think about transport and the commercial property market.

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Appendix

Maps

Fig 33 Map of the study area in 2001 adapted from Google earth pro (2018)

Fig 34 Map of the study area in 2005 adapted from Google earth pro (2018)

Fig 35 Map of the study area in 2010 adapted from Google earth pro (2018)

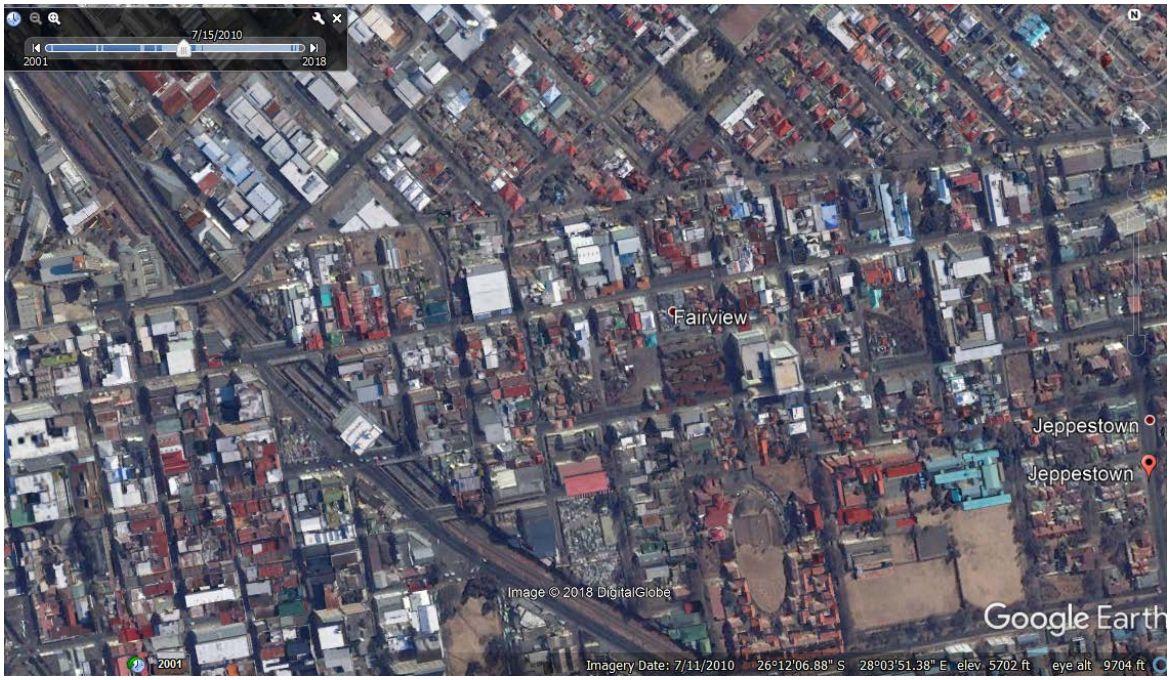


Fig 36 Map of the study area in 2015 adapted from Google earth pro (2018)

