

UNIVERSITY OF CAPE TOWN
DEPARTMENT OF CIVIL ENGINEERING



**VALUE CREATION & CAPTURE AROUND
TRANSPORT INFRASTRUCTURE STATION
NODES IN SOUTH AFRICA**

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Minor dissertation submitted to the Faculty of Engineering and the Built Environment of the University of Cape Town in partial fulfilment of the requirements for the Degree of Master of Engineering in Transport Studies.

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DECLARATION

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ABSTRACT

In the South African context, the infrastructure backlog is ever increasing and with limited government funding, the reality is that the gap will most likely never be closed. There are however, numerous value capturing mechanisms applied elsewhere in the world that can help with infrastructure funding, but little or none have been applied in a South African context yet. This report reviews the literature on value capturing, and explores whether or not it can be applied in transport infrastructure additions in South Africa.

This report seeks to understand the applicability of the different mechanisms to a case study of the Gautrain project in Gauteng. Secondary data is used to evaluate the effect of the newly constructed stations on adjacent residential property values. This is done by looking at three variables, namely distance to station, analysis year and housing type. The data used in the analysis is validated by means of an ANOVA analysis, which is assessed by the F-test and a consequent Tukey's HSD test.

This paper illustrates that value capturing is possible in a South African context. Stations such as Pretoria and Johannesburg indicated a direct correlation between increased property values and infrastructure additions and can therefore act as justification for value creation and consequent value capture. Further studies evaluating other variables should however still be conducted.

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1 Introduction

1.1 Background

Due to South Africa's apartheid history, which is possibly the main reason for the country's major infrastructure backlogs, municipal infrastructure expenditure now constitutes more than half of public sector capital expenditure (Brown-Luthango, 2010). In Africa, it is estimated that \$93 billion per year is required to address infrastructure backlogs. A massive burden is consequently placed on local governments in terms of raising revenue to further finance major infrastructure upgrades and additions. Over the past ten years, the National Treasury has contributed significantly towards transport infrastructure investment, where fund allocations are expected to increase even more within the near future. (Brown-Luthango, 2010).

While transport infrastructure provides access to various economic opportunities for individuals (World Bank, 2009), McGaffin (2011) sees the expenditure as something more than just access provision. He believes the expenditure can be seen as an investment that can lead to possible value creation and value capture opportunities. Value creation is seen as the additional value created due to infrastructure investment, where value capture is seen as the acquisition, by public and/or private entities, of a portion of the returns for the investment (Huxly, 2009). This additional value can then be used for the financing of certain projects.

From various previous studies in the literature, it has been determined that the effect of transport infrastructure on property values differs vastly. The findings are mixed in the sense that property values range from little to no significant change to significant negative and positive change (Debrezion, Pels, & Rietveld, 2003). These authors suggest that, in general, commercial properties enjoy a higher positive impact when compared to that of residential properties. The same can be said in the case of commuter railway stations (Debrezion, Pels, & Rietveld, 2003).

1.2 Objective of the Study

The purpose of this research is to provide insight into the fairly unknown finance mechanism of land value capture and perhaps motivate further studies in this specific field. Areas needing further research will be highlighted for future prospective studies.

One such area is to investigate the potential application of value capturing mechanisms for financing future transport infrastructure projects in South Africa in order to capture the wider socio-economic opportunities associated with the infrastructure investment.

The objective of this study is: to investigate the characteristics of property values near Gautrain stations, the type of properties and the time of investment; to determine the impact of infrastructure investments on adjacent property values; and to assess the potential for value creation. Consequently, value capture mechanisms will also briefly be explored.

The hypothesis is stated as follows:

“The Gautrain transport infrastructure investments have the potential to enhance property values which can be measured.”

1.3 Scope of Research

The following limitations to the study are listed:

- Limited studies on value capturing have been conducted in South Africa. Thus the case studies referred to in the literature review were mostly compiled in other countries with few referring to South Africa.
- Property values are only for residential properties and commercial properties are not taken into account, due to the limited availability of data.

1.4 Method

To achieve the objectives of the investigation, a literature review was carried out on various aspects regarding value capturing, value capturing mechanisms and methods, especially in the field of transport.

The Centurion, Hatfield, Johannesburg, Marlboro, Midrand, Pretoria, Rhodesfield, Rosebank and Sandton Gautrain stations were used as the case study nodes in the dissertation research. A quantitative analysis was undertaken at each station in order to establish which attributes of erven around each specific node (type of property and land use, distance from the station and year of analysis) played a role in the additional value change and consequently answer the research questions at hand.

The quantitative analysis entailed information being gathered from secondary data received from Lightstone Property, which was made available for the purpose of the dissertation. The data contains property types (freehold or sectional title), distance from station (0 - 1 km, 1 - 2 km, 2 - 5 km and 5 - 8 km) and year of investigation (2008 – 2014) for all stations.

The results from the analysis were discussed, and finally conclusions were drawn as to whether value infrastructure investments create additional value on surrounding property prices. The research method will be described in greater detail in Section 3.

1.5 Organisation of Report

The report consists of the following chapters:

Chapter 1, the current chapter, serves as an introduction to the dissertation;

Chapter 2 presents a review of the literature, which serves as a basis for the method used in the study;

Chapter 3 describes the research problem at hand and discusses the method applied in the study;

Chapter 4 describes the case study, along with data analysis and thereafter a discussion of the data analysis;

Chapter 5 closes the report with a summary of the main conclusions drawn from the study, as well as recommendations for further studies or investigation opportunities in this field.

2 Literature Review

2.1 Introduction

The literature review introduces the available literature that relates to the concepts important to the investigation of infrastructure investment, property values, value creation and value capturing. The chapter starts with a review of infrastructure investment and the reasons behind the massive expenditures in infrastructure in South Africa. The general observations from property values associated with infrastructure investments are then briefly discussed. This is followed by a description of numerous variables that have an influence on these values. The concept of value creation and capturing and associated value creation measuring techniques and value capturing mechanisms are then discussed in detail. The suitability of infrastructure investment as a mode of value creation and subsequently as a value capturing mechanism is considered. The chapter concludes with a summary of the literature review that is noteworthy for the remainder of the report.

2.2 Infrastructure Investments

Aside from the significant expenses associated with building or maintaining infrastructure, infrastructure investments have generally proved to be beneficial for a country's GDP (Perkins et. al, 2005). History has also shown that transport infrastructure has helped to promote the growth and development of the world's greatest cities such as London and New York (ADEC, 2010). Further evidence of GDP tracking infrastructure investment can be seen in Figure 1 below. Increased infrastructure investment in the 1970's led to a growth in the GDP between 1970 and 1980. The decline in infrastructure investments after 1980 had an effect on the decline in the GDP between 1980 and the mid-1990s.

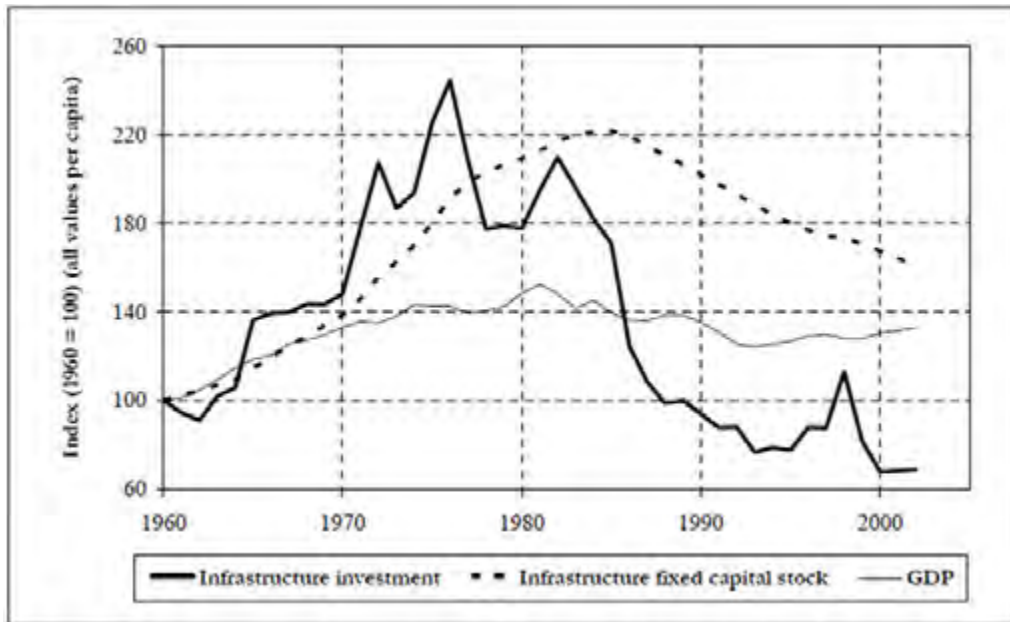


Figure 1: Real GDP and public-sector economic infrastructure investment (gross) and fixed capital stock in the United States (Perkins et. al, 2005)

Generally it is expected that for every dollar spent on infrastructure, the gross domestic product will increase by approximately 0.05 – 0.25 US\$ (World Economic Forum, 2012). Strategic infrastructure can further be described as the backbone that interconnects our modern economies, where most are functional and create the greatest impact in terms of economic growth, social uplift and sustainability (Suzuki, Murakami, Hong, & Tamayose, 2015).

In a South African context, most cities lack modern mass transit systems and users are dependent on partially gridlocked roads. As a result, South Africans are forced to spend a high share of their disposable income on transport (Statistics South Africa, 2011). This especially places a burden on low-income workers who now face a huge financial and economic opportunity cost (ADEC, 2010).

2.3 Transport Infrastructure & Property Values

2.3.1 Background

For the purpose of the discussion, it was decided to define the term 'property'. Property in the context of the discussion will refer to any type of estate, ranging from a vacant

lot to an area occupied by any kind of building, be it for commercial, residential, industrial etc. use (Brigham, 1965).

There are many theories behind what exactly it is that determines the value of a property, from which choices of location can be deemed as one of the most crucial. This is a topic frequently discussed by urban economists. Early studies (Von Thünen, 1863) suggest that land values are derived from transportation savings afforded by the location of the stand or land parcel. This theory or model developed to later on became bid-rent model, which assumes that the price of a land parcel increases due to the proximity to the CBD and land sizes increase with an increasing distance from the CBD (Fujita, 1989). Bid rent curves represent the price that a household or firm would be willing to pay at varying locations in a city in order to reach a certain level of satisfaction. In theory, the land use activity having highest bid will occupy a certain location. Typical bid rent curves for a 'monocentric city' can be seen in the figure below.

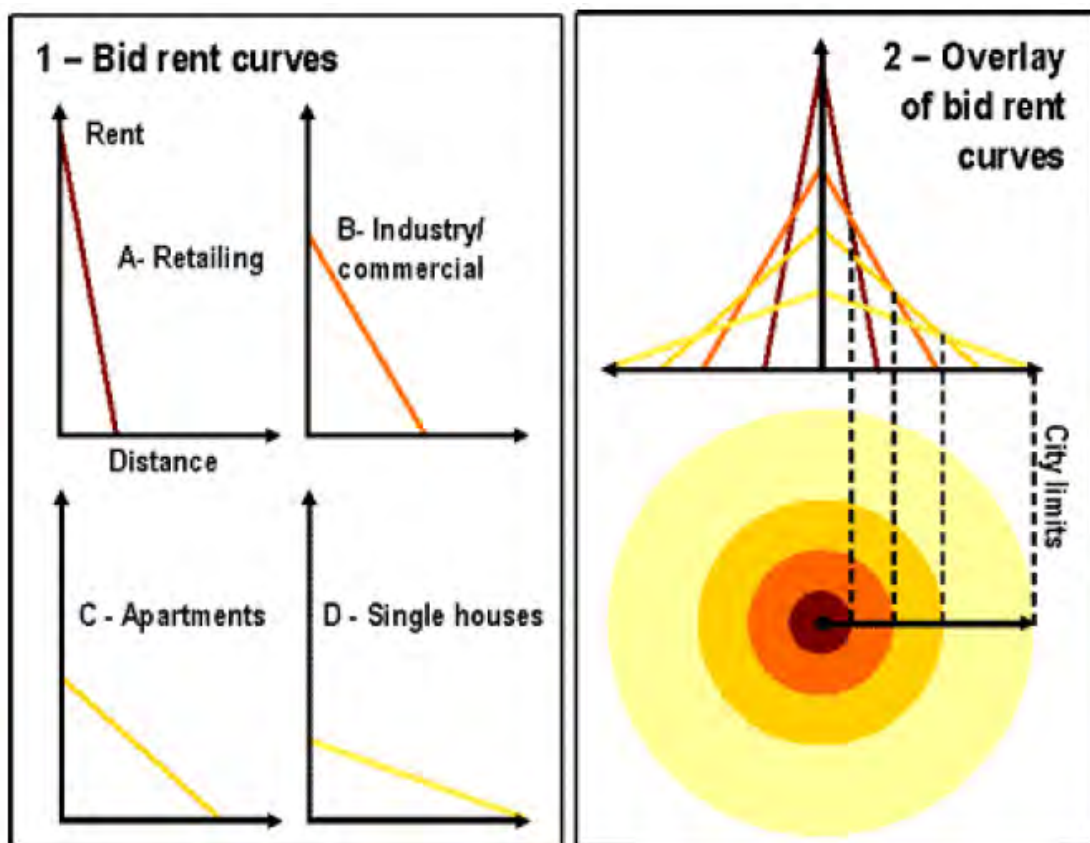


Figure 2: Bid rent curves of a 'monocentric city' (Rodrique, Comtois, & Slack, 2004)

Transport system improvements often lower the costs of transporting goods or people in a city and improve the level of accessibility. In the case of a 'polycentric city', the

rent gradient will in theory change, where the CBD will no longer be the most accessible place. This is evident in various developed cities around the world, where sub centres start emerging at a certain distance from the CBD. A so-called 'polycentric city' with different bid-rent curves from the 'polycentric city' is subsequently developed (Behrens, 2014). When looking at property value peaks, one can expect to see a relationship as shown in the figure below. CBD represents the centre of the city, where S refers to stations or sub centres along the line.

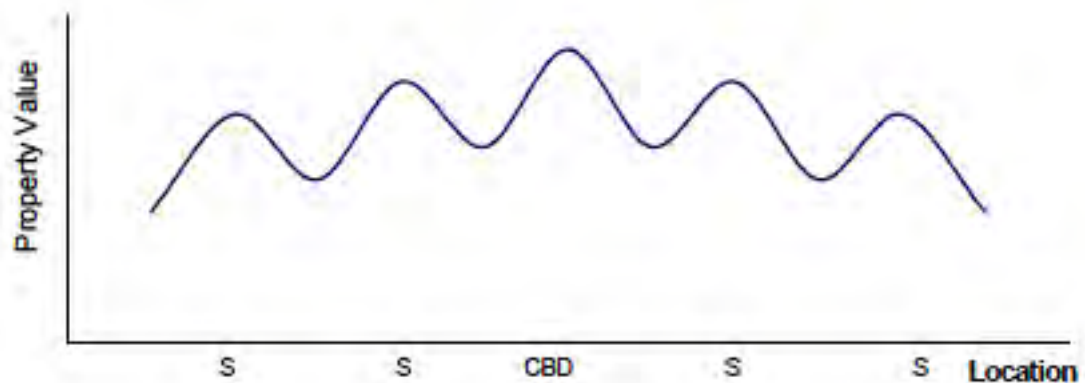


Figure 3: Sinusoidal pattern of property values along a line centred by the CBD (Debrezion, Pels, & Rietveld, 2003)

Furthermore, it is argued by some that living close to a nearby transport facility increases the accessibility of the property and therefore the value of the transport facility is capitalised in the property's value, although there are also negative implications which are often raised (Debrezion, Pels, & Rietveld, 2003).

