THE EFFECT OF BUILDING DENSITY ON HOUSING PRICES AND THE SUPPLY OF HOUSING IN STELLENBOSCH: THE APPLICATION OF A HEDONIC PRICE MODEL

BY

SAMKELISO SIPHEPHELO MAKHUBU

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Supervisor: Danie Du Plessis

Department of Geography and Environmental Studies

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DECLARATION

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ABSTRACT

Densification has received considerable interest worldwide as a solution to the exacerbated housing demands that are normally associated with rapid urbanization. The Stellenbosch housing market is characterized by very expensive residential properties and remain unaffordable to the average South African household. The municipality of Stellenbosch has put in place densification measures such as prescribing limits for floor area ratio (FAR), building coverage and building height guidelines to positively influence the production of houses by developers and investors.

The aim of this research, therefore, is to investigate the impact of building density on the housing prices and the housing supply in Stellenbosch. The objectives of the research are twofold: firstly, to understand the impact of building density through FAR and building coverage area on the overall housing market in Stellenbosch, and secondly to identify the relationship of FAR and the other independent variables in estimation of housing prices in the different submarkets (neighbourhoods) in Stellenbosch. The study employs a hedonic regression model to investigate the impact of densification on housing prices. The research attempts to estimate the impact of densification on the overall market of Stellenbosch and subsequently look at the submarket housing variations across Stellenbosch.

The hedonic models' results confirmed that FAR is a significant determinant in predicting housing prices, while Building Coverage Area (BCA) is not statistically significant in most of the models. The FAR variable was found to be significant in all the models including the overall and the submarkets models. For estimating house prices, the overall model suggests that the coefficient of FAR is 6687.45 which implies that one unit of FAR will increase housing prices by R6687.45 per square metre when the other variables are controlled. The hypothesis that building density positively influences housing prices is supported by the model. The overall model indicates that the availability of a garage and swimming pool were insignificant in the Stellenbosch model but the other variables including, FAR, BCA, distance to CBD, distance to nearest school, plot size, and the six neighbourhood variables, were significant in estimating house prices in Stellenbosch.

KEY WORDS: Densification; Floor Area Ratio; hedonic price model; Stellenbosch housing market; housing prices; regression model.

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ACRONYMS

ANOVA Analysis of Variance

ASGISA Accelerated and Shared Growth Initiative for South Africa

BCA Building Coverage Area

CBD Central Business District

DFA Development Facilitation Act

FAR Floor Area Ratio

GEAR Growth, employment and redistribution

IDP Integrated Development Plan

ISRDS Integrated Sustainable Rural Development Strategy

IUDF Integrated Urban Development Framework

IZS Integrated Zoning Scheme

LUMS Land Use Management Systems

NFAR Net Floor Area Ratio

NGS National Growth Strategy

NSDP National Spatial Development Perspective

NDP National Development Plan

OECD Organization for Economic Co-operation and Development

OLS Ordinary Least Squares

RDP Reconstruction and Development Programme

SACN South African Cities Network

SDF Spatial Development Framework

SGIID Spatial Guidelines for Infrastructure Investment and Development

SPLUMA Spatial Planning and Land Use Management Act

SPSS Statistical Package for Social Scientists

UGB Urban Growth Boundary

DEFINITIONS OF CORE CONCEPTS

Building Coverage Area (BCA) refers to the percentage of the lot area that is covered by the building area which includes the total horizontal area when viewed in a plan.

Floor Area Ratio (FAR) refers to the measurement of a building's floor area in relation to the size of the lot or parcel of land that the building is located on. It is expressed as a decimal number and is derived by dividing the total area of the building by the total area of the parcel of land.

Integrated Development Plan (IDP) refers to a strategic five-year plan for an area that gives an overall framework for development. It is a coordination instrument that links the work of local government and other spheres of government.

Integrated Zoning Scheme (IZS) refers to a legal document that records all land use rights on properties in its area of jurisdiction. It stipulates what type of buildings and what type of activities can occur in an area. It also includes regulations pertaining to restrictions on such rights and how they can be exercised

Ordinary Least Squares (OLS) refers to a type of linear least squares method for estimating the unknown parameters in a linear regression model. It is the most commonly used procedure used for regression analysis. The OLS procedure minimizes the sum of squared residuals.

1. CHAPTER ONE – INTRODUCTION

1.1 BACKGROUND

The town of Stellenbosch has been experiencing persistent periods of high property prices coupled with a limited new housing stock supply which has consequently affected the affordability levels of housing for low- and medium-income households. The value of full-title and sectional-title properties in the Stellenbosch urban areas increased by 47% between 2012 and 2016. The total number of houses greater than $80m^2$ completed since 1996 was about 134 per year and the number of flats and townhouses completed per annum over the same period was 137 per year. Full-title property rentals in Stellenbosch town showed growth of approximately 8.1% per annum between 2008 and 2017, while sectional-title property rentals grew by 10.5% per annum over this period. Policy interventions by the municipality has been largely focused on the importance of increasing the supply of affordable housing for these groups in strategic locations within the town (Stellenbosch Municipality, 2012) and several densification instruments, such as infill development and subdivision of lots to minimum sizes, have been put in place to improve housing density and housing supply in the land use management approach of the municipality.

Sharam *et. al.* (2015) argue that planning plays an important function in the provision of housing because it is seen to influence the escalation of housing production costs by contributing to increased development costs in the form of materials used and the type of buildings that can be erected. The government on the other hand, can regulate its planning control by confining land uses, increase densities, and endorsement rates of the developments, in order to influence housing supply in future. Pacione (2009) argue that inconsistent planning policy objectives and ineffectiveness of local planning practices have often resulted in a gap in the production of housing. In general, planning systems are currently fashioned as important intervention instruments to increase the supply of housing by maximizing the potential of land parcels, but conversely also being responsible for the laissez faire approach that leads to urban sprawl and slow reaction to private housing market forces. Hui et. al. (2003) note that planning policies do not affect housing markets immediately because private developers require substantial financial resources and time to convert low density sites into high-rise residential developments.

Many global cities employ growth management strategies to address urban sprawl and guide urban growth into a denser and compact development through use of regulatory tools such as densification, mixed use developments and rigid urban edges that discourages sprawl (Chobokoane & Horn, 2014). Generally, densification can be realized in basically two approaches. Firstly, through the intervention of the government by directly providing of new social and low-income housing through various public institutions and secondly through market interventions by using incentives or regulations to influence developers to provide new housing by increasing densities. Based on the relationship of land value, property prices, and distance from the central business district, residents are faced with making trade-offs between travel costs and transportation costs and the fact that land developers prefer areas in locations and density where they can maximize profits. The density of buildings fluctuates varyingly over the entire urban area due to the imperfections and complexity of the residential property markets in terms of areal differences, associated regulation, and social welfare elements.

Fasselmeyer et al. (2017) note that while there has been extensive research in densification in general, there is limited research on the effects of densification of housing on property prices. In the Stellenbosch area, a number of studies have investigated the extent of densification and people’s preferences and satisfaction in property price and selection (Benn, 2010; Kruger, 2017). The former largely concentrated on the extent of densification on the urban form of the town and the implications of such densification on urban management policies in Stellenbosch. On the other hand, the latter study highlights the housing preferences of the population of Stellenbosch and the features that attract specific groups of people to neighbourhoods with different income capabilities. The current study is an attempt to contribute to this research area by investigating the impact that building density might have on property prices and the housing supply side while cognizant of the unique characteristics of Stellenbosch that may influence the local housing market.

1.2 RESEARCH PROBLEM

Stellenbosch has limited space for further urban expansion to cater for the rapidly growing demand for housing due to a rigid urban boundary and characterized by restrictions such as surrounding mountains, wine farms and contiguous developed suburbs. These factors reinforce the exaggerated property prices locally, consequently influencing their affordability and supply.

The Spatial Development Framework (SDF) of Stellenbosch proposes the delivery of affordable housing in strategic locations to address the limited supply and affordability of housing. Conversely, the current zoning restrictions seem to promote the historical low-density development character within the town which contributes to urban sprawl and unsustainable usage of land specifically in areas in proximity to the city centre. The impacts of existing policy density measures on the supply of housing and on the costs of the resultant housing products in Stellenbosch is unclear.

1.3 RESEARCH QUESTION

What is the effect of housing density on the housing prices and the provision of housing in Stellenbosch where currently there is limited housing supply in light of the municipality's policy ambitions to increase affordable housing?

1.4 RESEARCH AIM AND OBJECTIVES

Aim:

The overall aim of the study is to assess the impact of the density variables on the prices and provision of residential properties in Stellenbosch. The specific research objectives are defined as follows:

1. To determine the effect of housing density (floor area ratio (FAR), building coverage area (BCA) and building height) on housing prices in Stellenbosch housing market.

2. To identify the relationship of housing density variables with other independent variables in the determination of house prices for the submarkets (neighbourhoods) in Stellenbosch.

1.5 HYPOTHESIS

The hypothesis is that the optimal application of densification measures such as improved floor area ratio could improve housing supply and affordability in Stellenbosch.

1.6 RESEARCH METHODOLOGY

The data for the study was obtained from the Stellenbosch Municipality and include property values and housing density variables such as plot sizes, floor area ratio, building coverage, availability of swimming pool and garages. In this study housing density is measured and investigated by variables such as floor area ratios (FAR), building coverage area (BCA) and building height restrictions. The focus is on the FAR variable as it also reflects the characteristics and impacts of the other two variables. The different residential zoning districts are also used in the analysis of density parameters on each district and the impact of these variables to the property values in each district. The focus of the analysis is to establish the relationship between housing price patterns and variation in housing density and zoning districts.

Chapter 2 focuses on existing literature on the available measures of housing density and their relevance to property prices and the delivery of housing. Chapter 3 describes the methodology and the use of quantitative methods such as descriptive statistics, inferential statistics and spatial statistics techniques in the analysis of the data set that include variables that reflect property prices, floor area ratio (FAR), building coverage, and building height restrictions. The results and the relationships of the dependent variable and the important variables in the hedonic model are discussed and summarized in Chapter 4. Chapter 5 presents conclusions of the study, identifies some potential limitations of the research, and highlights the implications of the research in influencing housing policy.