Graphs

Fig 37 graph of Property Size/Floor Area Ratio

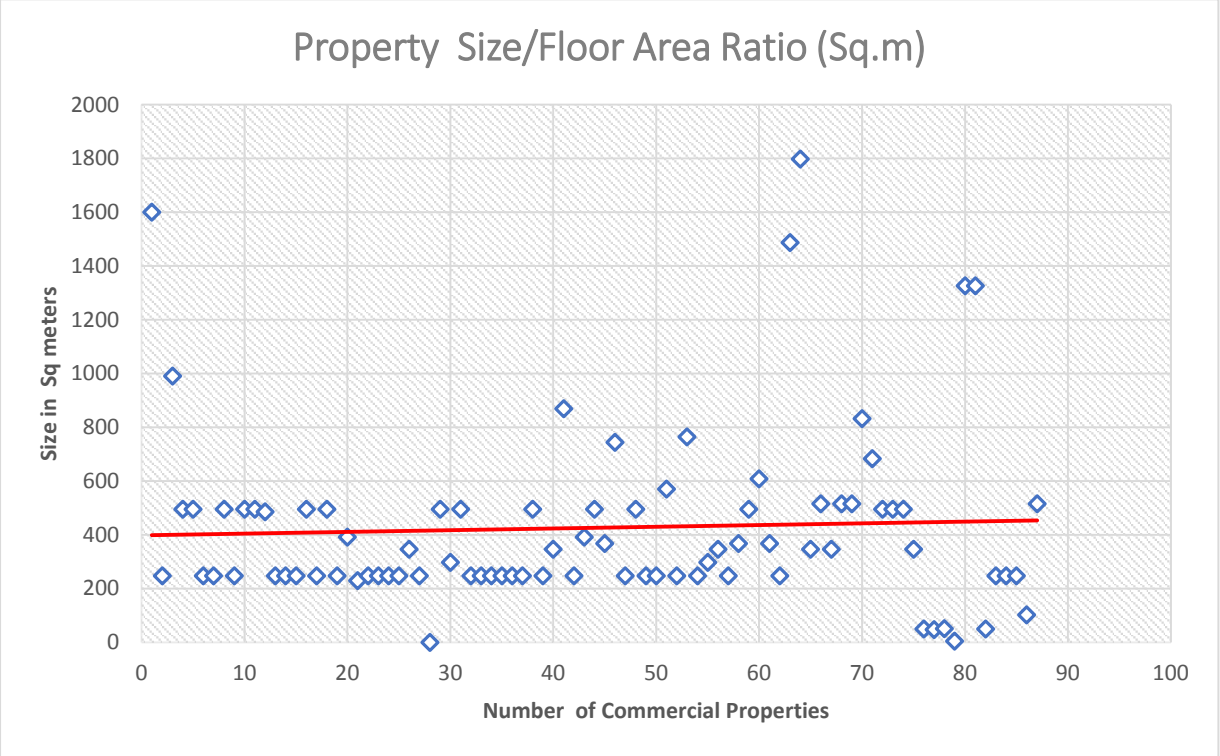