But land value is not only dependent on location of the site. Various authors have conducted studies to determine exactly what the different determinants for increased property values are and most authors agree on three broad categories that include:

1. Physical,
2. Environmental, and
3. Accessibility factors (Bowes & Ihlanfeldt, 2001).

Physical factors speak to the quantitative and qualitative features associated with a certain property, such as the size, type of land use and existing infrastructure on the land parcel.

Environmental amenities are the externalities that emerge from the surrounding neighbourhood. Externalities or secondary costs and benefits are those costs incurred by communities as a whole. It includes those entities that are not directly involved with the use of a certain facility (Kumares & Labi, 2007). The externalities do not necessarily affect only the station nodes, but rather the neighbourhoods along the transport corridor (Debrezion, Pels, & Rietveld, 2003). In earlier studies, environmental amenities were not included. However they are included in the hedonic price approach, which is explained in section 2.4.3. The difficulty of environmental amenities lies in the measurement problems associated with them, but it still plays an integral role in accurately quantifying land value.

The accessibility of a place of interest, generally the CBD, is determined by different modes of travel. Accessibility variables are often kept constant in property value studies and therefore only the impact of the remaining variables is captured. 'Highway accessibility is an important competitor to rail way accessibility' says Debrezion (2003). However, in recent studies this was not taken into consideration.

2.3.2 Variables Leading to Property Value Change

Numerous studies conducted focussed mainly on North America and Europe and it was not until recently when similar studies were conducted in South America and Asia (Smith & Litman, 2006). As mentioned earlier, there has been no consistent recorded relationship between infrastructure investments and property values in the literature. The magnitudes of the influences also differ vastly. Different methodologies (such as simple matched pairs, repeat sales ratios, and hedonic price approach which will be elaborated later) also play a role in assessing the impacts of infrastructure investments on land values.

It has to be underlined that in most of the earlier studies recorded in the literature, certain constraints were put on variables such as:

- property type,
- type of transport infrastructure, and
- distance to the station or node.

The effects of these variables and how they are affected by transport infrastructure are discussed below. Another study conducted by the Royal Institution of Chartered

Surveyors (2002) summarises different cases taken from the literature and is tabulated in APPENDIX A.

Property Type

Commercial

Evidence on changes in commercial property prices mostly comes from heavy rail infrastructure systems that are implemented close to these properties. From these studies, changes in property prices have proven to be inconsistent. The BART rail system in San Francisco proves just that when an early study done by Falcke (1978) found no relationship between property value increase and rail presence.

The physical integration of commercial properties and rail stations appears to have somewhat of a bearing on the property market. Joint development projects tend to have better architectural integration, better on-site circulation and made use of resource sharing which allowed for more efficient use of space (Cervero, 1994).

Residential

Most hedonic-price studies, especially from heavy and commuter-rail systems, show a positive increase in land values. Transport cost saving is generally seen in residential property value studies as mentioned earlier on. This phenomenon was justified early on by Dewees (1976) who found that the site value of a property increases close to the subway station. A subsequent study (Grass, 1992) found a direct relationship between the distance of residential property values and metro stations. Other extensive studies found that property values close to a station enjoy a higher increase than those further away (Voith, 1993).

Other records (Landis, Cervero, Guhathukurta, Loutzenheiser, & Zhang, 1995) show the exact opposite, where in fact a general decline in property values occur. This might be due to noise implications or other factors, which are discussed later.

Type of transport

Railways are known to have shown higher impacts on property values than other transport modes. This might be due to the fact that railways are considered to support

a much denser and compact urban structure than other transport modes (Cervero & Duncan, 2001). Contrary to popular belief, researchers have found that light-rail systems have introduced more benefits to surrounding properties than heavy-rail systems. The Dallas Area Rapid Transit (DART) light-rail stations produced increases of 14% and 37% for the average value of office and retail properties respectively (Weinstein & Clower, 1999). Similarly, a study of Santa Clara County's light-rail system found that properties within a radius of a quarter and half mile of stations increased more than other properties in the same area (Weinberger, 2001).

The land-value impact from commuter rails is fairly unknown when compared to light and heavy rail systems. This is quite surprising when one looks at the track miles covered by the respective systems, where commuter rail track miles exceed the other two significantly in the United States (Cervero, 2003).

Bus Rapid Transit (BRT) has revolutionised the last decade of public transport planning in developed and developing countries. A BRT is a system where an entire lane in a road network is dedicated to buses only. Because BRT is such a new public transport solution, little is still known about the potential magnitude of these effects (Hook, Lotshaw, & Weinstock, 2014). A study that was done on Bogotá's Transmilenio suggested mixed results in property prices, although most of them increased. It was also noted that value changes differ from one neighbourhood to another (Mojica & Rodriguez, 2008).

Distance to station

In the literature, it is commonly accepted that the value of a property is determined by the proximity to a station node. It is expected that properties closest to a station node will have the highest value, with values decreasing in distance from the transport node. This effect is seen in Figure 3 above. The Royal Institution of Chartered Surveyors (2002) conducted an in depth study in which they found that where more than one threshold is given, the impact on property prices decreases with distance progressively. The decrease was evident in all but two cases.

There are growing suggestions, however that in some cases that the vicinity of a station only starts to play a role at a certain distance away from the station node in the case of residential properties. The effect of being 'too close' to the station is evident

and as Nelson (1992) explains, the noise levels of dense mixed-use environments often become a nuisance when living within a block or two from rail transit.

Other Variables

Apart from the variables mentioned above, there are numerous others that also affect property values with the addition of transport infrastructure. These might include income class, social classes, density, time of infrastructure provision, and commencement of system operation. It is generally accepted that the proximity to a transport node is of higher value to low-income household owners than medium or high-income household owners, due to the transport cost saving principal mentioned earlier (Bowes & Ihlanfeldt, 2001).

It also important to distinguish between the effects of market changes and infrastructure additions on property values. A certain kind of threshold has to be set on market changes to see the actual difference. Consequently, the effect of infrastructure additions on a property value will be clearer and more reliable.

2.4 Value Creation and Capturing

2.4.1 Background

Huxly (2009:7) describes value capture finance (VCF) as 'the appropriation of value, generated by public sector intervention and private sector investment in relation to an underused asset (land and/or structure), for local re-investment to produce public good and potential private benefit.' The benefit from value capturing is thus seen as not only quantitative (private monetary benefit), but also qualitative (public good). VCF is however often confused with other developmental finance mechanisms. This can be due to the rather complex financial and contractual arrangements associated with VCF. These arrangements can also change according to the local development context, legal frameworks and the purpose of funding.

Value capturing can therefore further be described as a method whereby additional land value is extracted as a result of public investment into the community. This might occur where for instance a school or more specifically public transport and other infrastructure is provided to the community. The additional land value is the total land

value after the public investment, minus the property's value if the additional public investment did not occur. Seeing that the additional value occurred due to state (often local government) action, it is therefore generally seen as state owned and can be extracted using various value capturing methods (Rodriguez & Mojica, 2008). The main reason for value creation and capturing is simply because many municipalities don't have the required funding to undertake the required infrastructure expenditure.

There are a number of mechanisms, which can be used in order to capture additional value and will be discussed in section 2.4.3. These mechanisms, although vastly different, all form part of the same intricate cycle. The cycle includes four components, namely value creation, value realisation, value capture and local value recycling (Huxly, 2009). The cycle can be seen in Figure 4 and the four components are discussed below:

- i. Value creation: The unlocking of under-utilised assets' potential value increases. This is done by the public sector to increase the demand for private sector investment.
- ii. Value realisation: The actual investment from the private sector, ensuring the value increase is realised.
- iii. Value capture: Public sector arrangements, which involve the arrangement that a portion of the private sector investment is returned locally (monetary or in-kind contributions).
- iv. Local value recycling: The re-investment from the public sector, which might lead to further funding arrangements.

The two most important components are generally seen as Value Creation and Value Capture and their importance is thus emphasised throughout the report.

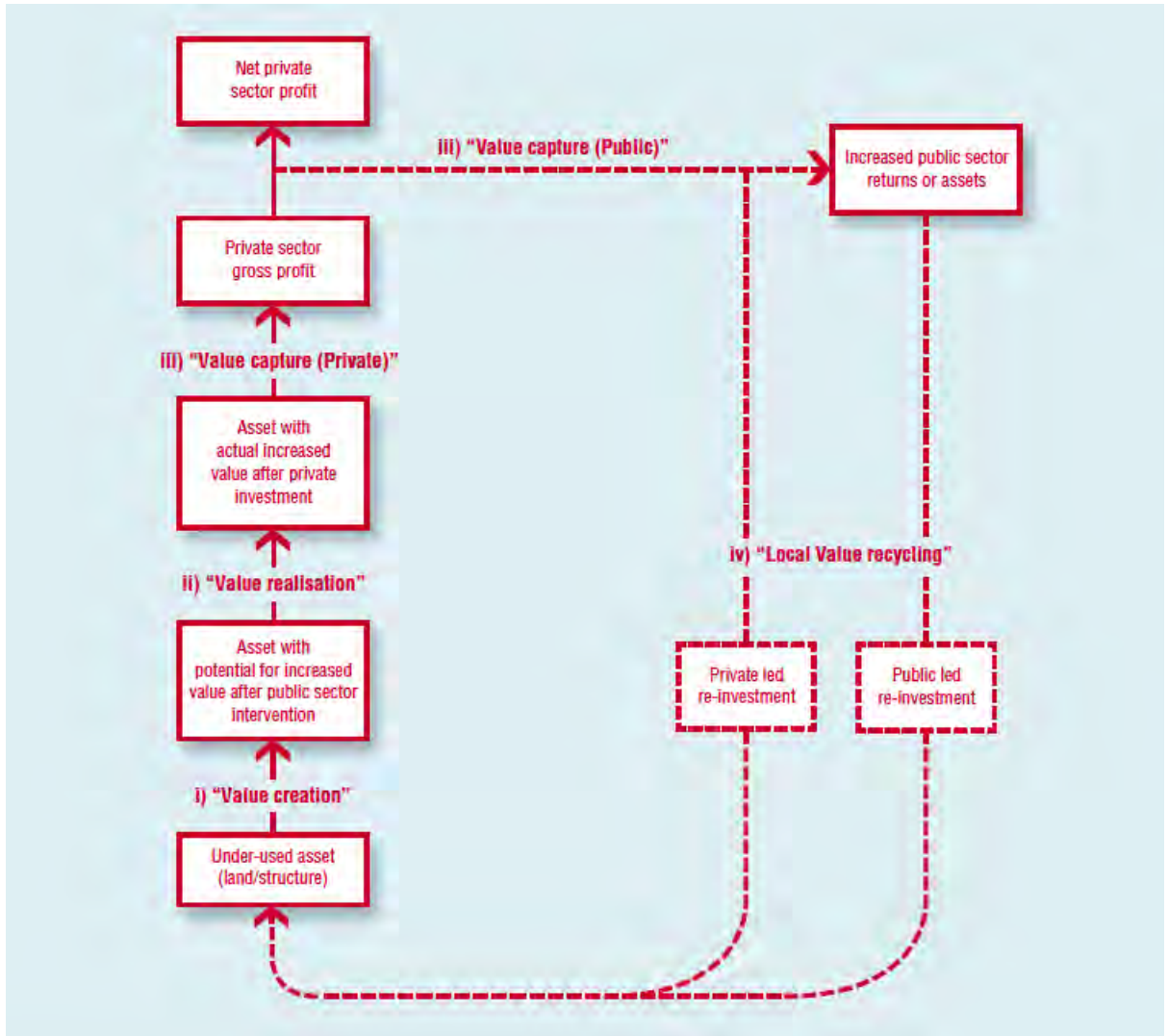


Figure 4: An Idealised VCF Positive Feedback Loop (Huxly, 2009)

2.4.2 Value Creation

When infrastructure provision in an area does not change the level of spend or investment in that particular area, it is very unlikely that any additional value will be generated. With any infrastructure additions, one has to ensure that there must be a change in the level of income that can be attracted and captured. As seen in the VCF positive feedback loop above, value has to be created first before it can be captured. Thus, an increase in spend after an infrastructure investment is expected to happen through complex market mechanisms in an increase demand for space in the specific area which will eventually result in higher rentals being paid and in turn create higher residual values. The potential to capture these increased values therefore exist and

can ultimately be used to pay for, or at least offset some of the cost of, transport infrastructure. This is obviously dependent on the market conditions that exist – the market comprises the user, development, and financial markets that have complex relationships. The process is graphically presented in Figure 5 below (Whitelegg, 1994).



Figure 5: Infrastructure spend (Whitelegg, 1994)

The increase in the value of spend will in most cases not be adequate to create the required value, but is still of utmost importance. One has to also consider the surrounding development conditions and potential. Poor development conditions will most likely lead to development potential that will not be realised or maximised and no value creation or capture taking place. Poor development conditions typically include limited availability of land, land ownership problems, poor infrastructure levels and poor urban management which are prevalent in a South African context. Poor urban management refers to a situation where development rights are lacking or difficult to obtain. Public authorities can therefore not intervene very easily and value creation opportunities are consequently lost (McGaffin, 2011).

2.4.3 Value Creation Measuring Methods

Value creation can take place in various forms as discussed above. How the additional value is calculated is also a very important feature in the value creation and capturing process. There are different measuring methods, all leading to a different results that are discussed below. It is important to understand all of these methods and to see how exactly all of them differ in order to avoid public and private sector disputes.

Hedonic pricing method

Cervero (2003) explains that the hedonic pricing theory assumes that most consumer goods consist of a number of attributes (size of structure, quality of neighbourhood etc.) or variables. The transaction price of certain goods will then comprise of the component or 'hedonic' price of each attribute. The hedonic pricing method attempts to isolate the different attributes and measures how much change in one attribute (or variable) has an effect on another attribute. It is assumed that people value attributes of a land parcel, rather than the land parcel itself, meaning that the value of a parcel of land will reflect the value of a set of attributes (Royal Institution of Chartered Surveyors, 2002). The bid-rent theory, as explained earlier, holds with fixed dummy variables (such as the municipality in which a property lies) to statistically capture unique attributes of certain neighbourhoods (such as the quality of schools in the area, crime rates etc.). Accessibility is a key predictor variable for the hedonic pricing model (Cervero, 2003).

It is often challenging to measure land price effects by utilising the hedonic price approach. In order to single out one attribute's effect, all the others have to be statistically controlled. The results may sometimes be misleading. Outcomes often vary, due to different input variables used in the model. This can especially become a problem seeing that the hedonic pricing model determines the amount of change in one variable compared to the change in another. Thus, case studies with different variables cannot be compared and conclusions drawn will differ significantly (Debrezion, Pels, & Rietveld, 2007). Other shortcomings experienced by the hedonic pricing model include:

- a) Difficulty to identify the value-generating characteristics of a property. The wrong characteristics might be identified and have misleading results to effect,
- b) The need for time-series data over at least three different periods. Data from different time periods are required to ensure reliability in results ,
- c) Factoring in the time before the value of infrastructure addition is realised which might take over three years, and
- d) Time for property transaction data to reflect (McGaffin, 2011).