2. CHAPTER TWO - LITERATURE REVIEW

2.1. INTRODUCTION

Rapid urbanization influences urban development in numerous cities and has to deal with the challenge of limited land supply in urban areas. At the same time densification has become increasingly prominent in planning policies worldwide (Cheng, 2010). According to Sharam et al. (2015), the inflation of housing prices is a severe concern given the serious decline in the number of low- and middle-income households able to purchase housing and aggravated by the supply of housing does not match the housing demand. Li et al. (2016) note that the supply of real properties is largely dependent on the supply of developable urban land and this relationship plays an important role in influencing policy interventions for governments with strong control over the physical supply of land.

However, laissez-faire expansion of the urban built-up area in many developing countries because of urbanization pressures often result in negative socio-economic and environmental effects (Musakwa & Van Nierkerk, 2015). Urban authorities have attempted to implement control measures to halt or even reverse the trend. The main challenge is however to monitor progress from the uncontrolled expansion of the built-up area in urban centres to the anticipated sustainable urban growth trajectory, particularly in cities of the global south, including South African cities. Urban policies often require local governments to promote sustainable urban development, but here is limited or lack of measures put in place to monitor advancement towards sustainable urban development (Musakwa & Van Niekerk 2015). According to Sharam et al (2015) laissez-faire planning also aggravates housing affordability issues because it fails to resolve the basic economic problem which is the failure of the market to efficiently match supply and demand to advance an orderly development process which has limited risks. They reported that the city of Melbourne experienced an extended period of real estate price inflation coupled with a severe under-supply of new housing stock, which gave rise to acute housing unaffordability for low- and middle-income households. Policy interventions to address the escalated house prices did not yield the expected results in the intended areas and where positive results were witnessed, it resulted in perceived over-development (Sharam et al., 2015). Additionally, housing affordability remained inaccessible to the low- and middle-income households, and affordable housing solutions that was provided has been criticised for poor quality and design.

According to Li et al. (2016) housing price oscillations have continually been considered an intriguing research area because housing is both a social product for accommodation need, and an investment product for capital gains specifically for low-income households and affluent households respectively. As the production of housing is dependent on the availability of land, a political economy perspective of the land supply mechanism makes the topic even more fascinating because governments can influence the amount of land that can be released for housing development through two options that inform most urban policies worldwide. Firstly, the government or a public entity has direct control over the supply of land to the developers or private entities. Secondly, the state can indirectly influence housing provision in terms of zoning and planning measures.

Gradually, housing affordability remains a persistent challenge for both national and local governments around the world. Efforts by governments such as the deregulation of mortgages have resulted in the increase in the demand for housing, whilst housing supply and planning systems have been recognized as significant influencers of housing prices (Murphy, 2016). The social and spatial implications of unaffordable housing provision for modern societies are severe and are highlighted below.

Firstly, a middle-class that cannot afford housing significantly affecting housing tenure in the form of limited homeownership and increase private rental housing. The collective effect of limited access to homeownership and high rental prices adversely affect the social status and upward mobility of citizens of many countries specifically those in the low- and middle-income groups (Wetzstein, 2017). This poses a serious risk for future social harmony, political participation and economic citizenship. Tilak et al. (2016) posit that if housing prices surge at the proportion of lifetime incomes of residents, sustainable housing affordability would be certain in the long term. On the other hand, when this scenario is not reached there is a likelihood that households will be overwhelmed by extreme mortgage debts.

Secondly, Wetzstein (2017) further notes that urban housing has become an important factor of growing intergenerational divisions as many post-baby boomers who have diminished buying strength to purchase homes and limited capacity for retirement savings are facing material decline when compared with older generations. Tilak et al (2016) further highlights two fundamental forces that may result when housing prices increase above the sustainable level and these are limited supply and market induced housing price inflation.

Thirdly, Wetzstein (2017) cites the combined effects of both private and public sectors in terms of market and governance failure relating to housing provision and affordability leading to segregation, dysfunctional or even dystopian cities featuring decaying neighbourhoods, increasing economic inefficiencies and irreversible environmental externalities.

2.2. DENSIFICATION AND THE CONCEPT OF DENSITY

Churchman (1999) highlights that the concept of density has remained complex and ambiguous but has solicited substantial attention and interest from planners. The vagueness around this concept is partly associated with the different interpretations in how density is defined and applied across different disciplines and locations. Density relates to the relationship between a specific physical area and the number of people who inhabit or use that space and can be expressed as a ratio of population size or number of dwelling units to area units (Churchman, 1999). Density is commonly measured in terms of population density, that is, the number of people per given area, however, in some areas it is often defined according to the density of the built environment, in essence, the number of dwelling units per given area (Churchman, 1999; Burton, 2002; Guerois, 2008). The change in population density specifically in urban areas results in substantial change in the housing market. In cities, the density of occupation of space is normally measured by the amount of used up space, the spatial distribution of population, the mean travel distances of residents to CBD, or the intensity of daily commuting activities (Guerois, 2008).

Du Plessis & Boonzaaier (2015) note that in urban form analysis, density measures may refer to the extent of activity intensity within a demarcated space including several indicators such as built-up areas, residential land use, urban land conversion, population density, and urban density. In relation to housing and human settlements, density measures may be inclusive of indicators such as the population, dwellings per surface area, building coverage and floor area ratio (Cheng 2010; Turok 2011). In recent times, cities have seen the importance of densification in addressing issues of limited housing supply and sustainable land use because increased densities result in more residential units in a same amount of land. Turok (2011) highlights that there are three approaches to densification: (i) through the intervention of the state by releasing land available for development, or through the direct provision of affordable housing to low income households, (ii) through state incentives or regulations to inspire developers to construct higher density developments, and (iii) through economic measures to improve household preferences and location choices.

2.2.1. Residential density

Cheng (2010) defines residential density as the ratio of a population to residential land area. This measure can be further categorized in terms of net and gross residential densities based on the definition of the reference area. Net residential density is cross-cutting on numerous issues such as concepts relating to urban form, city size, preferred building or settlement type, site design, economic issues and policy, zoning and other land use issues. Aspects such as social issues and values, women's issues, children's development, cognitive and perceptual processes, stress, sustainable development, compact cities, street and transportation systems, conflicts between public transportation and the private car, urban sprawl, environmental quality policies, and the role of professional planning and government in setting density standards can also play a role (Churchman, 1999). Gross residential density on the other hand reflects the residential area in its entirety considering the non-residential spaces such as roads, parks, schools and community facilities.

2.2.2. Building Density

Building density refers to the number of building units per unit area, for example buildings per hectare (Musakwa & Van Nierkerk, 2015). Building density is a significant measure of urban sustainability as medium-to-high building densities minimize the negative environmental, social and economic externalities of the urbanization process. The intensity of development within a plot and is usually represented as the ratio of the floor area developed relative to the overall site area (FAR) as discussed in section 2.3.1. Building density has a sophisticated relationship with urban morphology as it plays a significant part in the determining urban form (Cheng 2010). For instance, different combinations of plot ratio and building coverage will manifest into a variety of different built forms. In the face of rapid urbanization, the relationship between building density and urban form has attracted significant interest from planning professionals due to the inadequate land supply resulting from increased urban population which has necessitated widespread investigation on the spatial advantages of multi-storey buildings.

In economic terms, high density housing is viewed differently by developers who maximize profits in exchange for increased amenities for potential inhabitants of houses. The balance is that there is a benefit to increasing density such as profits maximization, however at the cost of residents' preferences for low density and maximized environmental amenities and facilities. Consequently, the marginal advantages of increased density will diminish, and the marginal cost of consumers' preferences increases, and this balance motivates the developers to improve the value of housing developments (Musakwa & Van Nierkerk, 2015). On the other hand, high density developments are associated with the absence of privacy which leads to noise, nuisance and recurrent clashes among inhabitants. Furthermore, (Musakwa & Van Nierkerk, 2015) highlight that high-density developments may reduce sunlight in high rise buildings which is seen as a negative effect and will affect housing prices negatively.

Built-up area characteristics that have been analyzed and showed to explicitly affect sustainable urban development are building height, building density, plot ratio, site coverage, proportion of impermeable surfaces, and restricted sunlight access (Cheng, 2010; Musakwa & Van Nierkerk, 2015). Because land is a limited resource in urban areas, optimum land utilization can be appreciated by increasing building density and increasing building coverage on individual sites (Cheng, 2010). Increasing building density, therefore, helps to reduce the challenge of permanent conversion of open spaces and yields additional land for communal facilities and services to improve the quality of life in urban areas. Therefore, the understanding of the course and the scale of the effect of building density on the housing market remains a fundamental question.

2.3. MEASURES OF BUILDING DENSITY

2.3.1. Floor Area Ratio

Plot ratio is the ratio of total gross floor area of a development to its site area (Cheng, 2010). The gross floor area usually considers the entire area within the perimeter of the exterior walls of the building, which includes the thickness of internal and external walls, stairs, service ducts, lift shafts, all circulation spaces, and so on. Site area refers to the total lot area of the development, which, in most cases, is accurately defined in planning documents (Cheng, 2010). The integrated zoning scheme of the Stellenbosch Municipality (2012b) describes floor area as the area of a floor which is covered by a roof, slab or projection and shall be measured from the outer face of the exterior walls or similar supports of such building, and where the building consists of more than one level. Consequently, the total floor area is defined as the sum of the floor area of all the levels, inclusive of basements and exclusive of covered paved areas outside, any covered balconies, veranda or terrace and any stairs, stairwells and atriums. Since the definitions of both floor area ratio (FAR) and floor coverage ratio are relatively distinctive in the measurement, plot ratio is regarded as one of the most explicit measures of density.

The FAR is expressed as the value (expressed as a ratio or a number) that when multiplied by the lot area, expresses the maximum area that can be utilized in a lot for a building, and this value includes all floors areas, measured from the exterior face of exterior walls, or from the center line of walls separating two buildings. Practically, the FAR articulates the building density of a lot. Cheng (2010) highlights the importance of FAR in building design because it is extensively applied in project design briefing and budgeting. It indicates the amount of floor area to be built which makes it easy to estimate the amount of resources needed during construction; and can also be adopted during forecasting of the financial balance of investment and returns.

Different floor area ratios for different types of land uses in urban settings are usually prescribed in urban management tools. A FAR value of 1.0 means that the floor area may be equal to the plot area whereas a FAR of 3.0 suggests that the floor area may be up to three times as large as the plot size. In planning practice, FAR is an effective technique to estimate the volume of building structures on the plot and is usually combined with other development restriction variables such as building heights, lot coverage and lot area usable open space, spacing between buildings on a single lot, and zoning to encourage a desired urban development form (Cheng, 2010). Fu & Somerville (2001) emphasize that when density restrictions vary with location, then the FAR combined with the specific location characteristics will explain the disparity in real estate prices across the urban landscape.