Fig 38 graph for Stand Size

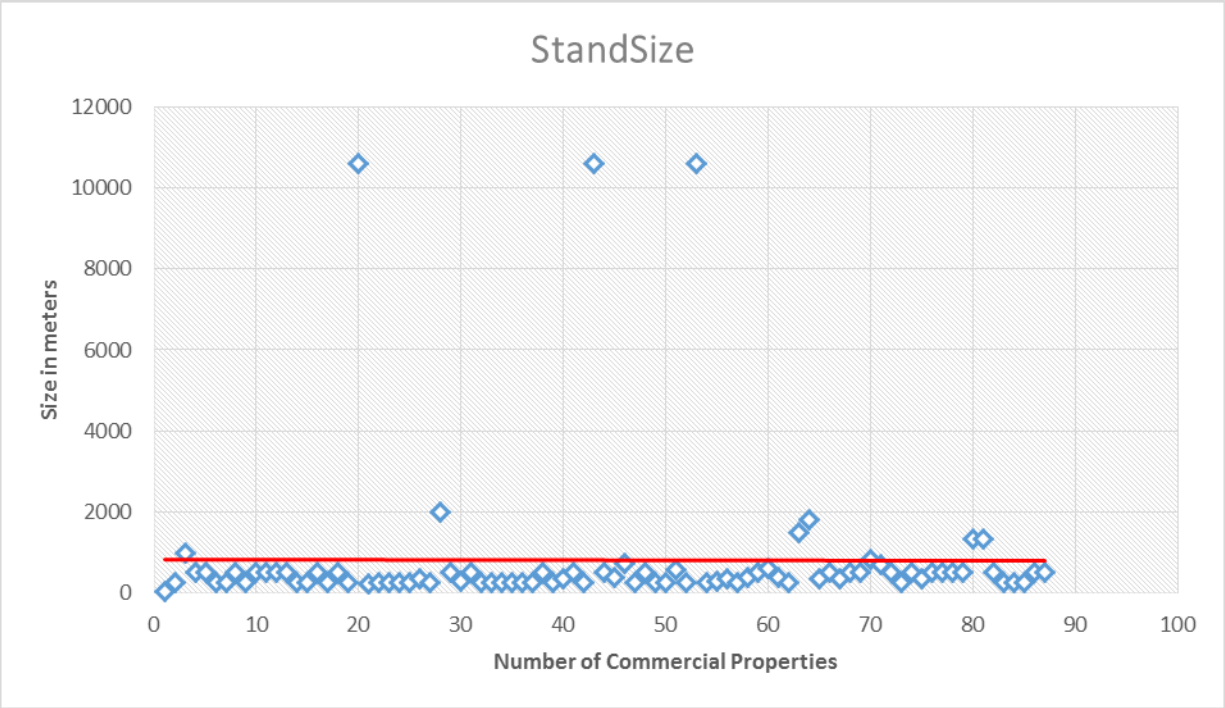
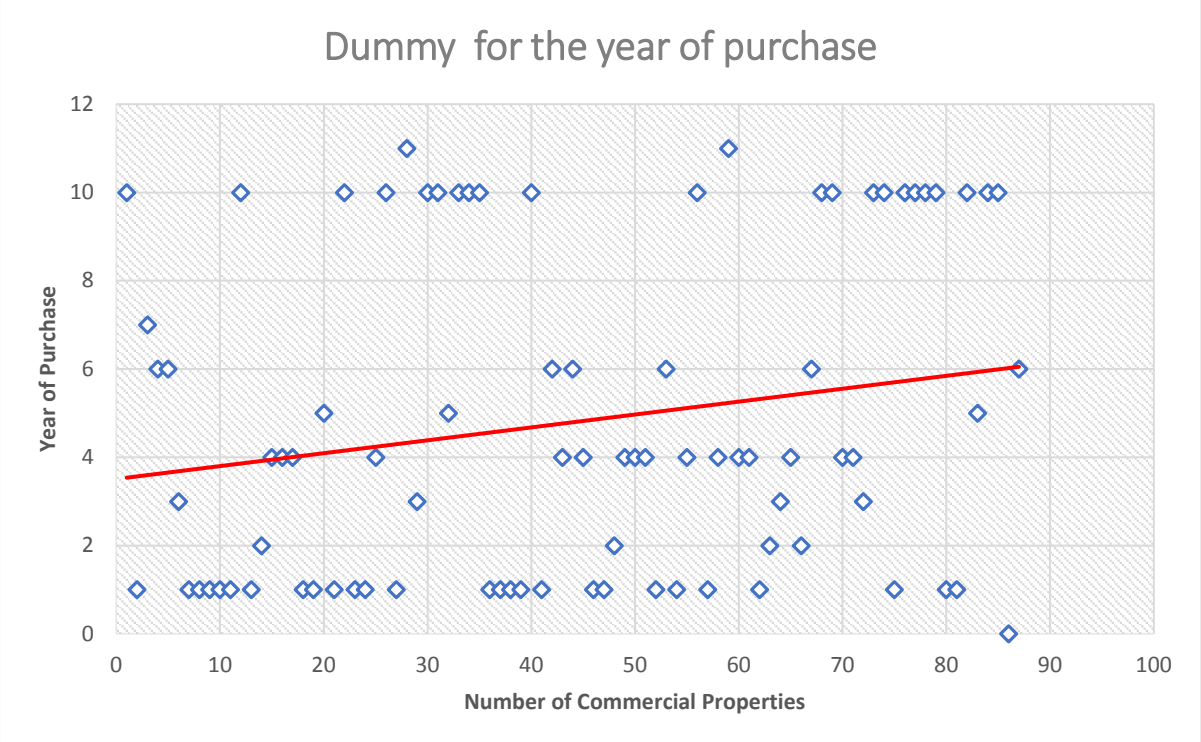