Hedonic models for land value impacts are commonly formulated in the following form (Cervero, 2003):

$$P_i = f(T, A, S, C)$$

Where P_i = *estimated price of the parcel*

T = *vector of transportation proximity to transit and highways, and accessibility via highway and transit networks*

A = *vector of property characteristics (structure size, age etc.) and location attributes (type of commercial etc)*

S = *vector of neighbourhood socio – demographic characteristics (racial composition, household income etc.)*

C = *tvector of fixed effect controls*

Meta-analysis model

Meta-analysis models are very similar to hedonic pricing models in nature, however a meta-analysis identifies the results of underlying studies which are then treated as dependent variables that could potentially explain the variations in land prices. It is important that meta-analysis models are in the same measuring unit. A typical meta-analysis model will look as follows (Debrezion, Pels, & Rietveld, 2007):

$$Y = f(P, X, R, T, L) + \varepsilon$$

Where Y = *the variable under study*

P = *set of causes of the outcome Y*

X = *characteristics of the set of objects under examination affected by P in order to determine the the outcome Y*

R = *characteristics of research method*

T = *time period covered by the study*

L = *the location of each study conducted*

ε = *the error term*

Residual valuation method

In a local study conducted by McGaffin (2011) the residual valuation method was used instead of the hedonic price approach with all its shortcomings as discussed earlier. The estimates from this method are based on calculations prior to the infrastructure investment, so additional value created is estimated before the infrastructure investment. The residual valuation method also has a number of shortcomings, namely if the input variables (such as income received, development costs and required profit levels) change, the calculated residual value will differ considerably. Incorrect or poor input data will lead to misleading results.

The residual valuation method assumes that with all variables constant, a developer will only invest in a parcel of land if the selling price of the final development is equal to or more than the profit acquired from the development plus the acquisition and development costs of the parcel of land. In other words: Selling price \geq All-inclusive development cost + Profit. If a greater value is paid, it is assumed that the development will not be feasible and the developer will accordingly not purchase the property (The Appraisal Institute, 2008). The residual valuation method is expressed in the equation below (McGaffin, 2011):

$$Y = P - X - \alpha$$

Where Y = *the residual amount left to pay for the land*

P = *selling price of the land*

X = *all inclusive development cost*

α = *profit*

A hypothetical example of calculated residual value can be seen in the table below.

Table 1: Hypothetical Residual Value Example (McGaffin, 2011)

Description	Price
Selling price	R650 000
All inclusive development cost	R500 000
Profit	R100 000
Residual amount left to pay for the land	R50 000

Repeat sales method

The repeat sales (or fixed effects) method is applied when panel data is available. Time-invariant but unobservable neighbourhood or parcel effects can be controlled. The model assumes there are unobservable individual- or neighbourhood-specific attributes that contribute to price. A more elaborate explanation of the repeat sales method is given in section 3.4. The model is applied by utilising the formula below (Salon & Shewmake, 2011):

$$P_{it}^j = \alpha_i + x'_{it}\delta + \beta D_t^j + \varepsilon_{it}^j$$

Where P_{it} = the price of parcel i at time t

α_i = a constant

x'_{it} = observable neighbourhood and parcel level characteristics

D_t = a dummy variable that equals zero before the treatment and one after the treatment

ε_{it}^j = the error term

The constant, α_i can be on the neighbourhood or individual parcel level. Difference in time periods allows the fixed effect to be removed, while still allowing for estimation of time-variant parameters such as β (the impact of the treatment).

The benefit of panel data is that it allows for flexibility, seeing that it composes of multiple observations of individual parcels rather than a single observation. The researcher is able to compare the difference in appreciation between properties within and outside a treatment area. This methodology does however require a lot of data and an active real estate market in order to generate enough repeat sales (Salon & Shewmake, 2011).

2.4.4 Value Capture Mechanisms

Various mechanisms to capture value have been developed across different continents. Although all mechanisms work differently, all of them can be divided into two broad categories:

- Mechanisms where the value is captured from income-related value capture mechanisms to pay for transport or other urban infrastructure (monetary mechanisms), and
- Mechanisms where the added value is used to facilitate broader planning outcomes (for example densification and inclusionary housing).

Some mechanisms used elsewhere in the world are outlined below.

Zoning tools

Depending on the market demand, zoning tools can be used as a powerful tool for directing location, type and scale of development. Two typical zoning tools include incentive zoning and inclusionary zoning (McGaffin, 2011). These tools can be used to strengthen the value proposition.

Land banking

There is no single definition for land banking seeing that it can be applied in various scenarios. Alexander (2011) describes land banks as: 'entities that specialise in the conversion of vacant, abandoned and foreclosed properties into productive use.' Effectively, land banking can be seen as a strategy where governments or private entities acquire land cheaply and hold it for future developments in an effort to control land use in a city.

Betterment tax or Special assessment

Betterment taxes are taxes imposed by local governments because of additional land value increases occurring from private infrastructure investment. Betterment taxes or special assessments oblige homeowners to pay for the additional public service. Political resistance often prevents such taxes from being captured. Betterment taxes have been proven to flourish in more affluent communities, which will typically result in a concentration of infrastructure investment in wealthier communities (ADEC, 2010).

Business Improvement Districts

A Business Improvement District (BID) is an *ad valorem* levy imposed on homeowners or businesses in a certain area or district for an extra service above the normal service provided in the city. These levies are often used to combat crime by providing added security or cleaning services. Other improvements include infrastructure upgrades, landscaping, signage, and marketing management (ADEC, 2010).

Development impact fees

When developers make a once-off payment to public authorities to accommodate public infrastructure required for new development, it can be seen as development impact fees. Developers are regularly required to pay for additional infrastructure outside of their site's boundaries. (McGaffin, 2011).

Joint development agreements or local service agreements

These types of agreements can be seen as a type of public-private partnership in the sense that both developer and public authority pay for additional infrastructure and consequently share in any revenue resulting from the facility provision. These agreements are very complex and are often location specific where community involvement is required (ADEC, 2010). The MTR in Hong Kong is a typical example of joint development agreement.

Land value increment taxes

Land value increment tax is similar to betterment tax, however with land value increment tax payments are made in an on-going basis and betterment tax is usually a once-off payment. This tax is a variation on the conventional property tax system, where a mechanism to capture incremental increase in the value of land at specific locations due to public intervention is used.

Air rights

Developments above public infrastructure such as railway stations and highways make use of air rights. Rights to develop above public infrastructure, where no development was initially planned, is given at a certain price. In the United States, air rights were used in Madison Square Garden's construction above the Pennsylvania station. Public authorities are known to have granted air rights for the provision of public amenities, infrastructure and affordable housing (ADEC, 2010).

Tax increment financing (TIF)

Tax Increment Financing (TIF) works on the basis of an additional infrastructure investment in a precinct that is expected to increase the property values within a certain vicinity of the additional investment. This will evidently increase public tax revenues, which can ultimately be used to pay for infrastructure, streetscaping, and private development. Municipal governments ultimately finance improvements within the certain precinct based on the expected revenue stream occurring because of the investment. TIF districts are most common with transport interchanges, but can be applied to various other infrastructure scenarios. TIF is a perfect incentive for private development, because it helps in the provision of infrastructure required for a typical development (Salon & Shewmake, 2011).

Other mechanisms

- Debt servicing or loan guarantees where loans are secured against the increased or future value of land.
- Private-led local infrastructure and amenity provision and enhancement, which include schools, community centres and transport links.
- Operating revenue such as ticket sales or toll fees associated with infrastructure upgrades (Huxly, 2009).

2.5 Transport Infrastructure as a Catalyst for Value Capturing

As seen from the literature review, a general trend in land value becomes present with the provision of transport infrastructure and is again justified in APPENDIX A. If utilised correctly an opportunity for additional housing becomes available because of accessibility. This results in an increase in travel and consequently a source of finance or income as Johansson (2014) explains. The cycle can be seen in Figure 6 below.

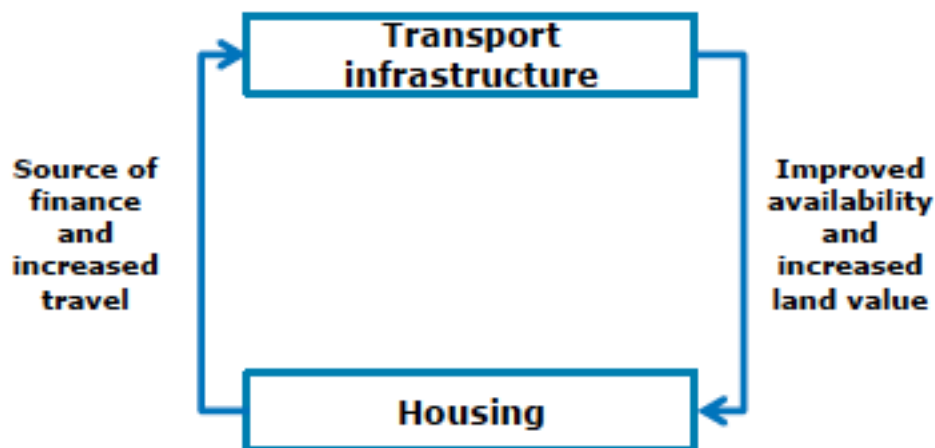


Figure 6: Transport Infrastructure and Housing Development (Johansson, 2014)

Cervero (2003) states that it is important to understand the land-market impacts of public transport investment from a policy standpoint. There are several reasons for this statement, which include:

1. To measure the benefits associated with transport infrastructure investment. This might help mediate any disputes associated with service improvements or additions,
2. To provide evidence for investors to eventually craft public-private partnerships and consequent financial arrangements, and
3. To create new forms of innovative infrastructure financing such as benefit assessments or other forms of value capture.

McGaffin (2011) also drew conclusions on certain observations with respect to different value capture mechanisms. He summarised these in three important conditions for success:

1. Policy objectives must be clear and non-contradictory. Not too many policy objectives should be attempted to be satisfied at once. For the case where financial objectives need to be met, the project should not attempt to meet social-orientated objectives in conjunction with the financial objectives.
2. The market conditions should be so that a surplus value can be created over and above the value required to make a development viable. All parties involved in the project should have a thorough understanding of the market forces and conditions, and
3. The establishment of Public Private Partnerships (PPPs) are required by many of the mechanisms discussed. The necessary institutional systems and legal frameworks therefore need to be in place to allow for an accelerated process for such partnerships.

McGaffin (2011) mentions that further research is required to assess whether South Africa's legislation and institutions are structured to facilitate such arrangements and to maximise benefits associated with transport infrastructure provision.

This study uses the literature as a stepping-stone and examines the possibility of potential value creation and value capturing with transport infrastructure additions.

2.6 Summary of Literature Review

The literature review introduced the available literature that relates to the concepts important to the investigation of infrastructure investment, property values, value creation and value capturing. From a review of the literature, the following key points are noted:

- Value capturing mechanisms have hardly been considered when planning and financing transport infrastructure in South Africa. Infrastructure investment is key to a country's economic growth and GDP. Due to the high costs associated with infrastructure provision, value capturing can lead to greater saving on investments, especially in a South African context.
- In general, property values within close vicinity to transport infrastructure have shown increased values. The extent or degree to which the increase does however differ and depends on a number of variables including transport type, context, market conditions, location etc. The effect that commuter rails have on

property prices is fairly unknown and will be explored in the study. Another comprehensive summary of different case studies can be seen in APPENDIX A.

- Previous literature indicates that infrastructure provision will lead to additional value in surrounding properties. Other authors suggest that there are a few simple steps to follow when implementing value capturing. It is evident that public-private partnerships will most definitely dictate value capturing agreements, but this was not considered in the analysis of the study.

3 Research Method

3.1 Introduction

It has been established from the literature review that transport infrastructure investments have the potential to create additional value to adjacent properties under specific conditions and that this additional value can be captured through various value capturing mechanisms. Due to the exceedingly high capital required for transport infrastructure, it is generally expected that the additional value will contribute to social and financial gains for communities. A data analysis was undertaken to evaluate the hypothesis, restated below:

“The Gautrain transport infrastructure investments have the potential to enhance property values which can be measured.”

To analyse the hypothesis secondary residential land value data was obtained from Lightstone Property. The vicinity to the station or node is one of the key characteristics of a property used in determining the effect of an infrastructure addition (Royal Institution of Chartered Surveyors, 2002). It was therefore decided to include this characteristic in the study, along with time of construction and property type, which are also useful tools in estimating changes in property prices. Various relationships of the different characteristics were examined and are discussed in the paragraphs below.

3.2 Case Study

The Gautrain is a planned rapid rail link comprising of two links between Tshwane (Pretoria) and Johannesburg as well as between Sandton and OR Tambo International Airport in Gauteng. There are three anchor stations on these two links and seven stations, which is linked by approximately 80 kilometres of rail along the route. Travelling at a maximum speed of 160 km/h to 180km/h, it reaches Hatfield (Tshwane) from Park (Johannesburg) in less than 40 minutes. The route network can be seen in Figure 7 below. The premium service is provided for 18 hours per day, with an initial minimum frequency of 6 trains per hour. Dedicated bus services from the respective train stations will be provided for commuting passengers.



Figure 7: Gautrain stations and stops (Gautrain, 2014)

It was decided to conduct a case study on the Gautrain railway in order to see if there is any correlation between public transport infrastructure investments and adjacent

property price increases. The Gautrain was specifically chosen as a case study, seeing that it is a unique project in South Africa and required considerable investment when constructed. The potential for this additional value being captured was also considered.

As seen in the literature, property price increases are dependent on various variables. For the purpose of the case study, emphasis was put on three important variables: housing type, distance from station and analysis year due to the availability of data and since they are very relevant variables to measure value creation and capture. The research problem and data used are discussed in the paragraphs below.

3.3 Research Problem

The research questions to be answered in the dissertation will essentially look at whether or not a property value increase occurred and to what extent. In order to answer this, the scope has been limited to three questions, of which all relate to a specific variable. These questions are:

1. What impact did the Gautrain have on different housing types?
2. Where did this value change occur?
3. When did this valuation change happen?

The three variables to be examined in each research question are housing type and land use; distance from station and analysis year respectively.

These three questions will help to answer the key research question of: 'Why did the Gautrain have an impact on the neighbouring properties and how did this impact differ by housing type, distance from station and timing?' By answering this question, we will be able to evaluate the hypothesis.

The flow of research questions can be seen in Figure 8.

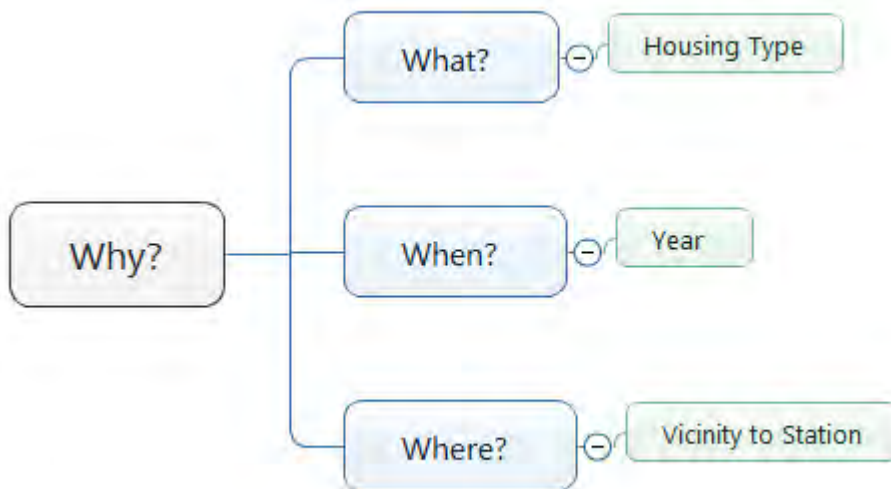


Figure 8: Research Questions & Variables

3.4 Data

Lightstone Property provided secondary data, which was used for the analysis.