Maximum floor area ratio is repeatedly used in the zoning schemes and land use management tools at municipality level to manage the extent of build-up area and to minimizes excessive development and crowding (Cheng, 2010). For land development purposes, the floor area ratio is extensively used in design concept and development planning to depict the extent of floor area, associated resources and the financial balance of investment and returns of the development.

2.3.2. Building Coverage

Building coverage refers to the ratio of the footprint area of a building to the lot size where the building is located (Cheng, 2010). Stellenbosch Municipality (2012b) defines building coverage as the total area of land unit that is covered by erected structures under a roof and is expressed as an area unit (square metres) or percentage of the lot size. It is measured from the outer surface outside walls and exclusive of: eaves projection, stoeps, basement areas, and other unclosed features that comprise a building. Consequently, building coverage is a measure of the proportion of the lot area that is covered by building structures within a specific plot. Similarly, as plot ratio, the building coverage of discrete developments is regularly controlled through urban management instruments such as zoning schemes and developments codes so that excessive development can be controlled and to improve environmental features such as greenery and open spaces. Cheng (2010) further highlights the difference in building coverage and open space ratio, where the latter is defined as opposite measure of building coverage which suggests the availability of open space on a development site.

2.3.3. Building Level (Height)

Due to exacerbated levels of urbanization and land scarcity, the areal benefit of multi-storey structures has received extensive scrutiny in recent years (Cheng, 2010). Building height is usually expressed the in number of floors (storeys) of a building and largely influences social, economic and environmental costs of buildings and houses, and it is closely related to building density (Jones & MacDonald, 2004; Musakwa & Van Nierkerk, 2015). In the Integrated Zoning Scheme (IZS) for the Stellenbosch municipality, building height is defined as the vertical measurement, measured in metres, from one floor level to another level, excluding features such as chimneys, flues, masts and antennae Stellenbosch Municipality (2012b).

Turok (2011) states that densification measures are characterized by adverse responses because density is associated with overcrowded housing developments and loud neighbourhoods. There is persistent concerns among communities that the development of multi storey buildings and increase in residential populations might have undesirable effect on the neighbourhood character, and the additional burden on infrastructure services. Musakwa & Van Nierkerk (2015) notes that a building characterized by a single storey is regarded as less sustainable than a building consisting of several floors because of the inefficient use of space, lower returns on investment, escalated infrastructure costs and low social vibrancy. However, both Cheng (2010) and Lee

(2016) argue that the benefits of denser developments diminish when the number of floors exceeds 12 because of lack of privacy, noise, reduced exposure to sunlight and increased accessibility costs, which may lead to decreasing house prices, therefore it is imperative for planning policy, particularly zoning, to prescribe appropriate building height restrictions.

Musakwa & Van Niekerk (2015) note that medium-to-high densities promote efficiency in the usage of space and minimization of encroachment into natural ecosystems and agricultural landscapes. Turok (2011) resonates that high-density developments lean towards to the delivery of more living space; therefore, it is important to promote efficient land usage, incentivize developers to construct taller buildings and save on the limited floor space for residents and this results in a better neighbourhood and public open spaces. In the quest of achieving sustainable residential densities, large proportions of high-rise buildings are inevitable and can conversely result in negative densification externalities such as limited open spaces and crowding. To manage such interventions and curb the adverse impacts of high-density development there is a need for planning to play a crucial role and enforce the appropriate density control measures.

Fasselmeyer et al. (2017) note that while there has been extensive research in densification, there is limited work done to attempt to establish the effects of localized building density of housing on property prices. In the Stellenbosch area, several studies have investigated the extent of densification and people’s preferences and satisfaction in property price and selection (Benn, 2010; Kruger, 2017).These studies mainly attempted to understand the extent of densification and housing preferences but did not investigate the impact that building density might have on property prices and the housing supply side and the current study specifically attempts to investigate the relationship of building density and property prices.

2.4. LAND USE MANAGEMENT AND HOUSING SUPPLY

Land-use planning is considered as an instrument for the local governments to display development control on the urban development process and urban planning plays an important function in the provision of housing because it is seen to be contributing to increasing housing production costs by requiring development standards placed on specific zonings (Hui et al. 2003; Sharam et al. (2015). Hui et al. (2003) accentuates that land-use regulations (such as zoning and growth controls) tend to influence the property market by limiting housing supply and increasing demand on the other hand Jaeger et al. (2012) highlight two approaches in which land use regulations are likely to influence property values, namely restriction effects and amenity effects.

'Restriction effects' inhibit the highest and best use of land. According to Gerald (1992) in Hui et al (2003) land use planning confines the supply of land in the following ways: (1) limiting the amount land available for housing; (2) restricting where housing land is located; (3) development restrictions on housing land; and (4) influence when housing developments occur. Pacione (2009) argues that inconsistent planning policy objectives and incompetence of local planning practices could also contribute to limiting housing supply in terms of new housing developments. Planning systems can thus act as intervention instruments to increase the supply of affordable housing, but conversely also being responsible for the lack of control and slow reaction to private housing market forces.

Tse (2002) argues that residential property is a multidimensional commodity that is defined by spatial fixity, durability and structural inflexibility. Individual housing property has a unique set of characteristics such as its accessibility, proximity to transport and the amenities, and the structural characteristics, neighbourhood and environment. Traditional location theory observes the effect of accessibility to central locations on house prices, in that those houses that are located closer to opportunities fetch higher prices in the housing market. Increase in housing prices tend to influence households to locate in areas which have more limited accessibility to business and employment opportunities and where prices are low.

One of the planning tools employed by numerous cities to improve housing supply and affordability is densification. Densification can be realized in two basic approaches: firstly, through the intervention of the government by directly providing of new social and low-income housing through various public institutions, and secondly through market interventions by using incentives or regulations to influence developers to provide new housing at increasing densities. Based on the relationship of land value, property prices, and distance from the central business district (specifically in the case of cities with predominant monocentric urban structures), residents are faced with making trade-offs between travel costs and transportation costs and the fact that land developers prefer areas in locations and density where they can maximize profits. Building density thus does not fluctuate evenly over the entire urban area due to the imperfections and complexity of the residential property markets in terms of areal differences, accompanying zoning regulations, and social and equity elements.

Marthur (2014) argues that growth management strategies such as rigid urban growth boundaries (UGB) are very likely to influence the escalation of land prices, and its impact on housing prices is dependent on housing demand and supply elasticity because of land supply. OECD (2018) argue that urban containment policies such as urban growth boundaries and greenbelts are possibly the most direct policy intervention alternative to manage urban expansion. These interventions establish boundaries to urban development, inspired by desires to conserve surrounding green spaces, minimize the costs of providing basic infrastructure services and encourage development in infill development. However, such policies are prone to have externalities that result in fragmented development, increased travel times and escalation in housing prices, which can threaten their efficiency in urban sprawl management and addressing environmental challenges.

Traditionally, spatial planning and land-use policy has overwhelmingly relied on regulatory instruments to control urban sprawl and mitigate its consequences. These government policies frequently effect the forces of housing demand and supply, such as those regulatory instruments that influence urban development and facilitate increased housing supply, for example, zoning policies and building bylaws that promote compact development, and multi-dwelling housing, could offset land supply constraints (Marthur, 2014; OECD, 2018).

Conversely, there are however also policies that could be restrictive on housing supply, such as density requirements in zoning schemes and other land use planning instruments which exacerbate supply constraints. Urban planners can only indirectly induce urban form of cities through land use regulations, infrastructure investment and various taxes, on the other hand the impact of market forces manifest physically in the building of cities in the long term in response to these planning tools (Bertaud, 2004).However, OECD (2018) argue that although land-use policies influence market-based instruments, and exchange of development rights, they seem to fail in promoting socially acceptable density levels and curbing urban fragmentation.

According to Marthur (2014), government regulations and growth control measures such as zoning, housing permit caps, and rigid urban growth boundaries exert an increasing stress on land and housing prices by constraining the supply of developable land, conversely restricting the supply and affordability of housing stock further raising equity related challenges by sidelining low- and middle-income households from participating in the housing market. Furthermore, growth management regulations can control the growth of an area's population by regulating the number of building plans issued each year, and by establishing urban growth boundaries, or by enforcing restraining criteria for the conversion agricultural land to urban uses. Such instruments tend to restrain the supply of land for urbanization leading to restricted supply of new housing which then increases prices in the housing market.

Internationally, most cities apply a range of growth management strategies to address urban sprawl and guide urban growth into a denser and compact development form through use of regulatory tools such as densification, mixed use developments and rigid urban growth boundaries that discourage sprawl (Chobokoane & Horn, 2014). Todes (2008) suggests that spatial frameworks in South Africa have constantly ignored the socio-spatial dynamics of cities where spatial concepts such as nodal development and corridors formation as well as densification and infill development have relegated the importance to understand location and mobility of different groups of people within the city, the influences of choices and the implications of these socio urban patterns on their daily livelihoods. In the case of Stellenbosch, the Spatial Development Framework (SDF) aspires to integrate low-, middle- and high-income accommodation as opposed to isolated settlements or gated communities with emphasis on approximately 25 dwelling units per hectare in larger settlements whereas in comparison with the United Kingdom, a residential density of 30 building units per hectare is considered as the national indicative minimum for new housing development (Cheng 2010; Stellenbosch Municipality, 2012a). Musakwa & Van Nierkerk (2015) however argue that in the South African context, building density values of approximately 20 or less building units per hectare may be low density developments, the range of 20 - 50 building units per hectare as medium density and greater than 50 building per hectare as high-density developments.

The actual implementation of this principle within the jurisdiction of the municipality has been slow and there has been a continued establishment of isolated gated communities in most areas and the high prices in real estate market has limited the integration process specifically the provision of affordable housing for low income households. (Kruger, 2017; Stellenbosch Municipality 2012a). The typical South African city is characterized by horizontal sprawling, fragmentation and segregation that has resulted in inefficiency in most urban areas and the efforts to address the imbalances caused by apartheid have repeatedly intensified the conversion of natural resources into built environment and resulting in the location of new housing developments on the periphery of cities leading to urban sprawl (Boraine et al., 2006; Chobokoane & Horn, 2014).