Fig 39 graph for Dummy year of Purchase



Descriptive Statistics

Price/Value(R)	
Mean	1170717
Standard Error	187772.1
Median	490000
Mode	346667
Standard Deviation	1751422
Sample Variance	3.07E+12
Kurtosis	4.455339
Skewness	2.334249
Range	7084667
Minimum	22000
Maximum	7106667
Sum	1.02E+08
Count	87

DistancetoStation	
Mean	460.0133
Standard Error	24.98771
Median	444.14
Mode	667.05
Standard Deviation	233.0699
Sample Variance	54321.56
Kurtosis	-1.40648
Skewness	-0.13235
Range	730.42
Minimum	76.47
Maximum	806.89
Sum	40021.16
Count	87

DistancetoMaboneng	

Mean	512.3576
Standard Error	29.06789
Median	426
Mode	292
Standard Deviation	271.1272
Sample Variance	73509.96
Kurtosis	1.836144
Skewness	1.580539
Range	1182
Minimum	218
Maximum	1400
Sum	44575.11
Count	87

DistancetoCommercialcenters (m)	
Mean	1437.379
Standard Error	49.00362
Median	1490
Mode	1490
Standard Deviation	457.0754
Sample Variance	208917.9
Kurtosis	-0.0614
Skewness	0.358037
Range	1930
Minimum	660
Maximum	2590
Sum	125052
Count	87

Distancetoschools(m)	
Mean	966.717

Standard Error	37.0638
Median	863
Mode	1410
Standard Deviation	345.7081
Sample Variance	119514.1
Kurtosis	-1.05939
Skewness	-0.16552
Range	1242
Minimum	208
Maximum	1450
Sum	84104.38
Count	87

PropertyAge	
Mean	36.14735632
Standard Error	2.292669917
Median	29.17
Mode	0
Standard Deviation	21.38460136
Sample Variance	457.3011755
Kurtosis	-0.496494009
Skewness	0.400076082
Range	81.58
Minimum	0
Maximum	81.58
Sum	3144.82
Count	87

Property Size/Floor Area Ratio (Sq.m)	
Mean	426.5057471

Standard Error	35.26151156
Median	347
Mode	248
Standard Deviation	328.8974843
Sample Variance	108173.5552
Kurtosis	5.845244277
Skewness	2.237518128
Range	1798
Minimum	0
Maximum	1798
Sum	37106
Count	87

StandSize	
Mean	806.8585057
Standard Error	202.6522035
Median	369.16
Mode	248.01
Standard Deviation	1890.213918
Sample Variance	3572908.654
Kurtosis	23.87679657
Skewness	4.960357563
Range	10562.38
Minimum	40
Maximum	10602.38
Sum	70196.69
Count	87

Retail	
Mean	0.528735632
Standard Error	0.053827271

Median	1
Mode	1
Standard Deviation	0.502067365
Sample Variance	0.252071639
Kurtosis	-2.033568889
Skewness	-0.117162623
Range	1
Minimum	0
Maximum	1
Sum	46
Count	87

Industrial	
Mean	0.229885
Standard Error	0.045372
Median	0
Mode	0
Standard Deviation	0.423198
Sample Variance	0.179096
Kurtosis	-0.30029
Skewness	1.306578
Range	1
Minimum	0
Maximum	1
Sum	20
Count	87

Unidentified	
Mean	0.045977011
Standard Error	0.022583984
Median	0

Mode	0
Standard Deviation	0.210649382
Sample Variance	0.044373162
Kurtosis	17.87741217
Skewness	4.412126704
Range	1
Minimum	0
Maximum	1
Sum	4
Count	87