Data used for the analysis includes Deeds Office Property Registrations for developed properties. Purchase dates since 2008 for properties within 8 km of the Centurion, Hatfield, Johannesburg, Marlboro, Midrand, Pretoria, Rhodesfield, Rosebank and Sandton Gautrain stations respectively are included in the data. Lightstone Residential has a flag that was used as a filter to select only residential sales.

For a property to be defined as Residential it must meet one of the following criteria:

- The property must be registered under a private name (or CC's/Trusts with fewer than five properties)
- The property is in an area where the majority of properties are privately owned
- The property is zoned as residential
- The property is not a farm
- Purchase price is less than R 40 million
- The zoning is the overriding criteria, and regardless of anything else a property zoned as non-residential will be deemed non-residential.

The residential properties analysed included freehold and sectional title property types. Freehold (full title) ownership describes the full transfer or ownership when you buy a

property. Sectional title ownership refers to a partial ownership of a complex or development when a property is bought or transferred (Private Property, 2010).

Lightstone's Hayley Greenstein specified their methodological approach for analysing the data as follows: If a purchase price was deemed to be non-market related or an outlier value, its value was nullified before calculating any figures mentioned in the results below. Examples of non-market related sales include portion of title deed sales, or transfer of the property from a family member (non-arm's length transaction) (Greenstein, 2015)."

Repeat Sales Methodology was employed in the analysis to avoid the pitfalls associated with changes in the types of properties that transact in one year versus another year. Using the repeat sales methodology, the inflation is measured on an individual property that transacted sometime since 2008 onwards. The previous sale price for the same property would be used to calculate the property's growth over the ownership period. The growth for the property would then be apportioned per year according to the same growth values we have seen for other properties in the same Automated Valuation Model (AVM) segment using Lightstone's AVM Repeat Sales indices. Thus if a property sold in 2010 and previously sold in 2008, it means that one would have the actual growth for this property assigned to the years from 2008 to 2010. To account for the sale of a property at different times of year, the growth for the portion of the ownership period of the year is annualized to represent the growth over a full year (Greenstein, 2015).

In order to organise the data and consequently simplify the analysis, the three variables (housing type; distance from station and analysis year) were all given subsections. The subsections for each variable were determined by the availability of data and can be seen in Figure 9 below.

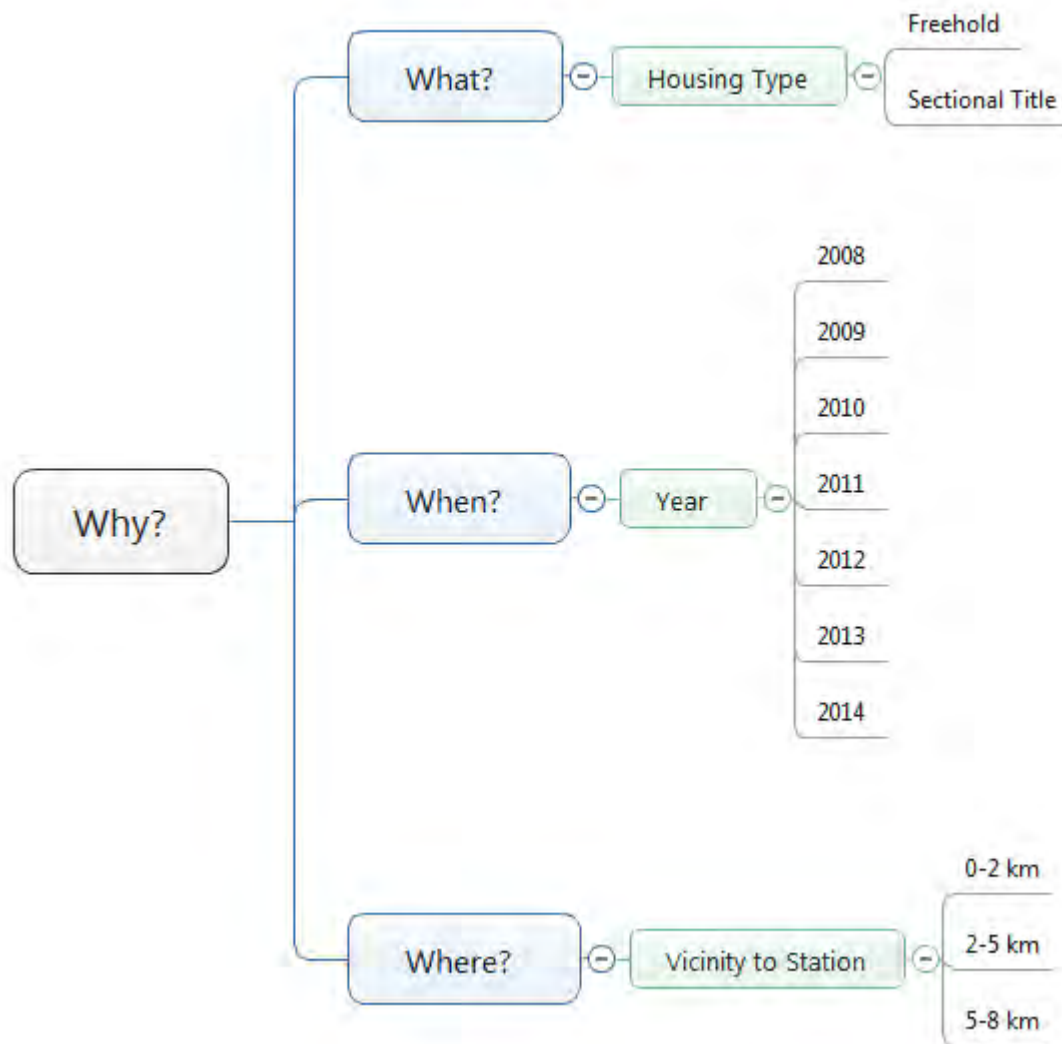


Figure 9: Research Questions, Variables and Subsections

For the purpose of the investigation, the three questions posed are answered by keeping the other two variables constant for each case as seen in Table 2. 'Before' & 'After' in the table refers to the construction (before) and operation (after) phase of the Gautrain. These relationships are discussed in more detail in Section 4.

Table 2: Constants and Variables

No.	Question	Variable		Constant	
1.	What?	Housing Type	Freehold & Sectional Title	Year	Before & After
				Distance	0-2 km
2.	Where?	Distance	0-2 km, 2-5 km, 5-8 km	Housing Type	All
				Year	Before & After
3.	When?	Year	2008 - 2014	Housing Type	All
				Distance	0-2 km, 2-5 km, 5-8 km

The reliability of the data was tested using an ANOVA analysis that tests multiple predictors for a certain outcome variable as in our case, which will be discussed in Section 4.5.

3.5 Summary of Research Method

- The Gautrain project in Gauteng will be used as a case study being researched in the dissertation, with specific emphasis on the stations.
- Distance to the station (Where), analysis year (When) and housing type (What) will be the three variables under consideration in the study.
- Secondary data from Lightstone Property will be used to analyse the effect of the stations on adjacent property values. The data's reliability will be tested by an ANOVA analysis.

4 Data Analysis

4.1 Introduction

During data analysis, an unconventional manner of presenting the results and directly thereafter discussing it was followed, instead of firstly presenting all the results and only discussing it later. It was decided to present results in this way in order to avoid confusion, seeing that there are numerous variables in the analysis.

From the results, residential property increases cannot truly be reflected when it has no base to compare it to. As per Lightstone Properties' advice, properties had to be analysed by using the average inflation due to location (the market trends are separated from structural factors such as infrastructure expenditure).

Average inflation increase due to location is defined as: (Average inflation of properties 0-2 km or 2-5 km of Gautrain station) – (Average inflation of properties within 5-8 km of station). It is assumed that the Gautrain does not affect properties 5-8 km away from stations. This then serves as the base residential property trend for a certain area. For example: In 2010 at the Hatfield station, property values within 0-2 km from the station had a 5% increase while properties within 5-8 km had a 3% increase. Therefore, the average inflation due to location for 0-2 km properties is 2% (5% - 3%). By applying this logic, the results are presented and then discussed below.

Finally, the reliability of the results are evaluated by means of an ANOVA analysis in Section 4.5.

4.2 Housing Type (What?)

4.2.1 Results

For the first research question, the housing type was analysed and therefore the year and distance had to remain constant. The two housing types analysed are freehold and sectional title properties as described in Section 3.4. The years were divided into 'Before' and 'After' operation to analyse the effect of the construction phase on commercial property value. The first rollout of the Gautrain was in 2010 (3 days before the start of the Soccer World Cup), where after the second phase was on 2 August 2011. The final phase linking Rosebank and Johannesburg Park Station started

operating on 7 June 2012 (Gautrain, 2011). The second roll out was the most significant and therefore it was decided to analyse the period from 2008 – 2010 as 'Before' operation (Construction phase) and 2011 – 2014 as 'After' (Operation phase). The weighted average for all of these were calculated, according to property sales during the specific year. The only available data for the two different housing types provided by Lightstone was for a distance 0-1 km and 1-2 km from the respective stations. Accordingly, properties price changes for a 0-2 km were calculated to make the data comparable to other variables analysed and consequently allow for consistency in the results. The calculated values can be seen in Table 5 & Table 6 in APPENDIX B.

4.2.2 Analysis

For the housing type analysis, the condition was applied and the results are discussed in the figures below.

Before (Construction Phase)

Freehold properties generally performed better than sectional title properties, with aggregated average increases of 0.45% and 0.34% respectively. Centurion, Hatfield, Marlboro, Midrand and Pretoria showed little to no increase in property value. Johannesburg, Rosebank and Sandton indicate significant increases due to proximity. Detailed tabulated results are shown in APPENDIX B.

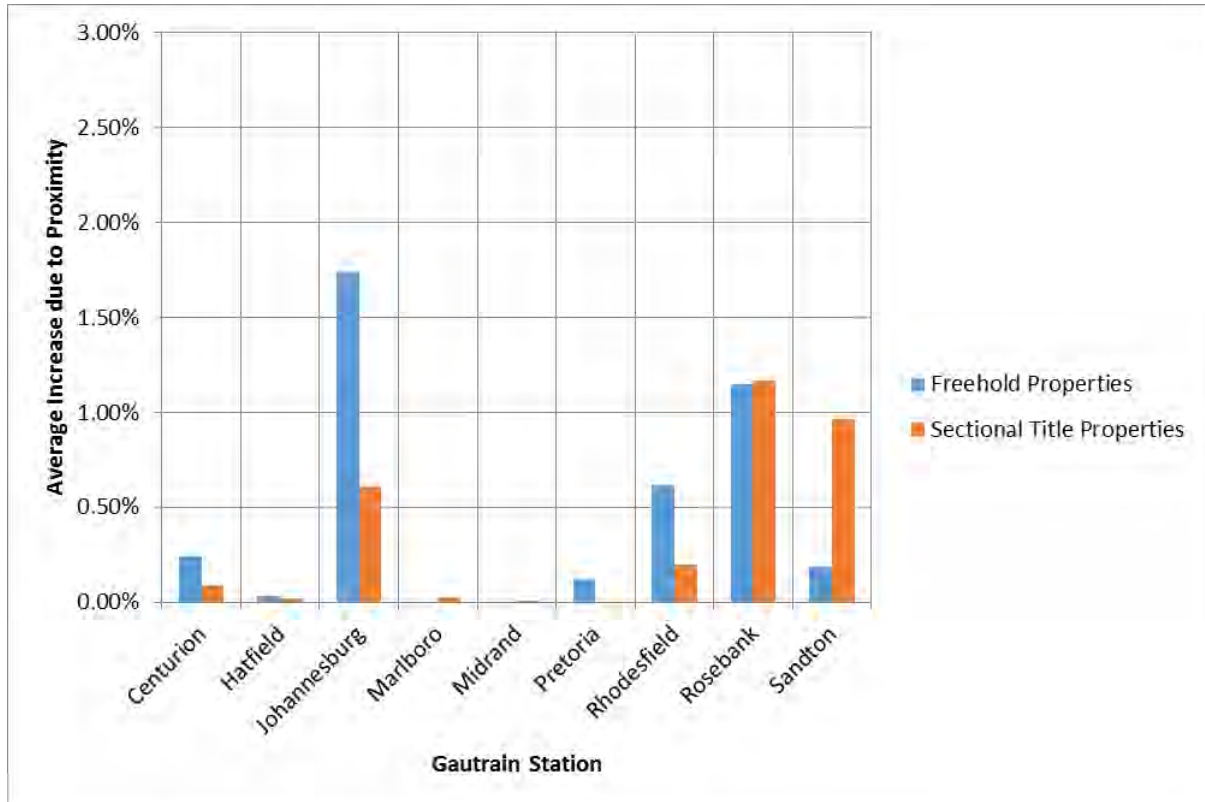


Figure 10: Weighted mean residential property value percentage change before Gautrain operation (During construction phase) for freehold and sectional title properties surrounding the station

After (Operation Phase)

Except for the case of Johannesburg and Marlboro stations, sectional title properties had a higher percentage increase than freehold properties. The aggregated average increases for freehold properties and sectional title properties are 0.75% and 1.21% respectively. This changed from the before phase, where freehold properties had a higher aggregated average than sectional title. Johannesburg station, however displays the same trend. This may be due the fact that sectional title properties are cheaper in general than freehold properties and more in demand. The type of built environment around properties also has an influence – in a city’s CBD, one would typically not have more sectional title properties. It can be said that the implementation of the Gautrain led to densification seeing that freehold properties are lower density and sectional title properties are higher density.

Centurion did not have any increase. However, there are not many residential properties within a two km radius of the station. Properties are inclined to have a higher increase in value in the operation phase of the Gautrain.