Todes (2008) argues that post-apartheid South Africa spatial frameworks relied on an abstract design approach and intensified the development of nodes and corridors as a typical form of planning. Therefore, to curb the development of housing projects on the edges of cities and poor economic conditions in townships and subsidized housing areas, requires that both national and local governments consider the densification interventions of well-located areas within cities (Todes, 2008; SACN, 2016) whereas Turok (2011) suggests a different urban agenda that is based on efficiency that will be based on critical objectives that include urban integration, densification and urban compaction, locating new housing developments on well-located land and efficiency in public transport systems.

2.5 ADVANTAGES AND DISADVANTAGES OF HIGH RESIDENTIAL DENSITIES

High building density can largely be described based on the plot ratio, where the larger extent of the lot is comprised of built-up floor area (Cheng, 2010). Turok (2011) notes that there are various reasons for raising densification levels, however trade-off concessions must be made between them. Turok (2011) and SACN (2016) identify the six reasons for the justification for higher densities and these are minimum resource consumption, feasible public transport systems, accessibility to opportunities, improved economic efficiency, improved housing alternatives and creation of liveable and safer places. However, there are diverse schools of thought regarding high-density development with some recognizing the advantages of high density and support urban compaction, while others disapprove the negatives of densification. Advocates of compact cities argue that the benefits such as reduced car travel translate into socio-ecological sustainability, better access and efficient use of infrastructure services, and renewal of inner urban areas (Chobokoana & Horn, 2015). Conversely, Snyder & Bird (1998) argue that sprawl affords low-density residential lifestyles which are characterized by easy access to green open spaces, accessibility, reduce travel times for those who both live and work in the nearby suburbs and minimize social problems that associated with poverty and the inner city such as conflicts and overcrowding.

To achieve high building density means the construction of high-rise buildings is unavoidable, and these structures when placed in relatively small plots, can equally result in a congested urban form with restricted open spaces. Cheng (2010) argue that through planning, the negative externalities of high-density development can be curbed, and the optimal use of infrastructural services and systems efficiency can be enhanced and likewise when the population demands exceeds the utility capacity this may result to systems overload and eventual deterioration of services. Burgess (2000) highlight that urban centres in developing countries are expected to encounter challenges in their compaction endeavors as consequence of already high densities, escalated land values within city centres; limited infrastructure capacity, diverse informal sector activities, uncontrolled rural–urban migration and rapid urbanization pressures. Turok (2008) emphasizes that in the context of South Africa, higher densities and mixed-use developments, specifically on brownfield sites, are critical to address the sprawling character of most cities because increased densities result in more living space, so to maximize efficient land utilization by encouraging taller buildings and cut back on the floor space available per resident.

2.6. THE POLICY FRAMEWORK FOR RESIDENTIAL DENSIFICATION IN SOUTH AFRICA

2.6.1. National and provincial policy framework

The initial attempt for an increased densification course for most of South African cities were made in around 1995 when the government passed the Development Facilitation Act (DFA) (Act No. 67 of 1995), with the intention of discouraging urban sprawl among other things and to exacerbate an urban development process that will result in compact urban centres (Chobokoane & Horn 2014).

Thereafter there has been a series of interventions from the national government to improve densification measures in the cities of South Africa such as the Reconstruction and Development Programme (1994); Growth, Employment and Redistribution (1996); the Accelerated and Shared Growth Initiative for South Africa (2007); the New Growth Path (2010); the National Growth Strategy (2016); the National Spatial Development Perspective (2006); the Integrated Sustainable Rural Development Strategy (2000), the Spatial Guidelines for Infrastructure Investment and Development (2003) ; and more recently the Spatial Planning and Land-use Management Act (SPLUMA) (2013); the Integrated Urban Development Framework (2016) and the National Development Plan (2012) (Harrison et al 2008, SACN, 2016).

Chobokoane & Horn (2014) emphasize the significance of the White Paper on Local Government as policy framework that prepared for the declaration of the Municipal Systems Act which required all municipalities to prepare Integrated Development Plans (IDP) for their jurisdictions. The IDP is an important tool that guides and inform all municipal planning, budgeting, management and decision-making activities and this plan includes a Spatial Development Framework (SDF) that prescribes the general guidelines for land use management activities within municipalities (Chobokoane & Horn 2014). In terms of SPLUMA, local governments are required develop and implement a single land use management scheme within five years of the Act coming into operation where the land use scheme should prescribe provisions to influence the affordable housing provisions in the development of residential land and prescribe specific requirements relating to special zones identified to realize the priorities of the municipalities such as affordable housing (SACN, 2017).

The publication of the National Development Plan provided strategic guidance to the reversal of spatial disparities produced by apartheid. The strategies include increasing of urban density (National Planning Commission, 2011). In 2013 the government promulgated the Spatial Planning and Land Use Management Act, which attempts to provide a framework to govern spatial planning and land use management; to regulate the relationships of planning laws and other laws and policies to forge an inclusive developmental equitable and efficient spatial planning at different spheres of government (Chobokoane & Horn, 2014). SPLUMA provides clarity and legality of effective planning processes such as town planning schemes and Spatial Development Frameworks (SDF) where clear intentions are set out and areas of priority for housing developments are identified and prescriptions of land use and appropriate residential densities are spelled out for investors and developers (SACN, 2016).

Chobokoane & Horn (2014) argue that densification is not adequate to achieve sustainable urban form, but it is imperative for planners to embrace the diversity of the South African urban landscape when adopting compaction strategies that would cater for the diverse urban dynamics typical of South African cities. Du Plessis & Landman (2002) on the other hand advise that densification principles can be adopted only where appropriate and that sprawl should not always be frowned upon because there are other advantages that are associated with it such urban agriculture.

2.6.2 Stellenbosch municipal policy framework

2.6.2.1 The Integrated Development Plan (IDP)

The integrate development plan (IDP) is the principal urban management tool for local governments that attempts to direct the present and future actions and the allocation of resources within municipalities (Kruger, 2017). According to the Stellenbosch Municipality (2017) and

(Stellenbosch Municipality 2012a) combined with the local version of the Spatial Development Framework (SDF), the IDP aims to address the accommodation demands and social integration aspirations through the provision social housing packages including GAP housing, improving the feasibility public transport systems in such areas, brownfield and greenfield developments, improve densities along key transit links and in proximity public open spaces, and encouraging densification measures such as the construction of additional dwellings and the subdivision of plots to lowest permitted sizes.

2.6.1.2 Stellenbosch Municipality Spatial Development Framework (SDF)

As highlighted in the above section, the purpose of spatial development frameworks (SDFs) is to guide and inform spatial development realize an urban form by prescribing policy and strategy to achieve this. Coupled with the land use management systems (LUMS), the SDF necessitates the preparation of zoning schemes and regulations to influence developmental rights within an urban area. Based on the principles prescribed in the municipality's SDF, there is pronounced high density developments experienced within town, and there is a dire need for strict adherence to the development restrictions prescribed in the municipality's integrated zoning scheme (Stellenbosch Municipality 2012a; Stellenbosch Municipality 2012b). The current SDF encourages the principles of reduced commuting times, purposeful social integration, strategic densification and settlement design that is influenced by the urban edge (Stellenbosch Municipality 2012a). Through the SDF aspirations, the densification of older suburbs is seen as a solution to the high demand for housing in the area, therefore, the encouragement of additional residential dwellings, subdivisions, sectional titles developments, intensifying land use in low-density areas, brownfield development and infill development (Stellenbosch Municipality 2012a).

However, the spatial development framework recognizes the challenges associated with uncontrolled growth on the exclusive urban character of Stellenbosch area and prescribes planning restrictions to manipulate building character and height, acceptable zoning scheme regulations and management of sensitive biodiversity areas (Stellenbosch Municipality 2012a)

Furthermore, the current densification trend in some areas in proximity of the University of Stellenbosch precinct appear to be eroding the historical urban character of the area due to the ever-increasing need for housing for students. The SDF recognizes the unique nature of the different neighbourhood and requires the application of appropriate local combinations of densification (Stellenbosch Municipality 2012a).

2.6.1.3 Stellenbosch Integrated Zoning Scheme (IZS)

Zoning schemes as land use planning instruments are governed by the Spatial Planning and Land Use Management Act (SPLUMA) (Act 16 of 2013) and all municipalities in South Africa are responsible for land use planning within their jurisdiction and have the autonomy to develop and apply administrative and integrated zone by-laws over that jurisdiction (Stellenbosch Municipality 2017).

The Stellenbosch Municipality (2012b) defines a zoning scheme as a legal tool that helps to shape the dynamics of urban and natural environments and should be adaptive to reflect the normative aspects of a specific society, and the unique aspects relating to the physical environment to which it is applied. The principal objective of the zoning schemes is to uphold, safeguard and advance the general welfare, public health and safety of all the residents of a municipality. Zoning schemes are regulatory frameworks that ultimately influence the urban form and the surrounding natural environment. Through zoning schemes, Council control the size of buildings, the location of buildings, the density of development, and the way land is used. A zoning scheme thus provide a key management tool for implementing planning policy relating to land use and the regulation thereof.

Zoning is globally recognized land management instrument that legitimately offers the balance between the property, property use and the quantity of the usage, hence prescribing different land uses at different locations such as commercial, residential, business, industrial, recreation, mixed-use and open space (Stellenbosch Municipality 2017; 2012b) and it is important that development applications observe to the provisions and aspirations of zoning scheme specific to a land parcel within an urban area. However, Hui et al. (2003) considers zoning to be the lease effective planning control because the current use of building or land can remain without any planning consent until a change of land use occur despite change of the zoning.

According the IZS of Stellenbosch municipality, land usage is characterized into three uses, these are: primary use, additional use and consent uses (Stellenbosch Municipality 2012b). The development proposals within the municipality's jurisdiction should conform to these land use categories. Primary uses refer to uses that are prescribed by the IZS on the specific property usually broad based such as commercial, residential and industrial rights and require no further authorization from Council (Stellenbosch Municipality, 2012b). Additional uses take place in addition to the primary use and are limited by several site-specific restrictions to minimize undesirable neighbourhood externalities (Stellenbosch Municipality, 2012b). Uses by consent generally requires the participation of the public and consideration and consent of the municipality based on criteria prescribed in the planning law (Stellenbosch Municipality, 2012b).