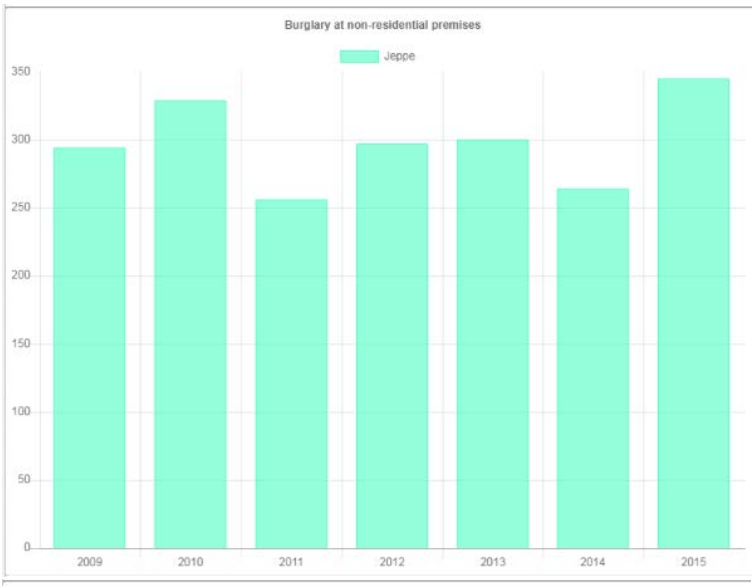
Date of Purchase	
Mean	39468.42529
Standard Error	480.3589202
Median	39568
Mode	39568
Standard Deviation	4480.48973
Sample Variance	20074788.22
Kurtosis	71.99337206
Skewness	-8.094713745
Range	42168
Minimum	0
Maximum	42168
Sum	3433753
Count	87

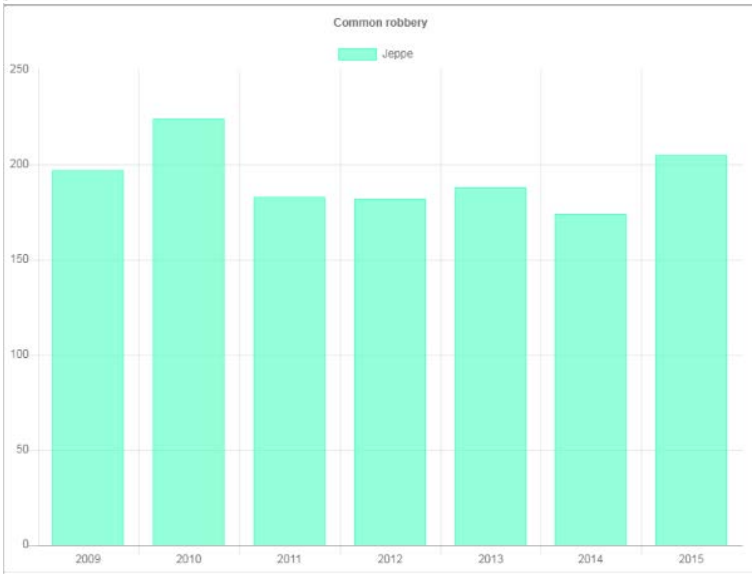
Number of Sales	
Mean	1.67816092
Standard Error	0.115022693
Median	1
Mode	1