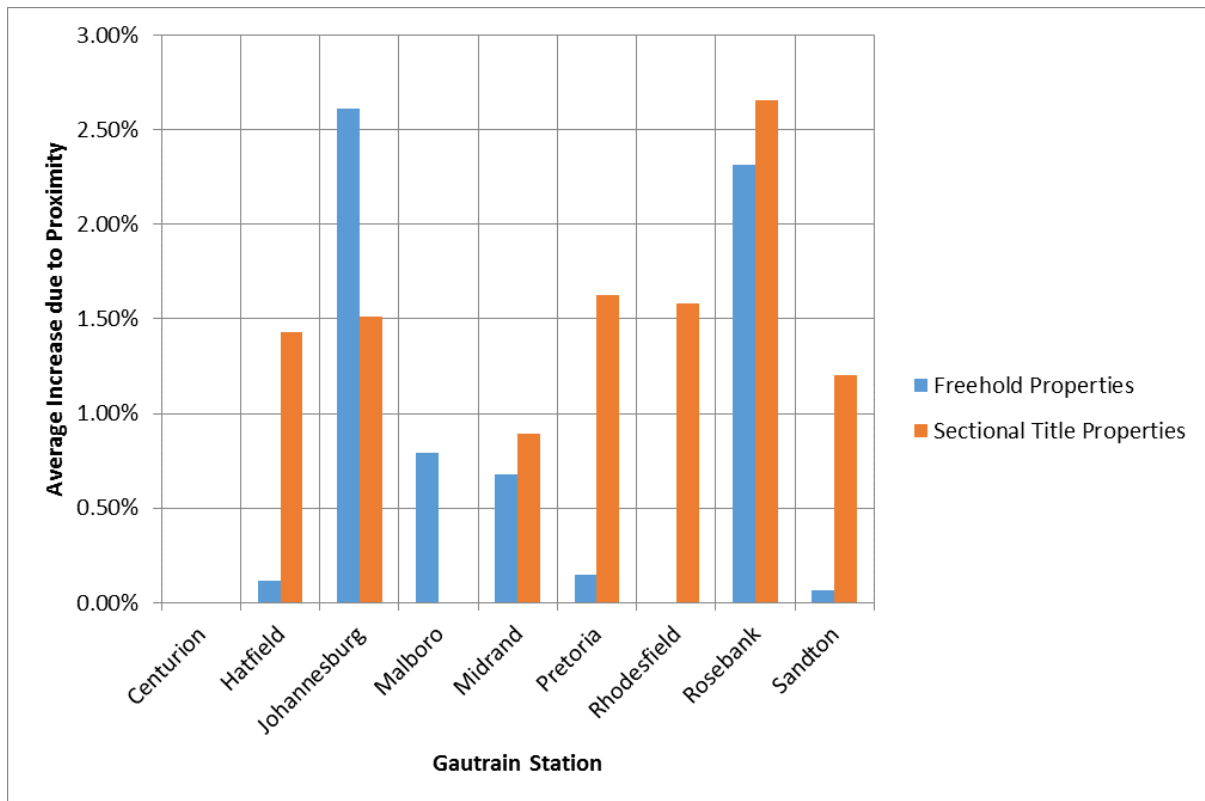


Figure 11: Weighted mean residential property value percentage change after Gautrain construction (operation phase) for freehold and sectional title properties surrounding the station

4.3 Distance from station (Where?)

4.3.1 Results

For the nine stations of the Gautrain, the average inflation increase or decrease was determined before and after the Gautrain's operation. This was done for all residential properties with a distance of 0-2 km, 2-5 km and 5-8 km from all stations. The results are indicated in Figure 12 & Figure 13 below.

Before (Construction Phase)

The table below indicates the average percentage increase before the Gautrain's operation. Properties in the 5-8 km category generally performed better than the 0-2 km and 2-5 km category, except for the Sandton and Rosebank stations, with aggregated averages of 1.53% for the 5-8 km category, 0.24% for the 0-2 km category and 1.07% for the 2-5 km category respectively. Relationships can be seen below. Detailed tabulated values can be seen in Table 7 in APPENDIX C.

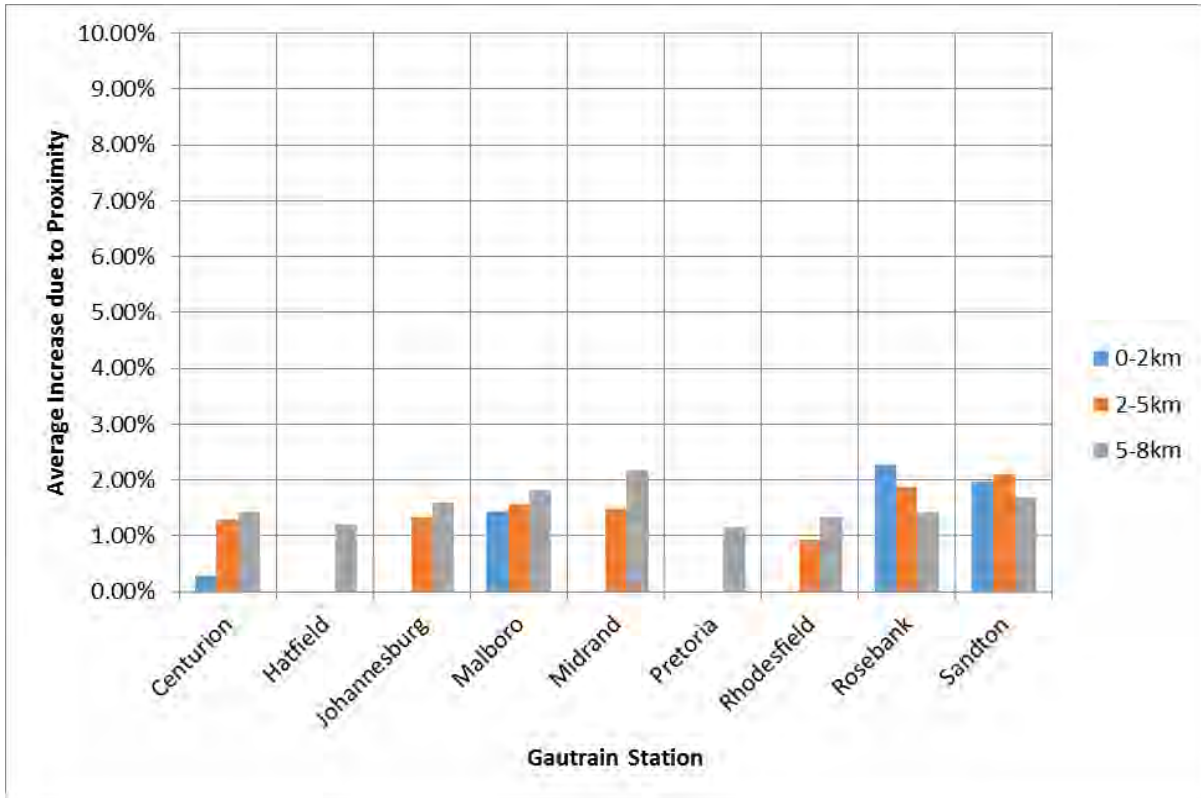


Figure 12: Weighted mean residential property value percentage change before Gautrain operation (During construction phase) between 0 and 8 km from the station

After (Operation Phase)

After the construction phase, the property market displayed a significant increase in average property values. Properties performed very similar at all distances, with the aggregated averages being 7.17%, 7.33% and 7.35% for the 0-2 km, 2-5 km and 5-8 km categories respectively. Rosebank and Sandton stations are again the odd ones out, where the exact opposite took place. Tabulated results are in Table 8 in APPENDIX C.

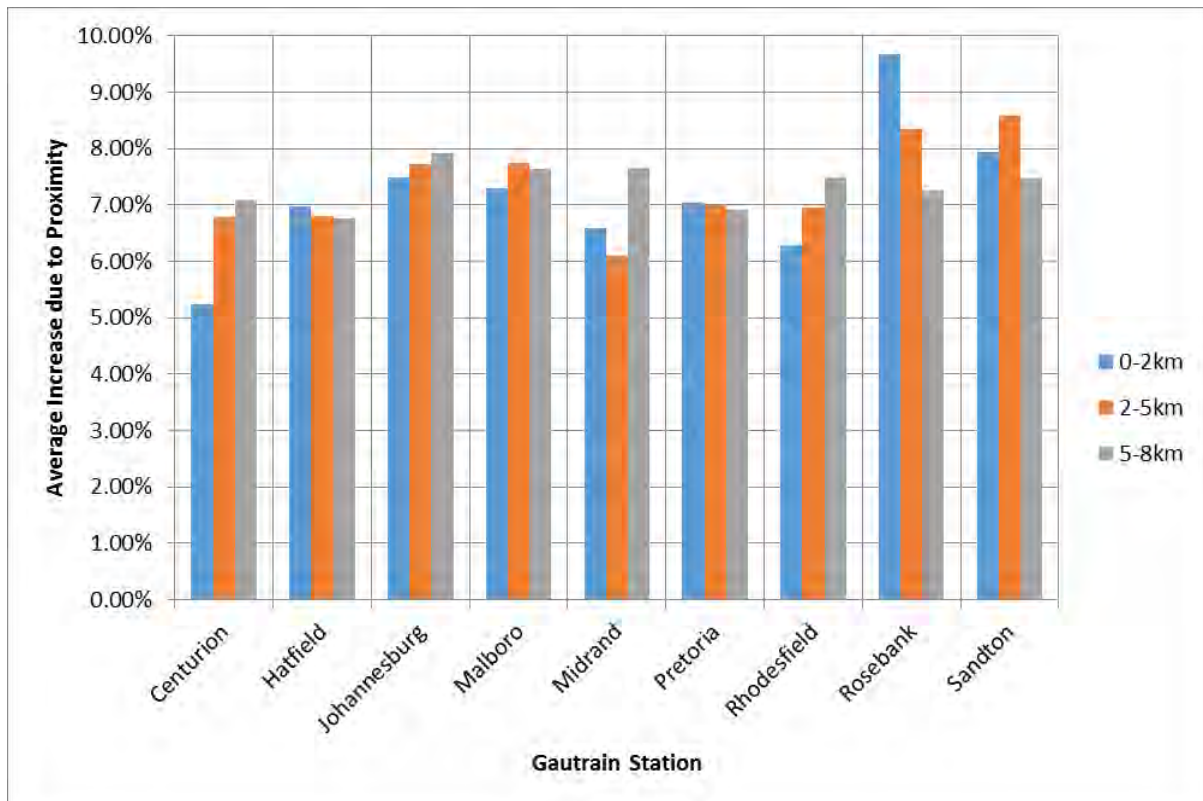


Figure 13: Weighted mean residential property value percentage change after Gautrain construction (operation phase) between 0 and 8 km from the station

4.3.2 Analysis

Similarly to the housing type, the condition mentioned earlier was applied to the distance from station. The results are shown in Figure 14 and Figure 15 and are discussed below. Tabulated results can be seen in Table 9 and Table 10 in APPENDIX C.

Before (Construction Phase)

Before the Gautrain's operation, properties within 5 km did not really change in value. The exception in this case is the Rosebank and Sandton stations, where 0-2 km increased more than 2-5 km in Rosebank's case and the opposite in Sandton's case. Rosebank properties performed better than Sandton properties, regardless of vicinity. The aggregated averages for the 0-2 km and 2-5 km categories are 0.57% and 0.43% respectively. For the case of the other stations, no increase was evident. The results are shown in Figure 14.

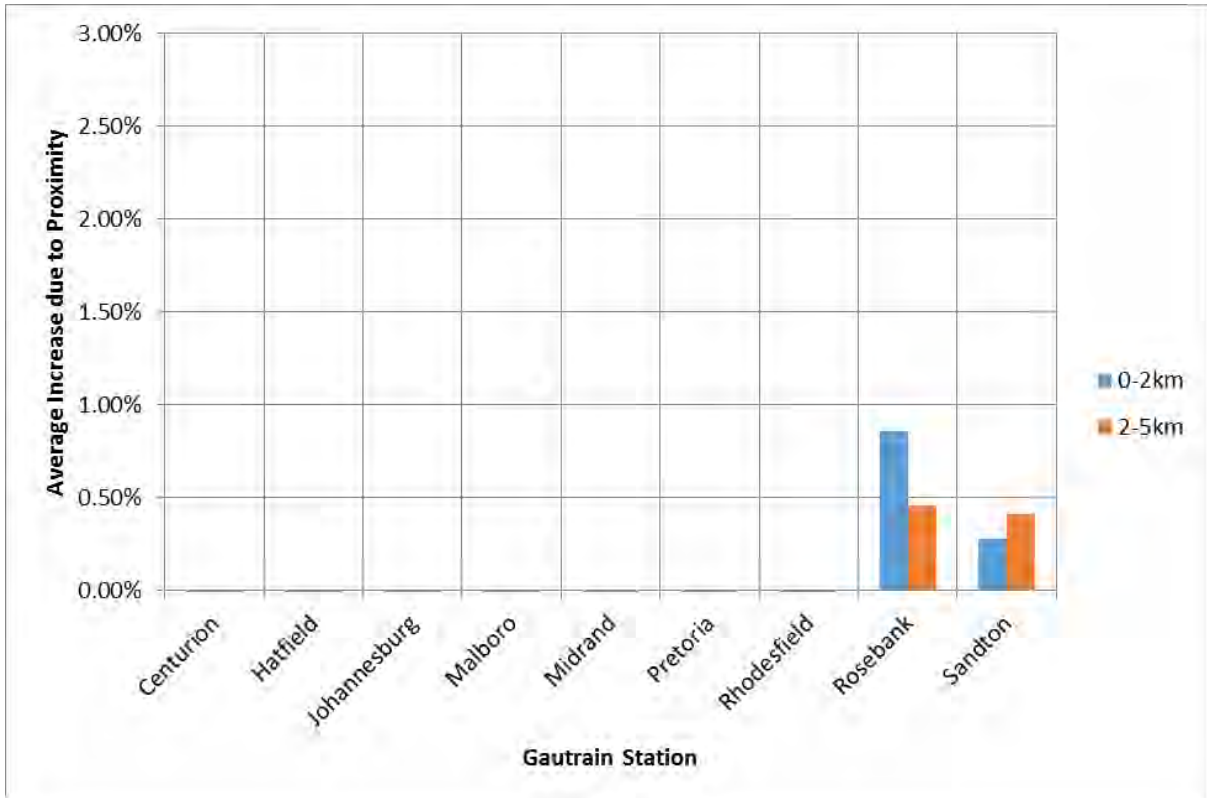


Figure 14: Weighted mean residential property value percentage change before Gautrain operation (During construction phase) between 0 and 5 km from the station

After (Operation Phase)

After the construction phase, properties started to increase more significantly. Hatfield, Marlboro and Pretoria started to show signs of increased values, whereas Rosebank and Sandton increased even more. The aggregated averages for the 0-2 km and 2-5 km categories are 0.81% and 0.48% respectively. As for the vicinity, there does not seem to be a clear trend in which one performs better, but properties in the 0-2 km category increased from 0.57% to 0.81%. Figure 15 shows the results.

One has to remember that the values are only taken as an average and may not be representative for the entire 'Before' or 'After' period. These results will be illustrated more clearly in Section 4.4.