3. CHAPTER THREE - METHODOLOGY

3.1 INTRODUCTION

Traditional location theory observes the influence of accessibility to central locations on house prices and postulate that housing and accessibility to job opportunities are mutually related because escalated prices are compensated by the reduced costs of commuting to the central business district (CBD). Consequently, households constrained by affordability tend to repel locations with higher prices to inferior locations in terms of accessibility and lower prices (Tse, 2002). The neoclassical approach emphasizes that the location of the housing unit, accessibility to central business districts and areas where there are job and business opportunities and travel time are the important factors that determine house prices or rental values (Keskin, 2008). However, explaining the factors of the housing prices with only these determinants is not adequate to explain the local housing market. Hence the neoclassical economic approach foundations need to be supported by hedonic price models to analyze the housing preferences of the consumers (Keskin, 2008).

Keskin (2008) identifies several factors that influence housing prices such as the interior structure of the house and building, the structure of the neighbourhood that the house is located, market conditions and housing policies. The exterior factors of housing prices are largely associated with the physical, economic, social, cultural elements and accessibility to CBD, job locations and urban facilities. Due to the large and heterogeneous nature of influences on house prices, the determinants of house prices cannot be limited to the individual characteristics and structural features of the housing units themselves, but should be extended to the socio-economic, behavioural environment, neighbourhood quality, and locational factors like amenities and disamenities (Tse, 2002; Keskin, 2008).

The analysis of the effect of housing attributes on house prices must be informed by careful examination of the separate influences of various characteristics and the possibility of interpreting the implicit effect of each attribute from the coefficients that can be predicted from the hedonic function (Tse, 2002; Keskin, 2008). Accordingly, hedonic models have often been taken into consideration, along with the physical structure of the housing unit, and spatial, demographical, and economic structure of neighbourhoods to explain the relationship of various factors and housing prices. However, the disparities in the quantity and quality of these characteristics tend to influence the housing market value differences, where the assumption is that the market is in equilibrium. Because generally there is no market for the individual features that constitutes a house, the prices of the various features cannot be directly observed, hence the application of regression analysis is preferred to estimate values of these attributes.

The usefulness of hedonic models is not limited to only the investigation of housing price changes, but also to operationalize the urban housing market system but care must be taken in capturing institutional factors into the models (Keskin, 2008). As stipulated earlier, the determinants of house prices cannot be reduced to only the demand for the attributes of the dwelling units themselves, but also the region in which the units are located, and the impact of different characteristics vary with geographical locations. A good hedonic analysis should be inclusive of neighbourhood quality measures at an appropriately disaggregated level (Tse, 2002).

3.2 THE HEDONIC PRICING THEORY AND JUSTIFICATION OF THE HEDONIC MODEL

The hedonic pricing theory was first presented by Rosen (1974) where he argued that the value of an item is determined by its characteristics, therefore the total price of an item is a summation of individual homogenous attributes where individually an attribute has a unique implicit price in an equilibrium market. In essence, a regression can be performed to understand how each attribute uniquely influence on the overall composite item’s price (Xiao, 2017). The hedonic price model is a method that defines the price of the housing unit by structural, locational, and environmental characteristics (Keskin, 2008). This technique is premised on a statistical analysis that describes the housing price as a dependent variable, and the structural, locational, and environmental attributes are considered as independent variables that explain the housing prices as a dependent variable (Keskin, 2008).

In the hedonic pricing model, the assumption is that consumers purchase a package of characteristics of a house or apartment (Lee, 2013). These characteristics vary from geographical location, density, and market conditions and others. The characteristics include density, market conditions, and geographical location. The hedonic model distinguishes the differences in each characteristic and estimates the influence of these characteristics on the housing prices. Lee (2013) argues that each of these characteristics is not valued in the real market, so the hedonic model attempts to quantify the value and the presumption is that the model is complete when the equilibrium is reached.

The assumption of the hedonic price model is that the housing market comprises a heterogeneous housing stock and diverse consumers and this heterogeneity affects the disparity in the pricing of houses within an area providing consumers with a range of housing product options (Keskin, 2008). Furthermore, housing consumer's preferences vary according to socio-economic and behavioural characteristics. Keskin (2008) argues that the heterogeneity of the housing stock and housing buyers means that the urban housing system comprises of submarkets, individually having distinct market prices for property features.

Although the general elements of hedonic pricing models for housing markets are widely recognized the estimation of housing prices is a complex procedure (Tse, 2002). Lee (2013) highlights generally two different types of hedonic pricing models that are commonly used: 1) the Standard Ordinary Least Squares (OLS), and 2) the OLS with transformation of variables. Tse (2002) however argues that the fundamentally vibrant and stochastic nature of the housing market, in terms quality and infrequent trade, rendering OLS approaches inadequate. Lee (2013) notes that these methods are not beneficial in terms of validating non-linear relationships but can be useful in the transformation of variables. For scrutiny of the non-linear relationships, square of the variable in OLS and quantile regression models are applicable for testing and identifying the existence of non-linear relationships (Lee, 2013).

The hedonic pricing model has mainly two significant advantages when compared with alternative methods of measuring quality and defining commodities in housing markets (Xiao, 2017). First, reducing the various housing attributes into one dimension allows the use of a homogenous commodity assumption, and consequently, the hedonic approach avoids the complications and intractability of multi-commodity models. Additionally, the hedonic approach considers the marginal trade-offs made by both the suppliers and the consumers among characteristics in the markets, so that modifications in amounts of attributes will be assigned the weights implicitly prevailing in the marketplace.

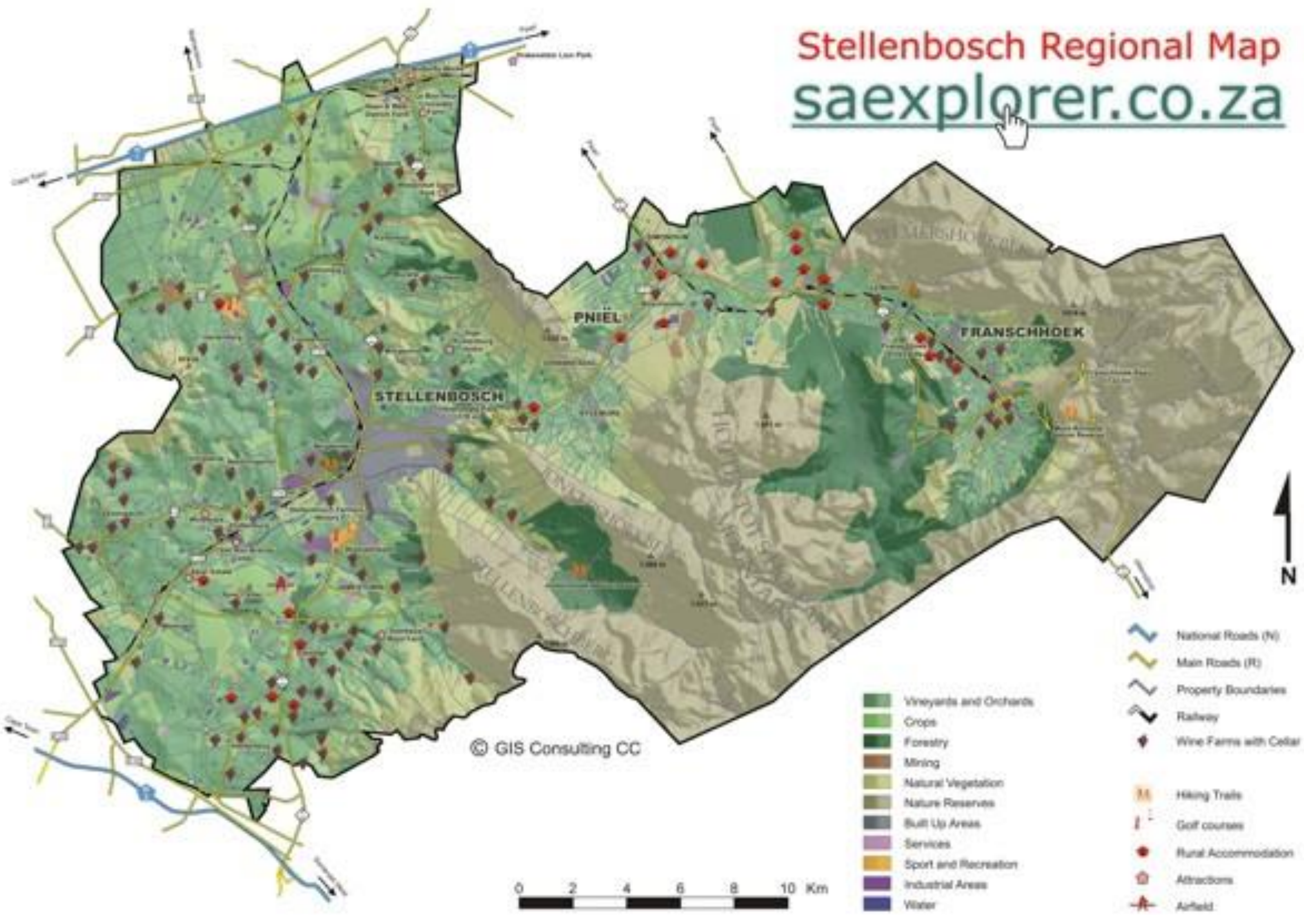
Xiao (2017) notes the importance of spatial dependency (also known as spatial autocorrelation) in the application of hedonic price modelling. Spatial autocorrelation is the degree of similarity between objects or activities at a specific location on the earth's surface to other objects or activities located nearby. Houses that are closely located are thus likely to have similar characteristics (Xiao, 2017). In a hedonic pricing model, there is an increased likelihood of spatial autocorrelation due to the close proximity of house locations to one another hence having similar unobservable attributes, which may not be included in the model.

While basic regression models assume that observations should be independent of each other, with hedonic price modelling the emphasis on spatial data renders the independence of observations a fallacy. Commonly, if the spatial element is ignored, there is a likelihood that the real variance of the data will be underestimated, resulting in bias of the results (Xiao, 2017). Spatial autocorrelation can be attributed to at least two potential sources; structural spatial dependencies across observations on the dependent variable and spatial dependence across error terms (Tse, 2002). Structural dependence is likely to manifest when the house price responds not only to surrounding houses determinants but directly to the sale price of neighbouring house. On the other hand, spatial dependence among the errors generally results from omitted variables that are spatially correlated, or as consequence of measurement errors that are associated with the variable's location (Tse, 2002).