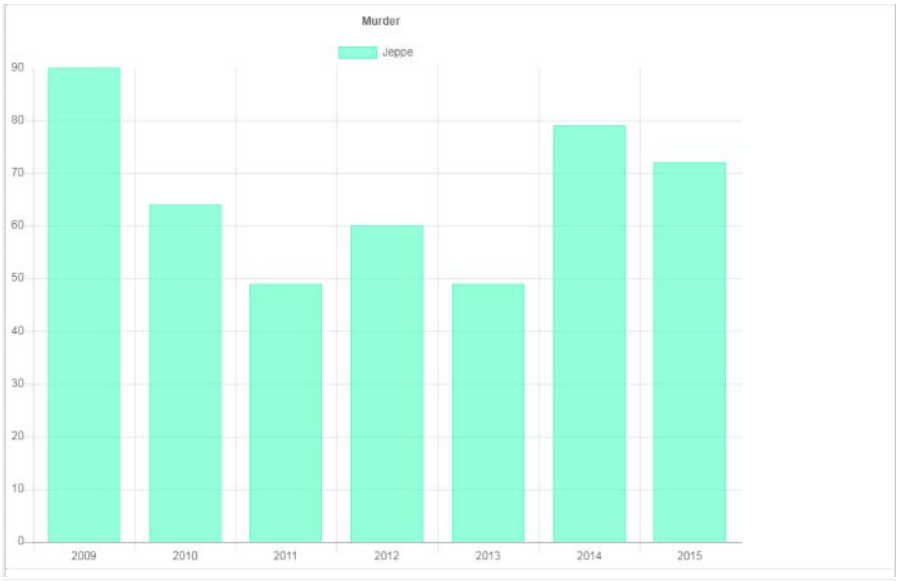
Standard Deviation	1.07286026
Sample Variance	1.151029137
Kurtosis	0.071366148
Skewness	1.199653404
Range	4
Minimum	0
Maximum	4
Sum	146
Count	87

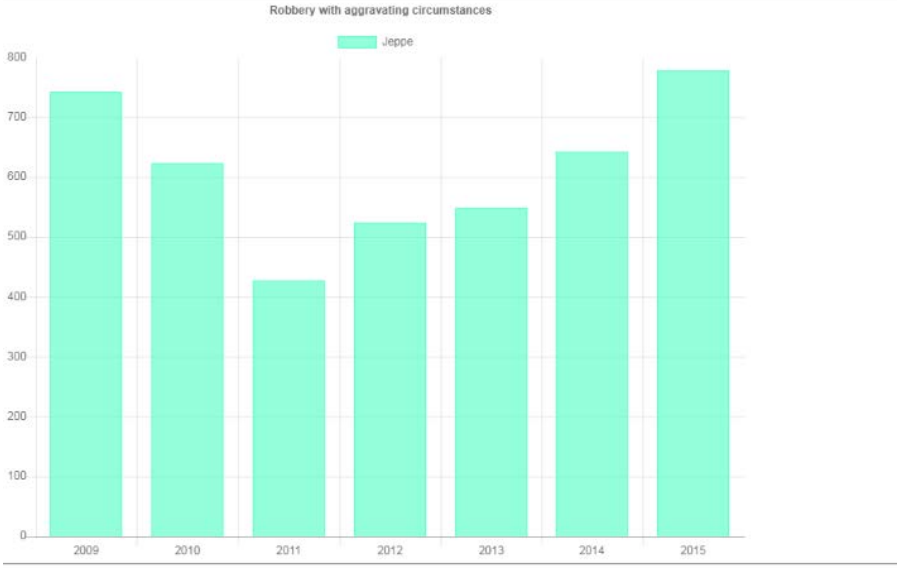
Dummy for year of purchase	
Mean	4.793103
Standard Error	0.392777
Median	4
Mode	1
Standard Deviation	3.663579
Sample Variance	13.42181
Kurtosis	-1.33669
Skewness	0.461137
Range	11
Minimum	0
Maximum	11
Sum	417
Count	87

Crime Statistics in Jeppestown (2009-2015)






Murder
Jeppe
90
80
70
60
50
40
30
20
10
0
2009
2010
2011
2012
2013
2014
2015


Robbery with aggravating circumstances
Jeppe
800
700
600
500
400
300
200
100
0
2009
2010
2011
2012
2013
2014
2015