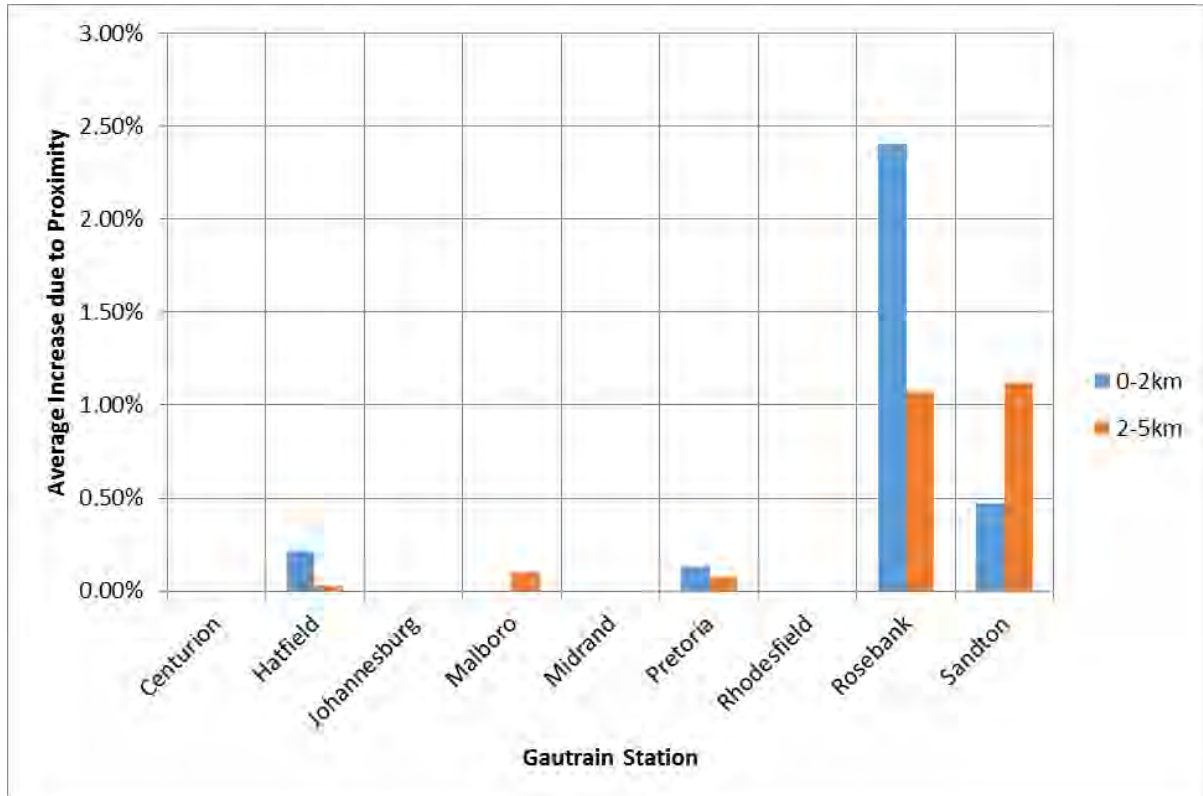


Figure 15: Weighted mean residential property value percentage change after Gautrain construction (During operation phase) between 0 and 5 km from the station

4.4 Analysis year (When?)

4.4.1 Results

In order to evaluate the analysis year, property types and distances had to be kept constant. Therefore, three graphs all representing different distances from the stations were drawn for the respective stations. The results are below.

0-2 km

The results from Figure 16 are as expected. An overall increase in most stations is present, with Johannesburg and Pretoria stations drastically increasing from 2012 to 2013. The negative values in 2008 indicate negative property percentage changes experienced.

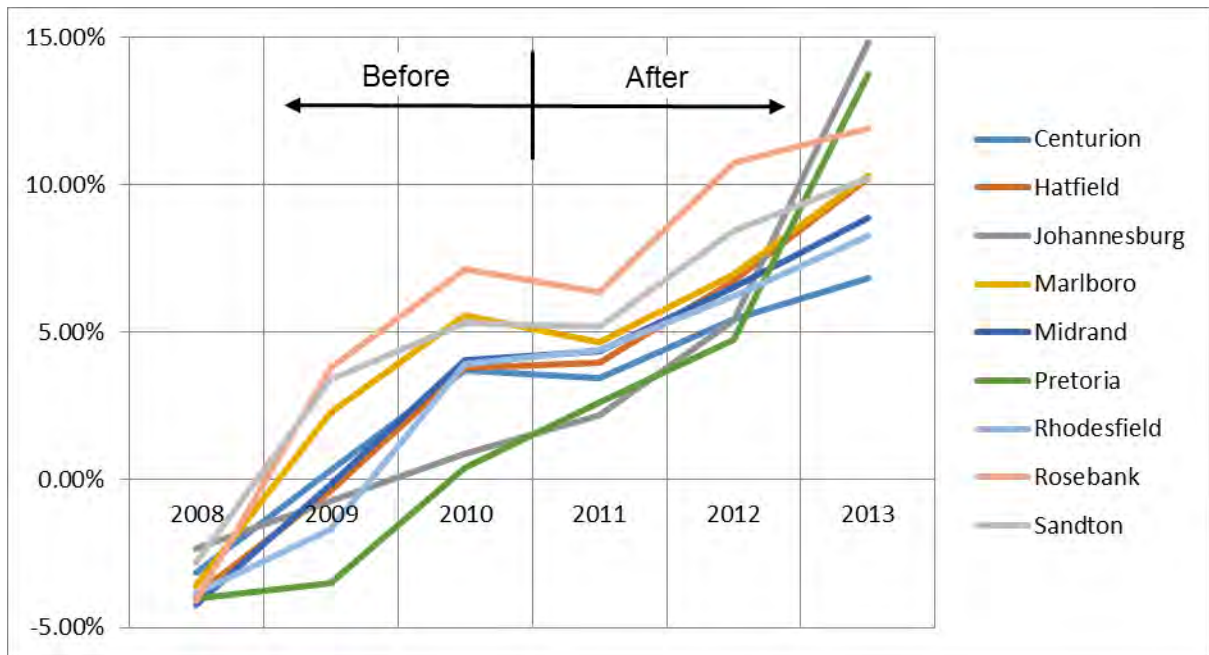


Figure 16: Weighted mean annual residential property value percentage change between 0 and 2 km from the station between 2008 and 2013

2-5 km

For the 2-5 km residential properties, the trends for all stations are rather similar. A net-increase is seen in all stations, with Pretoria and Hatfield stations behaving a little differently. Trends are shown in Figure 17.

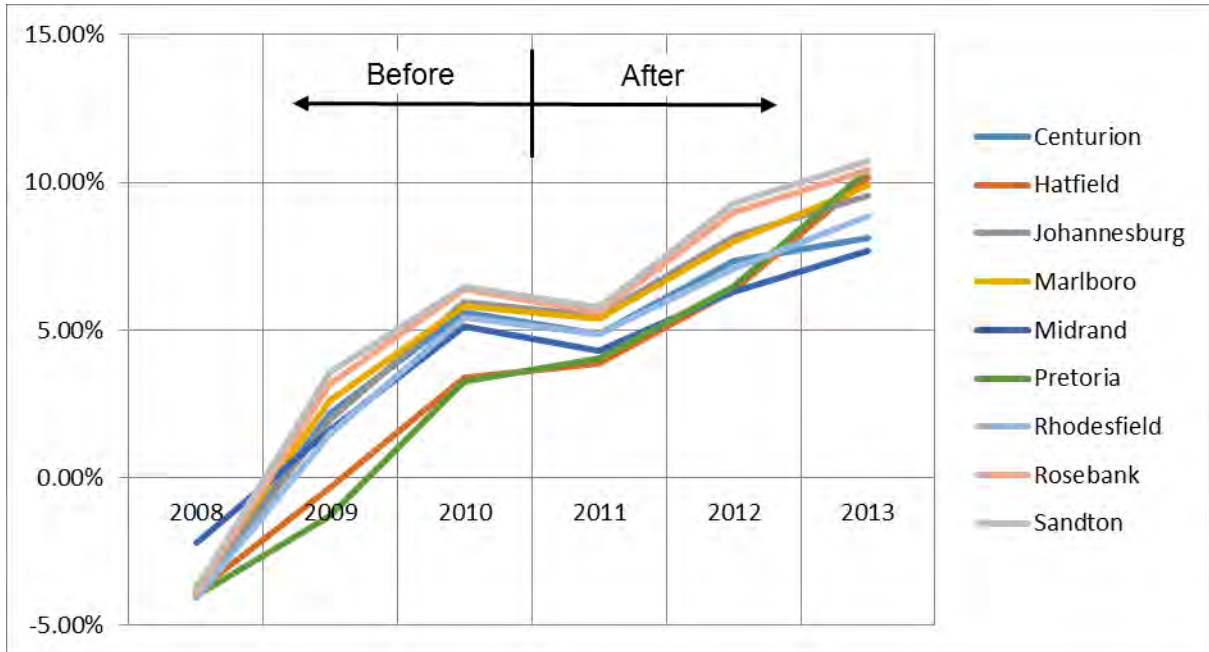


Figure 17: Weighted mean annual residential property value percentage change between 2 and 5 km from the station between 2008 and 2013

5-8 km

A general market trend for 5-8 km properties is clearly seen in Figure 18. An overall increasing property value is clearly seen from 2008 to 2010. The market tends to decline in 2011 and could partially be because of the economic recession. The market seems to stabilise after 2011 again.

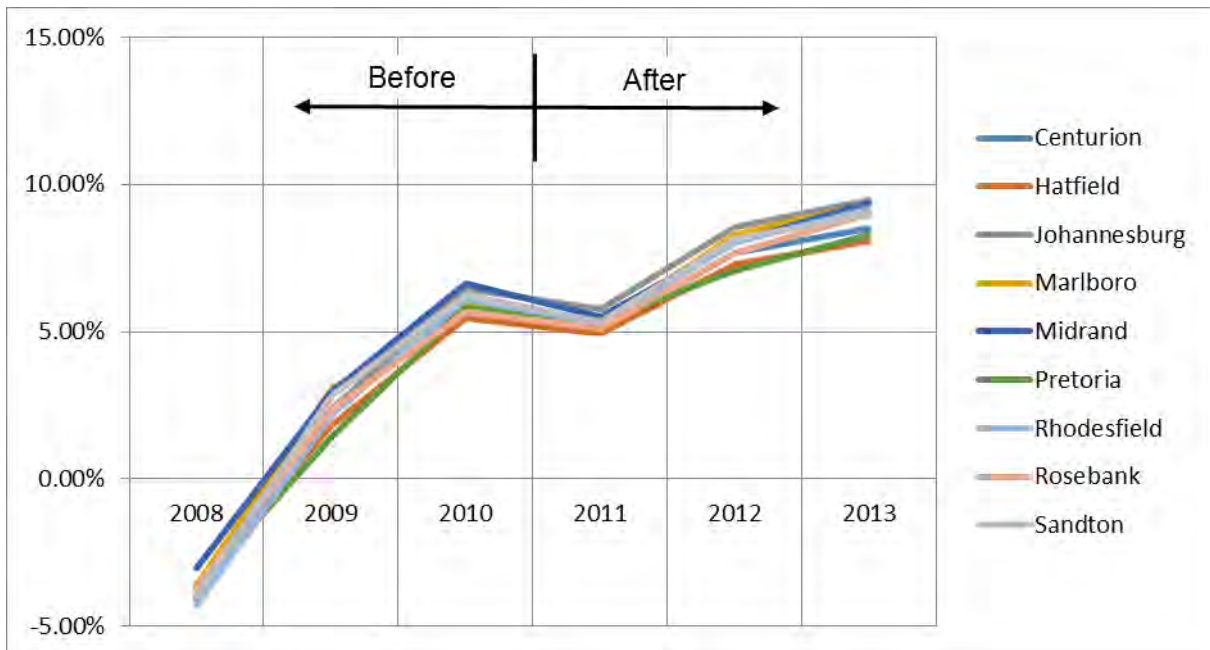


Figure 18: Weighted mean annual residential property value percentage change between 5 and 8 km from the station between 2008 and 2013

4.4.2 Analysis

As in the previous two sections, the base condition was applied to the 0-2 km and 2-5 km data sets. Tabulated results can be seen in APPENDIX D under Table 14 and Table 15.

0-2 km

The results displayed in Figure 19 clearly indicate the residential property trends for each station. Not all stations indicated property value increases. Noise implications might be one of the factors for decreasing trends. The Rosebank station seems to have the overall best performance regarding property value increase. Pretoria and Johannesburg stations performed very poorly prior to operation, but outperformed the other stations in 2013. This might be due to city revitalisation projects and initiatives taking place in the city centres.

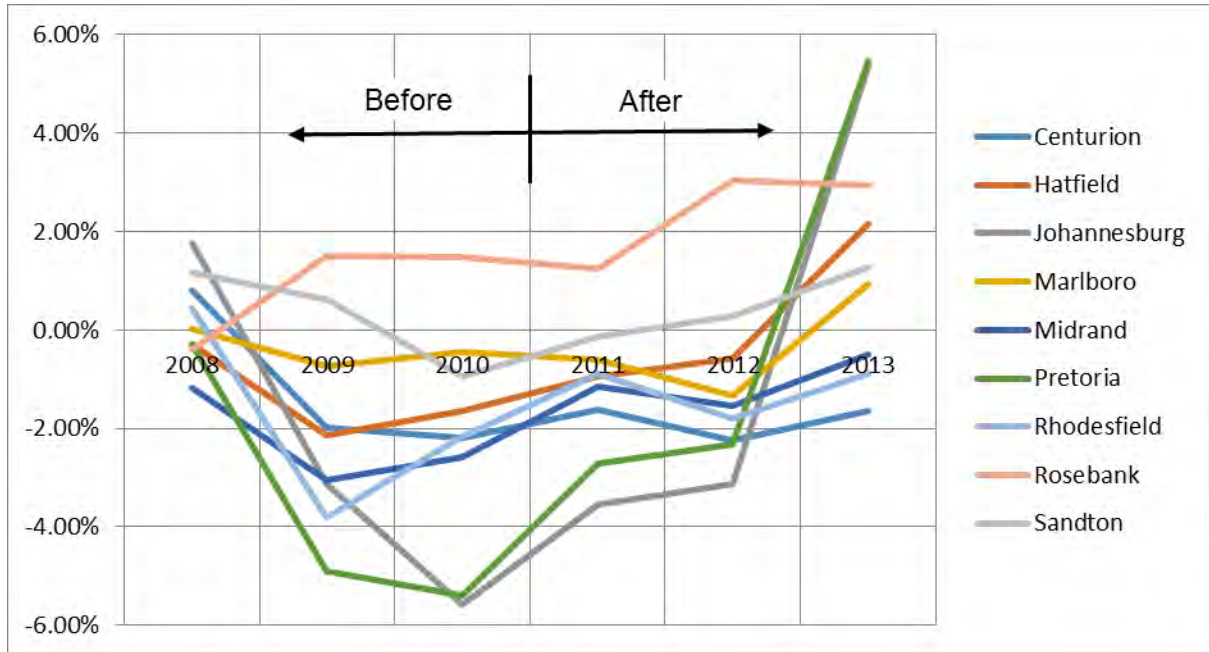


Figure 19: Weighted mean annual residential property value percentage change between 0 and 2 km from the station between 2008 and 2013

2-5 km

From Figure 20 it is clear that properties 2-5 km away from the Gautrain stations are not affected by the system as much as in the case of 0-2 km. Hatfield and Pretoria stations only started to show higher increases in 2013. This is possibly because of numerous accommodation projects taking place in the Hatfield area. Both Rosebank and Sandton performed well throughout the construction and operation phases and coincide very well with the results seen in the Distance from station results.

The area of the cities in which the properties are analysed increase markedly in the ratio 12.5:66:134 for the 0-2 km, 2-5 km and 5-8km ranges. This does much to explain the narrowing of the variation between stations as one moves out from the stations: there are many more property transaction and therefore the results should be treated with caution.