3.3 THE STUDY AREA

Stellenbosch is the second oldest town in South Africa and located in the Western Cape province of South Africa and was founded in 1679, located approximately 55 kilometres east of the metropolitan city of Cape Town (Figure 3.1). The town is largely characterized by wine producing farms, street cafés, historical buildings and educational institutions such as the University of Stellenbosch. The town of Stellenbosch has developed rapidly during last two decades with its population increasing from 60,000 inhabitants in 2001 to 90,000 inhabitants in 2010 at a mean annual growth rate of 8.5 % and the population of the Stellenbosch municipality has been estimated to have increased to 170 587 inhabitants in 2017 (Western Cape Government, 2014; Musakwa & Van Nierkerk, 2015). The economy of Stellenbosch is mainly based on tourism and the service sector with the tertiary sector accounting for approximately 70% of the GDP (WCGPT, 2017). Consequently, Stellenbosch faces the challenges of harmonizing urban and economic growth expansion, the permanent conversion of scarce and valuable agricultural land and the conservation of natural and cultural heritage. Owing to the strong institutional culture in Stellenbosch, the normal population growth is exacerbated by increase of immigration of students leading to high demand for housing and the area remains attractive to property developers and investors (Stellenbosch Municipality 2012b)**.**

The town of Stellenbosch is purportedly one of the most active and expensive housing markets in South Africa due to the high demand of student housing coupled with several historic and aesthetical features of the town which attract investors, and this has consequently affected the affordability levels of housing for low- and medium-income households (Shi, 2005). Policy interventions by the municipality has emphasized the importance of increasing the supply of affordable housing for these groups in strategic locations within the town (Stellenbosch Municipality, 2012) and several densification instruments such as the Spatial Development Framework and integrated zoning schemes have been put in place to improve housing density and housing supply in the land use management approach of the municipality.



Source: www.saexplorer.co.za

Figure 3.1: Jurisdiction of Stellenbosch municipality.

3.3.1 The selection of sub markets (Unit of Analysis)

Because housing property cannot be considered as a homogeneous commodity, the current study will employ a hedonic model that incorporates housing price determinants based on neighbourhood administrative boundaries as defined in the integrated zoning scheme which will reflect the heterogeneous physical and socio-economical configuration of Stellenbosch. According to Goodman & Thibodeau (2007) submarkets may either be demarcated by structure type (such as a single-family detached, sectional title development or a condominium), by structural characteristics (such as age of buildings), or by the attributes of a neighbourhood. Keskin (2008) states that many studies that investigated urban housing markets usually considers submarkets. The urban housing market is unlikely to be naturally uniform but is likely to be composed of collection of diverse and connected submarkets (Xiao, 2017).

Goodman & Thibodeau (2007) emphasized the importance of housing submarkets in house price modeling for the following reasons. Firstly, the demarcation of housing submarkets improves the prediction accuracy of the statistical models in the approximation of house prices. Secondly, boundaries of housing submarkets within urban settings enhance the probability of researchers formulating improved spatial and temporal variations in the prices model. Thirdly, the accurate assigning of properties to submarkets tend to improve the abilities of financiers to measure the risks related with housing finance.

Xiao (2017) however cautions that researchers agree on the need for a submarket definition based on structural and locational features but there are contradictory views as to how the identification of a submarket should be conducted in practice. Housing prices are diversified by locations and therefore, can be classified into different spatial submarkets. The common way to define housing price submarkets is to use predefined geographical and political boundaries. However, the use of these types of submarkets would not adequately represent location attributes of housing prices, especially in metropolitan areas.

3.4 THE SOURCES AND NATURE OF DATA

The data for the study was obtained from the municipality of Stellenbosch and in the form of secondary data that include property values from the municipality valuation roll. Housing density was investigated by using different density parameters such as floor area ratios, floor coverage ratios and building height restrictions. The different valuation zones and residential zoning districts was used to demarcate submarkets and in the analysis of density parameters on each district and the impact of these variables on the property values in each district.

The data comprised of 804 properties from five residential neighbourhoods (based on valuation zones) that was obtained the valuation records sourced from the Stellenbosch municipality from both the valuation and planning departments. The purpose of this research is to understand the effects of building density among other factors that affect property prices and the supply of housing. Information that would affect the property values such as floor coverage, floor area ratio, location, and neighbourhood characteristics were used in the analyses. The valuation data was gathered for a period of 5 years between 2013 and 2018 and the valuation roll was issued in 2018 by the municipality.

The study area was restricted to neighbourhoods in Stellenbosch town (as shown in Figure 3.2), based on the availability of records from the municipality. Six neighbourhoods were thus selected for the study due to appropriateness of the available information, namely; Die Weides, Simonswyk, La Colline, Krommerivier, Mostertsdrift and Uniepark. Due to their small size and similar neighbourhood characteristics, La Colline and Krommerivier were consolidated into one submarket for the submarket analyses. The analysis thus considered five individual submarkets. The type of properties considered for the analyses included both stand-alone properties and multi residential developments.

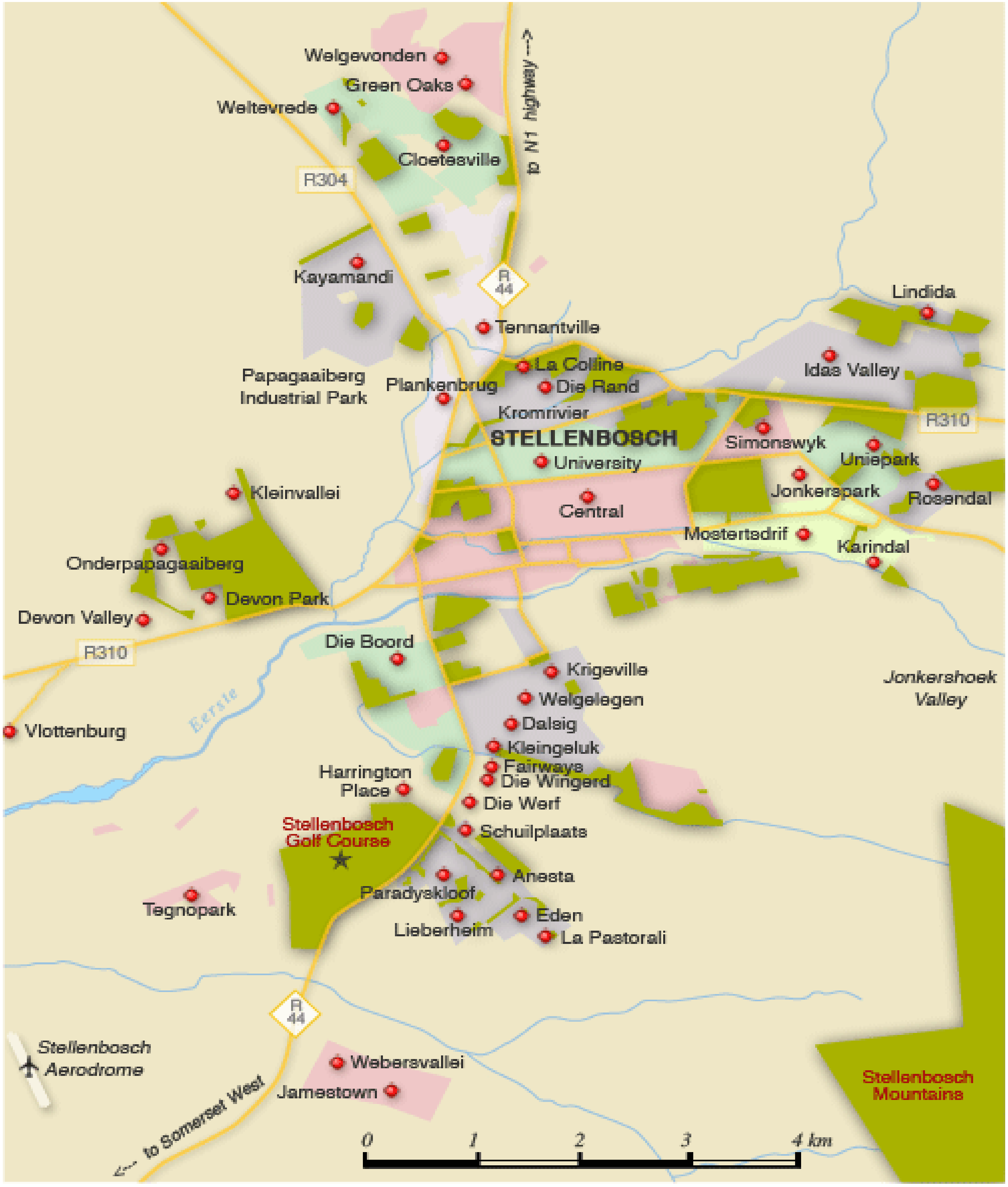


Figure 3.2 Location of the different neighbourhoods of Stellenbosch

The data received from the municipality were captured, verified, and coded in Microsoft Excel. Data processing and analyses were conducted using SPSS software; hence all the data was transferred from the Microsoft Excel format into the database of SPSS. The data was then used in the estimation of a hedonic regression formula by which the housing price (the valuation price) can be predicted and an estimation of a hedonic price regression model for the Stellenbosch housing market was established.

3.5 METHODOLOGY

The study explores the relationship between building density and residential property prices in Stellenbosch through two specific research objectives:

1. To determine the effect of density (floor area ratio, floor coverage and building height) on housing prices.
2. To identify the relationship of housing density variables with other independent variables in the determination of house prices for the submarkets (neighbourhoods).

To address these objectives, the study analyzed housing markets in the Stellenbosch area over a period of 5 years, between the year 2013 and 2018 based on the valuation roll interval adopted by the municipality of Stellenbosch. As indicated in Table 3.1 previous research studies on the application of the hedonic pricing model identified a variety of determinants that have been considered in the analysis of house prices based on the aims of each specific study. Generally, the variables included in the hedonic modeling can be grouped in four categories: property characteristics, socio-economic characteristics, neighbourhood quality characteristics, and locational factors.