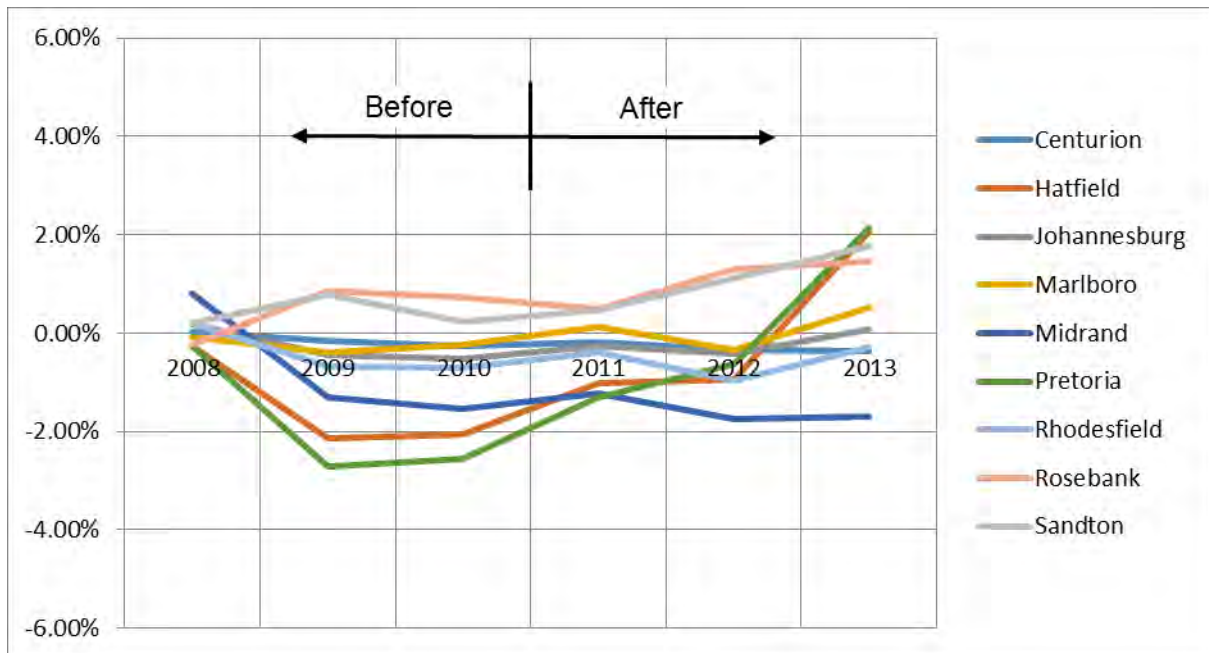


Figure 20: Weighted mean annual residential property value percentage change between 2 and 5 km from the station between 2008 and 2013

4.5 Analysis of Variance (ANOVA)

4.5.1 Background

In order to test the reliability of the data, it was decided to conduct an analysis of variance of the data used in the data analysis. A statistical software program called SAS (Statistical Analysis Software) was used for the analysis. Below follows a brief background on the method and interpretation of results.

In statistics, the term multivariate in “multivariate regression model” means that there are several/multiple response variables analysed simultaneously. Similarly, M in “MANOVA” stands for multivariate, also meaning multiple response variables (Carey, 1998). In the study at hand however, there is only one response variable of interest (average inflation) but four predictors (property type, distance from the station, year of investigation, and station); the resulting model is the multiple regression model, or the four-way analysis of variance (ANOVA).

In the four-way ANOVA, one needs to specify, besides the main effects of the four predictors, potential interactions between them. The size of the data allows one to include all interactions up to order three, i.e. interactions of up to any three predictors. However, it is hard to interpret interactions, especially those of order three or higher. If the interaction between type and distance is included, for instance, one can compare

the effects of different property types on the average inflation only when the distance from the station is at a fixed level.

The average inflation in a particular area is calculated based on the properties sold in that area. As can be imagined, the more sales in that area, the more confident we are about the resulting average inflation being representative of the true average inflation as if all properties were sold. Therefore, it was decided to put more weight on average inflation resulting from more property sales. Each average inflation is weighted by the number of property sales with finite-population correction (because there are only a finite number of properties in an area). The formula of the weight is:

$$\frac{1}{\frac{1}{n} * (1 - \frac{n}{N})} = \frac{n * N}{N - n}$$

Where $n =$ the number of property sales in the area, and

$N =$ the number of available properties in that area

Seeing that the availability of data for housing type is limited, it was decided to include three main interactions (property type and distance from station, property type and year of investigation, and distance from station and year of investigation). A higher interaction of all the variables was also included in the analysis even though it difficult to interpret.

The research is trying to determine firstly, if there is a change in value as a result of the infrastructure and then secondly, to determine if this impact on value varies depending on the property type, distance and time

After all the models were fitted to the data, the global F-test in the ANOVA table was used to assess the statistical significance of the effect of any other predictors. If the model was deemed to have statistical significance, it amounted to a post-hoc comparison. There are several approaches to do this but it was decided to use the Tukey's HSD (honest significant difference) test as suggested by staff at the University of British Columbia (UBC) (Sayed, 2015). The detailed calculations and associated results are shown in APPENDIX E.

4.5.2 Analysis

The ANOVA analysis was conducted by using SAS and it displayed the results in Table 3 below.

Table 3: ANOVA Analysis Results

Model No	Variable 1	Variable 2	F	Pr>F
1	Year	Distance	0.86	0.5472
2	Station	Distance	2.14	0.0239
3	Station	Year	1.90	0.0287
4	Year, Station, Distance		1.73	0.0453

The F Test was used to interpret the models. The F value is the ratio of the mean square for the model divided by the mean square for error. The F Test is a test of the null hypothesis that all parameters, except the intercept, are zero. The significance probability of the F-statistic is labelled Pr>F. If the value of Pr>F is smaller than 0.05, the model is deemed to have a significant correlation (SAS, 2014). Therefore, it can be said that models two, three and four have a significant correlation. Even though model 4 is very difficult to interpret and very close to not being statistically significant, it was still used in the analysis.

The respective parameters or variables were followed up with a post-hoc test for statistical significance inside the respective models using Tukey's HSD (honest significant difference) test. This is a post-hoc test, meaning that it is conducted after an ANOVA test. Tukey's HSD test determines which groups in the model differ significantly. The ANOVA test determines if the model is statistically significant, but Tukey's HSD test looks at the specific groups in the model. The HSD is obtained when the square root of the mean squared error within the ANOVA test divided by the total number of data points for a given group is multiplied by the studentized range statistic. A minimum difference between two group means is specified and if the difference between two group means exceed minimum difference, they are not deemed statistically significant (Stevens, 1999). Only the results for the models that are deemed statistically significant in the ANOVA test are discussed. Detailed results can be seen in APPENDIX E.

Station & Distance

For the first Tukey's HSD test where model number 2 was tested, the means of all the stations except Midrand station did not differ significantly. The distance variable also did not differ significantly. All the means and their differences can be seen in Table 20 in APPENDIX E.

Station & Year

In model number 3, the means of the stations were similar as in model number 2. Only Midrand station differed significantly from the rest. This might be due to the type of zoning present in the area as it is mostly zoned for commercial use. The year variable also did not differ significantly. All the means and their differences can be seen in Table 21 in APPENDIX E.

Year, Station & Distance

Even though model 4 had a p-value of just below 0.05, it was decided to still conduct Tukey's HSD test. Besides this, the results are even more difficult to interpret than in models 2 and 3 and have to be taken into consideration when analysing the results. The year variable and the distance variable had no significant difference. For the station variable, the Midrand station is once again the only station which differs significantly from the other stations. All the means and their differences can be seen in Table 22 in APPENDIX E.

4.6 Summary of Data Analysis

- A higher average inflation in properties is evident in sectional title properties except for the case of Johannesburg and Marlboro stations. Both sectional title and Freehold properties had higher average inflation after construction.
- Properties within a 0-2 km radius from stations always have higher average inflation than properties further away. A positive increase in the average inflation will not always be present, as seen in the cases of Centurion, Johannesburg, Midrand and Rhodesfield stations where no additional increase occurred. A higher increase was seen after construction was completed.
- Except for the Rosebank station, all property prices in a 0-2 km vicinity from stations declined during the construction period (2008-2009 & 2009-2010). In 2013 all property prices in a 0-2 km vicinity from stations performed better than

the previous year. In Johannesburg, properties within a 0-2 km from stations increased by 8.49% and similarly in Pretoria by 7.78% in 2013. Similar trends are seen in property prices in a 2-5 km radius from stations, but not to such an extent as in a 0-2 km radius.

- The Station & Distance, Station & Year and Year, Station & Distance models have p-values of less than 0.05 and are therefore statistically significant and subjected to a post-hoc test. In the post-hoc tests it was found that all the means of the variables, except for the Midrand station are not significantly different. It can therefore be concluded that for the above mentioned models, the dataset is reliable.

5 Conclusion and Recommendations

5.1 Study Objectives

The objective of this study was to investigate the characteristics of property values near Gautrain stations and thereby establish if the impact of infrastructure investments on adjacent property values presents an opportunity for value creation and consequently value capturing.

The hypothesis is stated as follows:

“The Gautrain transport infrastructure investments have the potential to enhance property values which can be measured.”

This chapter serves to summarise the main points that can be concluded from the literature review and data analysis and subsequently presents an evaluation of the hypothesis. Recommendations for further areas of study in this field, which were beyond the scope of this paper, are also discussed.

5.2 Conclusions from the Literature

The following conclusions have been drawn from a study of the literature presented:

- Value capturing mechanisms are hardly ever considered when planning and financing transport infrastructure in a South African context and can lead to a significant amount of financial savings in projects.
- In general, property values within close vicinity to transport infrastructure have shown increased values and the opportunity to capture these additional values consequently arises.
- Cervero (2003) suggest that there are a few simple steps to follow when implementing value capturing. Public private-partnerships will most likely dictate value capturing agreements, but was not considered in the analysis of the study.

5.3 Conclusions from the Case Study

The following conclusions can be drawn from the experimental procedure that was conducted in this study:

- Residential properties within a 2 km vicinity from stations indicated a more significant price increase than properties between 2 and 5 km away.
- Most properties performed better after the operation of the Gautrain started, but the difference might not be statistically significant. During the construction period, people might have been sceptical about the quality of service of the train.
- A general increase is present in residential properties in close vicinity to transit stations. Not all contexts will however perform (increase to the same extent) the same under the same conditions and variables. Midrand, Centurion and Rhodesfield showed little to no increases in most cases.
- For each variable, stations perform differently. It is therefore of utmost importance that as many variables as possible are taken into consideration when evaluating property price increases.
- The property market also has a big effect on the severity of change in property values.
- Sectional title properties generally performed better than freehold properties after the construction of the Gautrain. This might be an indication of increasing density around station nodes taking place.
-
-
- In the ANOVA analysis, for all variables, except for the Midrand station, the dataset is reliable.

5.4 Evaluation of the Hypothesis

In order to evaluate the hypothesis that is presented, it is necessary to first answer the research questions:

1. What impact did the Gautrain have on different housing types?

For residential properties, sectional title properties indicated the greatest property value increase.

2. Where did this value change occur?

Properties within a 2 km vicinity from public transport stations increased more in value than properties between 2 km and 5 km away.

3. When did this valuation change happen?

Changes in value were more prominent after the construction of the Gautrain, during operation. In 2013 all property prices in a 0-2 km vicinity from stations performed better than the previous year. In Johannesburg, properties within a 0-2 km from stations increased by 8.49% and similarly in Pretoria by 7.78% in 2013.

It was also concluded that the data is reliable for these stations by means of an ANOVA analysis.

The three questions helped to answer the key research question of: 'Why did the Gautrain have an impact on the neighbouring properties and how did this impact differ by housing type, distance from station and timing?'

The hypothesis can therefore be validated. It follows that:

"The Gautrain transport infrastructure investments have the potential to enhance property values which can be measured."

5.5 Recommendations

A number of recommendations could be made for further research in this field of study, these include:

- The analysis only took limited variables into account when evaluating. The results indicated different conclusions from every variable, so therefore it is recommended that one should look at other variables such as different transport infrastructure or commercial properties.
- The results are very specific for this case. One should look at a number of other cases as well, including different transport infrastructure, different locations, different value capture measuring methodologies and other property types such as commercial properties and industrial properties.
- Recommendations for practitioners include:

- Always consider the different variables, market trends and context such as transport mode and country when estimating land value increases.
- Regulatory frameworks and institutional systems have to be in place in order to establish public private-partnerships, which are required for numerous value capture mechanisms.
- Consider other forms of innovative infrastructure financing mechanisms to finance transport infrastructure in a South Africa and African context.

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APPENDIX A:

RESULTS FROM LITERATURE

Table 4: Literature Summary (Royal Institution of Chartered Surveyors, 2002)

Source	Case/Locati on	Impact of	Impact on	Impact
[1] APTA (2002)/after Diaz (1999)	North America	Proximity to rail (heavy and light)	Residential and commercial property values	In general, positive (via accessibility)
[2] APTA (2002)/Weinstein & Clower (1999)	DART (Texas)	Proximity to DART/LRT station	Property values	Positive +25%
			Class A office	+
			Class C office	+
			Strip retail	+
			Class A occupancy	80% 1994 to 88.5% 1998(+11%)
			Class A rent	\$15.6 to \$23/sqft (+47%)
			Strip retail occupancy	+ 49.5%
			Strip retail rent	+ 64.8%
[3] APTA (2002)/Cervero & Duncan (2002)	Santa Clara California	Walking distance of LRT	Commercial land values	Positive +\$4/sqft (+23%)
		¼ mile of CalTrain station	Commercial land values	+\$25/sqft (+120%) above mean
[4] APTA (2002)/Gruen & Associates (1997)	Chicago	Proximity to transit (MTA/Metro)	Value of single family homes	Positive
			Apartment Rent Value	Positive
			Apartment Occupancy	Positive
[5] APTA (2002)/Armstrong (1994)	Boston	Community with a commuter rail station	Single-family residential property values	Positive +6.7%

[6] APTA (2002)/ Sedway Group (1999)	San Francisco Bay Area	BART	Value of single family homes	Positive \$3200 to \$3700 depreciation per mile distance from BART station
			Apartment rental	Positive +15%to 26%
			Land price for office properties	Positive \$74/sqft within ¼ mile \$30/sqft over ½ mile
[7] APTA (2002)/ Cervero (1994)	Washington, DC & Atlanta	Systemwide ridership	Average office rents	Positive
		Joint development near rail station	Annual office rents	Positive +\$3/grsqft
			Office occupancy rate	Positive
			Share of regional growth	Positive
[8] Chesterton (2000)	London JLE	Set radii from the stations – 1000m and 3000m	Residential	Capital values - positive
			Commercial	Occupancy levels from estate agents, developers and investors perceptions – positive
[9] Chesterton (2002)	London JLE	Set radii from the stations – 1000m. Note that impact greater where rail infrastructure was poor – 25% increases in 7 out of 10 stations.	Residential	Capital values - positive, but variable. Highest for maisonettes and flats
			Commercial	Occupancy levels from estate agents, developers and investors perceptions – positive
[10] Pharoah (2002)	London JLE	Note that sites close to stations more attractive to commercial and mixed use developments, and those further from stations more attractive for residential developments	Residential	Development applications – variable impact by accessibility, potential and development history – positive, but in limited areas
			Commercial	Sites close to stations sought for mixed use and commercial developments
[11] Wrigley and Wyatt (2001)	Review Paper	Multi sector	Residential and commercial property values	Intra urban and regional, capturing agglomeration and network effects
[12] Hillier Parker (2002)	London Crossrail (projected)	Assumed impact area set at 1km from the stations	Commercial	Additional floor space of 10.87 million sq metres by 2025

			Residential	54,804 new dwellings in study area by 2025
[13] Henneberry (1998)	Sheffield Supertram	Assumed impact area at 1km along either side of line	Residential property values	House prices reduced with anticipation of construction of tram lines, but negative impact disappeared after opening
[14] Dabinett (1998)	Sheffield Supertram	LRT	Non Residential Property value	Unable to identify any discrete Supertram influence
[15] Dabinett (1998)	Sheffield (& Manch.)	LRT	House Prices	Influence so small that it cannot be separately distinguished.
[16] Laasko (1992)	Helsinki	Metro and Rail	Values	Overall, +\$550- \$650 million gain in value (US\$, 1990 prices)
[17] TRL (1993)	Tyne & Wear	Metro	House prices	200m +2% above those further away
[18] Wachter (1971)	London Victoria Line	Metro	Property values	Values in catchment area of line increased between 1% and 5% compared with properties outside the catchment

APPENDIX B:

HOUSING TYPE (WHAT?)