For the current study, the assumption is that households reach the decision of house purchase based on multiple factors including; density of neighbourhood, age of building, size of apartment of house, accessibility to the CBD and accessibility to recreational facilities. A linear regression model was estimated and a goodness of fit of the model was established. The hedonic formula that was adopted for the study, which measures housing price of properties as a function of the building density of properties and other variables, is indicated below;

Price = $a_0 + a_1\,Variable_1 + a_2\,Variable_2 + \ldots + a_n\,Variable_n + \varepsilon$

Where the price is the dependent variable and is the valuation price in Rands (R) per square metre, Variable_1 is the first variable that has a significant influence on the property price, and so on until the last variable is factored in and analyzed.

The purpose of hedonic price models is to estimate the implied price for each attribute of a residential property which are mainly separated into structural, neighborhood, and accessibility characteristics (Xiao, 2017). Therefore, the selection of the variables was based on these conventional hedonic pricing model categories of housing attributes that affect housing prices i.e. a) locational factors, such as accessibility to the CBD and accessibility of transport facilities (public transport), b) property features, such as floor level, building age and c) neighbourhood characteristics, such as the quality of the housing environment.

Therefore, the current study suggests that the appropriate hedonic equation should relate house prices to the floor area ratio and other building density attributes as well as location and neighbourhood characteristics. Accordingly, the current hedonic pricing model will specifically consider the following variables: housing price per square meter (dependent variable), floor area ratio (FAR), floor coverage, distance to the central business district (CBD), distance to the nearest primary educational institutions, and the neighbourhood characteristics depicted by the dummy variables of the different submarkets. In a hedonic model based in Hong Kong, Tse (2002) observed that the estimation of house prices was inclined to be more sensitive to net floor area than gross floor area hence the emphasis of the floor area ratio and plot coverage in this model.

Tse (2002) notes that the relationship between house prices and locational factors is a consequence of unverified variation in the location across properties combined with the heterogeneity of the real estate market where high-quality properties could reflect the quality of the location and attracting more high property development activity of high-quality properties in that area.

Table 3.1: A summary of the variables used in hedonic pricing models

RESEARCH WORK	PROPERTY ATTRIBUTES	SOCIO-ECONOMIC (MARKET) ATTRIBUTES	NEIGHBOURHOOD QUALITY ATTRIBUTES	LOCATIONAL ATTRIBUTES	DEPENDENT VARIABLE
Hedonic analysis of price in the Istanbul housing market (Keskin, 2008)	• Age of the building • The floor area of the housing unit • Number of rooms in the housing unit • Total storey of the building • If the storey on which housing unit is situated is lower than 5	• Average income • Household size • Living period in Istanbul • Living period in the neighbourhood	• Flat • Detached • Elevator • Balcony • Garden • Site • School satisfaction • Health service satisfaction • Cultural facilities satisfaction • Playground facilities satisfaction • Neighbour satisfaction • Neighbourhood quality satisfaction	• Travel time to jobs and schools • Travel time for shopping • Earthquake risk • Continent	• Price
Space and scale: A study of development intensity and housing price in Hong Kong (Tang & Yiu, 2010)	• Age of Building • Gross Floor Area • Floor Level		• Clubhouse/swimming pool provided within housing estate • Popularity of housing estate • "Spaciousness" of housing estate • "Scale" of housing	• Distance from CBD • Accessibility to MTR station	• Price • Log (Sales Price)

			estate		
The value of a floor: valuing floor level in high-rise condominiums in San Diego. (Conray et. al., 2013)	• Age • Square footage • Floor • Floor squared • Relative floor • Total no. floors		• Penthouse • Baths • Bedrooms • Penthouse		• Price
Estimating Neighbourhood Effects in house prices: Towards a new hedonic model approach. (Tse, 2002)	• Net floor area ratio (NFAR) • Age of building • Floor level • Square of (Log) Age of building		• Sea view • Availability of a clubhouse • Having more than one bathroom	• Accessibility to MTR	• Price per square foot
Spatial Autocorrelations and Market Segmentation (Tu *et. al.*, 2007)	• Floor area • The age of the condominium project • The floor level where the flat is • Freehold • Total number of dwelling units in the condominium project		• 15 Dummy variables, each with ONE indicating having the respective facility, otherwise ZERO. The facilities are: swimming pool, squash court, tennis court, sauna, playground, multi-purpose hall, gym, covered car park, and barbeque area, jacuzzi, wadding pool, 24 h security and other	• Distance to the first nearest top 10 secondary schools • Distance to the first nearest top 10 junior college • Distance to the nearest MRT station • Distance to the central of CBD	• Dwelling transaction price

Housing market segmentation. (Goodman, & Thibodeau,1998)	• The square feet of living area; • The per square foot price; • The dwelling age in years;		• the number of bathrooms • central heating system, • 13 dummy variables each one indicating availability of respective facility, otherwise zero. The facilities are: air conditioning system, a wetbar, fireplace, swimming pool, an attached garage, a detached garage, carport, uncovered covered parking facility • mean pass rate for standardized elementary school test • property tax rate		• The nominal transaction prices

Consequently, the relationship of the housing density variables and their connections to the other variables identified for this hedonic model will be analyzed using spatial autocorrelation analysis. Xiao (2017) postulates that the function of a spatial autocorrelation index is to measure the degree of interdependence among variables, the strength, and nature of that interdependence. Spatial autocorrelation analysis is hence applied for investigating whether the variable's observation is autonomous of the values of the variable with neighbours. Xiao (2017) postulates that positive autocorrelation occurs when there is a clustering of high or low values of the random variable in space, whereas negative autocorrelation occurs when locations are surrounded by neighbours with divergent characteristics.

Descriptive statistics will be performed for the different variables in the data set within the selected neighbourhoods (based on valuation zones). Descriptive statistics will help to determine the statistical significance of the data set and to demonstrate the mean, minimum, maximum and standard deviation of the values of selected variables for the hedonic model. To determine the relationships between the density variables and property prices, a multiple regression analysis will be performed to statistically determine the combined effect of the density variables on the property values. The study will employ a hedonic pricing model for the overall Stellenbosch sample and submarkets with consideration of the following variables: housing price per square meter (dependent variable), floor area ratio (FAR), floor coverage, distance to the central business district (CBD), distance to the nearest primary educational institutions, and the neighbourhood characteristics depicted by the dummy variables of the different submarkets. Different regression models will be performed for each of the density variables on the property values in the different zoning districts that would be selected for the study.

4. CHAPTER FOUR - RESULTS AND DISCUSSION

4.1 INTRODUCTION

By performing an empirical study of primary and secondary data, the magnitude of the impact of various housing characteristics (independent variables) on the final property value (dependent variable) in Stellenbosch using multiple linear regression analyses was quantified. This study employed hedonic regression analysis to examine the impact of structural, neighbourhood and locational characteristics on housing prices in five neighbourhoods (Simonswyk, Mostertsdrift, Uniepark, La Colline and Die Weides) of Stellenbosch. The overall model originally consisted of 13 independent variables including the dummy variables of the submarkets.

Property valuation data and dwelling characteristics were drawn from the Stellenbosch municipality which record valuation of properties every 4 years and the current research employs the recent valuation data for the year 2018. To minimize temporal variations in housing prices, this study covers housing valuation data completed in the recent 2018 valuation only. The valuation data (from the municipality's property valuation department) that was used for the analyses included information such as plot sizes, total gross floor area, housing site area, swimming pool, neighbourhood name, and existence of garages or carports. To control the influence of neighbourhood factors and accessibility on housing prices, this study only assembles housing data from the residential neighbourhoods located within the Stelleneboscn town and within proximity of the central business district of Stellenbosch.

4.1 REGRESSION RESULTS FOR THE OVERALL SAMPLE

A total of 804 residential properties based on the availability of data in the Stellenbosch municipality were considered for the study and analyzed with the assistance of Statistical Package for Social Sciences (SPSS), the data set covered five neighbourhoods of Simonswyk (13.3% of observations), Uniepark (33.2% of observations), Mostertsdrift (15.9 % of observations), Die Weides (10.4% of observations), La Colline and Krommerivier (27.1 % of observations) located in the town of Stellenbosch. Hedonic specifications were run to obtain estimates for the overall sample and the various submarkets demarcated by the five different valuation zones (neighbourhoods). The neighbourhoods of La Colline and Krommerivier were combined into one submarket because of their small sizes and the similarities of the neighbourhood characteristics. This was also confirmed by the valuation department within the Stellenbosch municipality.

A stepwise option was applied to develop the hedonic equation from all variables based on their statistical significance and to analyze the combined effect of the identified independent variables, and specifically to depict the influence of the floor area ratio on the housing prices. The initial variables (Table 4.1) that were entered include both the inclusive (enter method) and the stepwise regression procedure include PRICEPSQM which is the dependent variable and the independent variables (FAR, ERFSIZE, GARAGE, SWIMPOOL, BCA, DISTCBD, DISTSCHOOL, SIMONSWYK, DIE WEIDES, MOSTERTSDRIFT, LA COLLINE, UNIEPARK, KROMMERIVIER). These variables were selected based on the quality of the valuation data received from the municipal offices and influenced by the common variables that had been considered in previous hedonic studies as summarized in Table 3.1. The valuation data readily had information on plot sizes, total gross floor area, building area, location, and existence of swimming pool and garages or carports, which made it unsophisticated to calculate the building density variables such as floor area ratio and building coverage area.

The data were interpreted and the relative impact each housing characteristic coefficients, specifically the FAR variable, exerted on the property value was analyzed and ordered, allowing the development of a hedonic pricing model. The results of the regression analyses are described in the following sections.

Table 4.1: Variable characteristics

VARIABLE	UNIT OF MEASUREMENT
Price (PRICEPSQM) (Dependent Variable)	Rands per square metre
Plot size (ERFSIZE)	Square metres
Building Coverage Area (BCA)	Square metres
Floor Area Ratio (FAR)	Ratio
Distance to CBD (DISTCBD)	Kilometres
Distance to nearest school (DISTSCHOOL)	Kilometres
Availability of swimming pool (SWIMPOOL)	Dummy variable (1 – swimming pool, 0 – no swimming pool)
Availability of a garage (GARAGE)	Dummy variable (1 – garage, 0 – no garage)
Neighbourhood 1 (SIMONSWYK)	Dummy variable (1- Simonswyk, 0 – Otherwise)
Neighbourhood 2 (UNIEPARK)	Dummy variable (1- Uniepark, 0 – Otherwise)
Neighbourhood 3 (MOSTERTSDRIFT)	Dummy variable (1- Mostertsdrift, 0 – Otherwise)
Neighbourhood 4 (LA COLLINE)	Dummy variable (1- La Colline, 0 – Otherwise)
Neighbourhood 5 (KROMMERIVIER)	Dummy variable (1- Krommerivier, 0 – Otherwise)
Neighbourhood 6 (DIE WEIDES)	Dummy variable (1- Die Weides, 0 – Otherwise)

Table 4.2 presents the summary of descriptive statistics for each of the variables used in the analysis. Based on Table 2, the sampled properties were located between 1.4 and 3.8 km from the city centre of Stellenbosch. The mean plot area of the properties was about 1014.56 square metres. On average, the total gross floor area was about 34.8 % the size of plot size. The mean floor area ratio of the properties was about 0.3324. The expectation is that the impact of each of the explanatory variables on property price will be significant and the data used in the analysis should be normally distributed.