Table 5: Weighted mean residential property value percentage change before Gautrain operation (During construction phase) for freehold and sectional title properties surrounding the station

Station	Freehold	Sectional Title
Centurion	0,24%	0,09%
Hatfield	0,03%	0,02%
Johannesburg	1,74%	0,61%
Marlboro	0,00%	0,02%
Midrand	0,00%	0,01%
Pretoria	0,12%	0,00%
Rhodesfield	0,61%	0,20%
Rosebank	1,15%	1,17%
Sandton	0,19%	0,97%

Table 6: Weighted mean residential property value percentage change after Gautrain construction (operation phase) for freehold and sectional title properties surrounding the station

Station	Freehold	Sectional Title
Centurion	0,00%	0,00%
Hatfield	0,11%	1,43%
Johannesburg	2,61%	1,51%
Marlboro	0,79%	0,00%
Midrand	0,68%	0,89%
Pretoria	0,15%	1,63%
Rhodesfield	0,00%	1,58%
Rosebank	2,31%	2,65%
Sandton	0,07%	1,21%

APPENDIX C:

DISTANCE FROM STATION (WHERE?)

Table 7: Weighted mean residential property value percentage change before Gautrain operation (During construction phase) between 0 and 8 km from the station

Station	0-2km	2-5km	5-8km
Centurion	0,29%	1,29%	1,421%
Hatfield	-0,16%	-0,28%	1,205%
Johannesburg	-0,72%	1,32%	1,588%
Marlboro	1,43%	1,58%	1,815%
Midrand	-0,09%	1,49%	2,177%
Pretoria	-2,36%	-0,68%	1,159%
Rhodesfield	-0,52%	0,93%	1,323%
Rosebank	2,28%	1,88%	1,421%
Sandton	1,97%	2,09%	1,685%

Table 8: Weighted mean residential property value percentage change after Gautrain construction (During operation phase) between 0 and 8 km from the station

Station	0-2km	2-5km	5-8km
Centurion	5,24%	6,79%	7,076%
Hatfield	6,98%	6,80%	6,766%
Johannesburg	7,48%	7,73%	7,925%
Marlboro	7,30%	7,74%	7,640%
Midrand	6,60%	6,09%	7,649%
Pretoria	7,04%	6,99%	6,910%
Rhodesfield	6,29%	6,94%	7,494%
Rosebank	9,67%	8,34%	7,261%
Sandton	7,94%	8,59%	7,465%

Table 9: Weighted mean residential property value percentage change before Gautrain operation (During construction phase) between 0 and 5 km from the station

Station	0-2km	2-5km
Centurion	-1,13%	-0,13%
Hatfield	-1,36%	-1,49%
Johannesburg	-2,31%	-0,27%
Marlboro	-0,38%	-0,23%
Midrand	-2,27%	-0,68%
Pretoria	-3,52%	-1,84%
Rhodesfield	-1,84%	-0,39%
Rosebank	0,86%	0,46%
Sandton	0,28%	0,41%

Table 10: Weighted mean residential property value percentage change after Gautrain construction (During operation phase) between 0 and 5 km from the station

Station	0-2km	2-5km
Centurion	-1,83%	-0,29%
Hatfield	0,21%	0,03%
Johannesburg	-0,45%	-0,20%
Marlboro	-0,34%	0,10%
Midrand	-1,05%	-1,56%
Pretoria	0,13%	0,08%
Rhodesfield	-1,20%	-0,55%
Rosebank	2,40%	1,07%
Sandton	0,48%	1,12%

APPENDIX D:

ANALYSIS YEAR (WHEN?)

Table 11: Weighted mean annual residential property value percentage change between 0 and 2 km from the station between 2008 and 2013

Station	Centurion	Hatfield	Johannesburg	Marlboro	Midrand	Pretoria	Rhodesfield	Rosebank	Sandton
2008	-3,15%	-3,90%	-2,32%	-3,58%	-4,22%	-4,01%	-3,84%	-4,10%	-2,81%
2009	0,33%	-0,35%	-0,74%	2,29%	0,14%	-3,49%	1,65%	3,81%	3,42%
2010	3,70%	3,78%	0,89%	5,59%	4,07%	0,42%	3,94%	7,12%	5,30%
2011	3,43%	3,97%	2,20%	4,65%	4,38%	2,63%	4,39%	6,36%	5,18%
2012	5,45%	6,73%	5,41%	6,97%	6,52%	4,76%	6,22%	10,74%	8,42%
2013	6,85%	10,24%	14,83%	10,29%	8,89%	13,74%	8,27%	11,90%	10,22%

Table 12: Weighted mean annual residential property value percentage change between 2 and 5 km from the station between 2008 and 2013

Station	Centurion	Hatfield	Johannesburg	Marlboro	Midrand	Pretoria	Rhodesfield	Rosebank	Sandton
2008	-3,91%	-3,88%	-3,90%	-3,67%	-2,23%	-3,99%	-4,08%	-3,92%	-3,77%
2009	2,15%	-0,35%	1,94%	2,61%	1,61%	-1,31%	1,46%	3,16%	3,57%
2010	5,62%	3,37%	5,93%	5,80%	5,10%	3,25%	5,42%	6,39%	6,48%
2011	4,88%	3,89%	5,49%	5,38%	4,29%	4,05%	4,88%	5,60%	5,77%
2012	7,35%	6,35%	8,14%	7,97%	6,29%	6,47%	7,08%	8,99%	9,27%
2013	8,14%	10,15%	9,55%	9,88%	7,69%	10,43%	8,87%	10,42%	10,72%

Table 13: Weighted mean annual residential property value percentage change between 5 and 8 km from the station between 2008 and 2013

Station	Centurion	Hatfield	Johannesburg	Marlboro	Midrand	Pretoria	Rhodesfield	Rosebank	Sandton
2008	-3,94%	-3,61%	-4,08%	-3,60%	-3,03%	-3,73%	-4,28%	-3,70%	-3,99%
2009	2,32%	1,78%	2,38%	3,01%	2,91%	1,40%	2,14%	2,31%	2,80%
2010	5,89%	5,44%	6,46%	6,03%	6,65%	5,81%	6,11%	5,66%	6,25%
2011	5,05%	4,92%	5,75%	5,26%	5,52%	5,35%	5,28%	5,12%	5,31%
2012	7,69%	7,30%	8,55%	8,31%	8,05%	7,09%	8,03%	7,69%	8,15%
2013	8,49%	8,09%	9,47%	9,35%	9,38%	8,29%	9,17%	8,97%	8,94%

Table 14: Weighted mean annual residential property value percentage change between 0 and 2 km from the station between 2008 and 2013

Station	Centurion	Hatfield	Johannesburg	Marlboro	Midrand	Pretoria	Rhodesfield	Rosebank	Sandton
2008	0,80%	-0,29%	1,76%	0,02%	-1,18%	-0,29%	0,45%	-0,40%	1,17%
2009	-1,99%	-2,14%	-3,12%	-0,72%	-3,05%	-4,89%	-3,80%	1,50%	0,62%
2010	-2,19%	-1,66%	-5,57%	-0,44%	-2,58%	-5,39%	-2,17%	1,47%	-0,95%
2011	-1,62%	-0,94%	-3,55%	-0,61%	-1,14%	-2,72%	-0,89%	1,23%	-0,12%
2012	-2,24%	-0,57%	-3,14%	-1,34%	-1,53%	-2,33%	-1,81%	3,05%	0,28%
2013	-1,64%	2,15%	5,35%	0,94%	-0,49%	5,45%	-0,90%	2,93%	1,27%

Table 15: Weighted mean annual residential property value percentage change between 2 and 5 km from the station between 2008 and 2013

Station	Centurion	Hatfield	Johannesburg	Marlboro	Midrand	Pretoria	Rhodesfield	Rosebank	Sandton
2008	0,03%	-0,27%	0,18%	-0,07%	0,80%	-0,26%	0,21%	-0,23%	0,22%
2009	-0,16%	-2,13%	-0,45%	-0,40%	-1,31%	-2,71%	-0,68%	0,85%	0,78%

2010	-0,27%	-2,07%	-0,53%	-0,23%	-1,55%	-2,56%	-0,69%	0,74%	0,23%
2011	-0,17%	-1,03%	-0,26%	0,12%	-1,22%	-1,30%	-0,40%	0,48%	0,46%
2012	-0,34%	-0,95%	-0,41%	-0,34%	-1,76%	-0,61%	-0,96%	1,29%	1,13%
2013	-0,35%	2,06%	0,08%	0,53%	-1,69%	2,14%	-0,30%	1,45%	1,78%

APPENDIX E:

ANOVA TEST & TUKEY'S HSD TEST RESULTS (SAS)

Table 16: Year & Distance ANOVA Test

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	4266.283	533.2854	0.86	0.5472
Error	180	110978.4	616.5468		
Corrected Total	188	115244.7			

Table 17: Station & Distance ANOVA Test

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	12351.895	1235.1895	2.14	0.0239
Error	178	102892.82	578.0496		
Corrected Total	188	115244.72			

Table 18: Station & Year ANOVA Test

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	14	15312.334	1093.7382	1.9	0.0287
Error	174	99932.381	574.324		
Corrected Total	188	115244.72			

Table 19: Station, Year & Distance ANOVA Test

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	15965.256	997.8285	1.73	0.0453
Error	172	99279.459	577.2062		
Corrected Total	188	115244.72			

Table 20: Station Distribution in Station & Distance Tukey's HSD Test
Station:

Alpha	0.05
Error Degrees of Freedom	178
Error Mean Square	578.0496
Critical Value of Studentized Range	4.44112
Minimum Significant Difference	23.301

Means with the same letter are not significantly different.				
Tukey Grouping	Mean	N	Station	
A	9.547	21	Rosebank	

	A			
	A	8.632	21	Sandton
	A			
B	A	1.372	21	Marlboro
B	A			
B	A	-2.102	21	Johannesburg
B	A			
B	A	-3.187	21	Rhodesfield
B	A			
B	A	-3.669	21	Centurion
B	A			
B	A	-4.495	21	Pretoria
B	A			
B	A	-5.131	21	Hatfield
B				
B		-18.707	21	Midrand

Distance:

Alpha	0.05
Error Degrees of Freedom	178
Error Mean Square	578.0496
Critical Value of Studentized Range	3.34247
Minimum Significant Difference	10.125

Means with the same letter are not significantly different.			
Tukey Grouping	Mean	N	DistFromStationCat2
A	0	63	5-8km
A			
A	-1.451	63	0-2km
A			
A	-4.463	63	2-5km

Table 21: Station & Year Tukey's HSD Test
Station:

Alpha	0.05
Error Degrees of Freedom	174
Error Mean Square	574.324
Critical Value of Studentized Range	4.44238
Minimum Significant Difference	23.232

Means with the same letter are not significantly different.

Tukey Grouping		Mean	N	Station
	A	9.547	21	Rosebank
	A			
	A	8.632	21	Sandton
	A			
B	A	1.372	21	Marlboro
B	A			
B	A	-2.102	21	Johannesburg
B	A			
B	A	-3.187	21	Rhodesfield
B	A			
B	A	-3.669	21	Centurion
B	A			
B	A	-4.495	21	Pretoria
B	A			
B	A	-5.131	21	Hatfield
B				
B		-18.707	21	Midrand

Year:

Alpha	0.05
Error Degrees of Freedom	174
Error Mean Square	574.324
Critical Value of Studentized Range	4.21881
Minimum Significant Difference	19.457

Means with the same letter are not significantly different.			
Tukey Grouping	Mean	N	PurchYear
A	5.09	27	2013
A			
A	0.816	27	2008
A			
A	0	27	2014
A			
A	-1.145	27	2012
A			
A	-2.766	27	2011
A			
A	-7.273	27	2009
A			

Table 22: Station, Year & Distance Tukey's HSD Test
Year:

Alpha	0.05
Error Degrees of Freedom	172
Error Mean Square	577.2062
Critical Value of Studentized Range	4.21939
Minimum Significant Difference	19.509

Means with the same letter are not significantly different.			
Tukey Grouping	Mean	N	PurchYear
A	5.09	27	2013
A			
A	0.816	27	2008
A			
A	0	27	2014
A			
A	-1.145	27	2012
A			
A	-2.766	27	2011
A			
A	-7.273	27	2009
A			
A	-8.521	27	2010

Distance:

Alpha	0.05
Error Degrees of Freedom	172
Error Mean Square	577.2062
Critical Value of Studentized Range	3.34346
Minimum Significant Difference	10.12

Means with the same letter are not significantly different.			
Tukey Grouping	Mean	N	DistFromStationCat2
A	0	63	5-8km
A			
A	-1.451	63	0-2km
A			
A	-4.463	63	2-5km

Station:

Alpha	0.05
Error Degrees of Freedom	172

Error Mean Square	577.2062
Critical Value of Studentized Range	4.44304
Minimum Significant Difference	23.294

Means with the same letter are not significantly different.				
Tukey Grouping		Mean	N	Station
	A	9.547	21	Rosebank
	A			
	A	8.632	21	Sandton
	A			
B	A	1.372	21	Marlboro
B	A			
B	A	-2.102	21	Johannesburg
B	A			
B	A	-3.187	21	Rhodesfield
B	A			
B	A	-3.669	21	Centurion
B	A			
B	A	-4.495	21	Pretoria
B	A			
B	A	-5.131	21	Hatfield
B				
B		-18.707	21	Midrand

APPENDIX F:

ETHICHS CLEARANCE

EBE Faculty: Assessment of Ethics in Research Projects (Rev2)

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph 021 650 4791). **NB: A copy of this signed form must be included with the thesis/dissertation/report when it is submitted for examination**

This form must only be completed once the most recent revision EBE EIR Handbook has been read.

Name of Principal Researcher/Student: Samuel Lombard Department: Civil Engineering

Preferred email address of the applicant: samuelhombard@gmail.com

If a Student: Degree: MEng (Transport Studies) Supervisor: Roger Behrens

If a Research Contract indicate source of funding/sponsorship:

Research Project Title: Value Creation and Capture Around Transport Infrastructure Station Nodes in South Africa

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	<input checked="" type="checkbox"/>
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	<input checked="" type="checkbox"/>
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	<input checked="" type="checkbox"/>
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	<input checked="" type="checkbox"/>

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate. Ensure that you refer to the EIR Handbook to assist you in completing the documentation requirements for this form.

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

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

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	<u>Samuel Lombard</u> Signed	<u>01/12/2015</u>
This application is approved by:		
Supervisor (if applicable):	Signed	<u>01 DEC 2015</u>
HOD (or delegated nominee): <i>Final authority for all assessments with NO to all questions and for all undergraduate research.</i>	Signed	<u>01/12/15</u>
Chair: Faculty EIR Committee <i>For applicants other than undergraduate students who have answered YES to any of the above questions.</i>		