Table 4.2: Descriptive Statistics for Model 1

DESCRIPTIVE STATISTICS					
	N	Minimum	Maximum	Mean	Std. Deviation
ERFAREA	804	116	4114	1014.56	486.298
PRICEPSQM	804	71.43	16269.84	4202.82	2407.726
FAR	804	.027	2.668	.33240	.216296
BCA	804	16	3090	353.57	304.767
DISTCBD	804	1.4	3.8	2.537	.6160
DSTSCHOOL	804	.000	5.000	.90623	.403581
SWMPOOL	804	.00	1.00	-	-
GARAGE	804	.00	1.00	-	-
DIE WEIDES	804	.00	1.00	-	-
KROMMERIVIER	804	.00	1.00	-	-
LA COLINE	804	.00	1.00	-	-
MOSTERTSDRIFT	804	.00	1.00	-	-
SIMONSWYK	804	.00	1.00	-	-
UNIEPARK	804	.00	1.00	-	-
Valid N (listwise)	804				

Table 4.3 and Table 4.4 show the estimation results using the stepwise regression method. Table 3 shows the model summary and overall fit statistics and indicates that the regression models the housing price relatively good. The model summary of the stepwise method produced a R^2 value of 0.64 which means that the linear regression explains 64 % of the variance in the data set. Even though the significant ten variables explain 64 % of the housing price, the variable of specific interest, the FAR, predicts approximately 32.4 % of the variance in the model. This shows the importance of the variable that represents housing density in explaining the housing prices in the overall sample of the study area. However, the model summary indicates that there may be other potential variables that would have greatly assisted in the prediction house prices in Stellenbosch

and these may include the age of buildings, height of buildings and other socio-economic attributes of these neighbourhoods.

Table 4.3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.569[a]	.324	.323	1979.8
2	.679[b]	.461	.460	1768.8
3	.708[c]	.501	.499	1703.8
4	.742[d]	.550	.548	1618.1
5	.768[e]	.590	.588	1545.3
6	.789[f]	.622	.619	1484.7
7	.794[g]	.630	.627	1470
8	.796[h]	.633	.629	1465.2
9	.797[i]	.635	.631	1462.4
10	.800[j]	.640	.636	1452.4

Model 1. *Predictors: (Constant), FAR* ***Model 2***. *Predictors: (Constant), FAR, Mostertsdrift* ***Model 3***. *Predictors: (Constant), FAR, Mostertsdrift, BCA* ***Model 4***. *Predictors: (Constant), FAR, Mostertsdrift, BCA, DSTSCHOOL* ***Model 5***. *Predictors: (Constant), FAR, Mostertsdrift, BCA, DSTSCHOOL, DISTCBD* ***Model 6.*** *Predictors: (Constant), FAR, Mostertsdrift, BCA, DSTSCHOOL, DISTCBD, Krommerivier* ***Model 7***. *Predictors: (Constant), FAR,Mostertsdrift, BCA, DSTSCHOOL, DISTCBD, Krommerivier, Simonswyk* ***Model 8***. *Predictors: (Constant), FAR, Mostertsdrift, BCA, DSTSCHOOL, DISTCBD, Krommerivier, Simonswyk, ERFAREA* ***Model 9***. *Predictors: (Constant), FAR, Mostertsdrift, BCA, DSTSCHOOL, DISTCBD, Krommerivier, Simonswyk, ERFAREA, Uniepark* ***Model 10***. *Predictors: (Constant), FAR, Mostertsdrift, BCA, DSTSCHOOL, DISTCBD, Krommerivier, Simonswyk, ERFAREA, Uniepark,La Coline k. Dependent Variable: PRICEPSQM*

Table 4.4 indicates that the significance value of the F statistic is less than 0.05 and thus confirms the statistical significance of the model. Therefore, the null hypothesis that there is no linear relationship between housing price and all the selected explanatory variables can be rejected.

Table 4.4. Analysis of variance

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
10	Regression	2977155017.970	10	297715501.797	141.136	.000[k]
	Residual	1672772753.767	793	2109423.397		
	Total	4649927771.737	803			

The significant variables have been identified based on the standardized coefficients that compare the relative significance of the independent variables. The coefficient signs of all independent variables are depicted in Table 4.5 and the significant t-statistics at the 95 per cent confidence interval confirmed except for the variables: ERFAREA, SWIMPOOL AND GARAGE.

The floor area ratio (FAR), the availability of swimming pool (SWIMPOOL), the Mostertsdrift neighbourhood and distance to school (DISTSCHOOL) were found to have a positive effect on housing price as they depicted positive coefficients. Conversely, the distance from central business district (DISTCBD), availability of garage (GARAGE), Plot size (ERFAREA) and building coverage area (BCA) indicate negative coefficients signs. The variables related to the physical characteristics of the property such as the availability of a garage and swimming pool are however insignificant in the model.

The inspection of the neighbourhood dummy variables indicate that the coefficients of KROMMERIVIER, LA COLLINE, SIMONSWYK, and UNIEPARK are all negative values and are significant indicating that housing prices in these neighbourhoods are comparatively lower than housing prices of the reference neighbourhood, DIE WEIDES for houses that have similar features. The Die Weides neighbourhood was selected as a reference neighbourhood because of its proximity to the central business district and due to its location being closer to the university where there is increased demand for housing.

The coefficient of the Mostertsdrift neighbourhood is however positive and significant, suggesting that housing prices are higher in this neighbourhood for products with similar features compared to the Die Weides neighbourhood. The results also depict that the two variables relating to availability of a swimming pool and the proximity to a school are significant in the model and influence residential housing prices in Stellenbosch. The GARAGE variable is depicted by a negative coefficient, but Table 4.5 indicates that this variable is insignificant (Figure 4.5) within the 90% and 95% intervals in the model.

Table 4.5: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	5097.307	585.566		8.705	.000			
	ERFAREA	-.647	.270	-.131	-2.396	.017	-.228	-.085	-.051
	FAR	6687.452	509.078	.602	13.136	.000	.569	.423	.279
	BCA	-1.298	.435	-.165	-2.982	.003	.182	-.105	-.063
	DISTCBD	-653.738	215.046	-.168	-3.040	.002	-.365	-.107	-.065
	DSTSCHOOL	734.026	217.536	.123	3.374	.001	.143	.119	.072
	POOL	234.530	120.753	.047	1.942	.052	-.057	.069	.041
	GARAGE	-27.247	117.762	-.005	-.231	.817	.036	-.008	-.005
	KROMMERIVIER	-2970.041	358.886	-.363	-8.276	.000	-.182	-.282	-.176
	LA COLINE	-1247.667	368.052	-.197	-3.390	.001	.220	-.120	-.072
	MOSTERTSDRIFT	1019.792	272.088	.155	3.748	.000	.320	.132	.080
	SIMONSWYK	-1702.586	308.259	-.240	-5.523	.000	-.116	-.193	-.118
	UNIEPARK	-1556.293	384.889	-.305	-4.043	.000	-.406	-.142	-.086

a. Dependent Variable: PRICEPSQM

The use of the regression method does not mean that the independent variables will be able to fully explain the dependent variable (price per square metre). There are variables other than those identified for the current purpose that will also affect the predicted housing valuation price. The existence of these unidentified characteristics is taken into consideration by the intercept term. The value of this term for this hedonic regression model (equation) is indicated as a positive term which means that the net effect of unidentified factors influences the increase in the predicted price.

Using the hedonic price model for valuing housing density, specifically employing FAR, Table 4.5 indicates that the coefficient of FAR is 6687.45. This implies that one unit of FAR increases property value by R6687.45 per square metre when the other variables are controlled. The hypothesis that building density positively influences housing prices is thus supported by the model. The proximity to a school in terms of distance accounts for an increase of about R734.03 in the house price per square metre. This means that properties which are closer to schools will fetch a higher price than houses that are further away from schools. Furthermore, the negative coefficient of the DISTCBD suggests that as you move further from the central business district the property prices tend to decrease which supports the traditional location theories relating to land rents. The estimates of the coefficients of the dummy variable SWIMPOOL suggests an increase of R234.53 per square meter in housing price can be attributed to the availability of a swimming pool. The availability of a swimming pool and a garage have however been depicted as insignificant in the model (Table 4.5) and are hence excluded in the model.

The overall hedonic model for Stellenbosch in the current study can thus be expressed as follows:

Housing Price$_i$ = 5097.31 + 6687.45 FAR - 0 .647 ERFSIZE + 734.03 DISTSCHOOL - 1.298 BCA – 653.74 DISTCBD - 27.247 GARAGE + 234.530 SWIMPOOL – 2970.04 KROMMERIVIER – 1247.67 LA COLLINE + 1019.80 MOSTERTSDRIFT – 1702.59 SIMONSWYK - 1556.29 UNIEPARK+ ε_i

4.2 REGRESSION RESULTS FOR THE NEIGHBOURHOODS

This subsection presents the results and the differences in housing prices across the neighbourhoods represented in the data. The Die Weides neighbourhood which had been chosen as the reference neighborhood in the analysis of the overall sample is included.

4.2.1 Neighbourhood 1: Die Weides

The most significant variable that explain the variation in house prices at the 95% significance level in the Die Weides neighbourhood is the floor area ratio (FAR). The model summary (Table 4.6) shows a R^2 value of 0.492 indicating at the 95% significance level that approximately 50 % of the variation in house prices in this neighbourhood is explained by the floor area ratio (FAR). It is important to note that the FAR is the only predictor variable that was considered in the regression model in this submarket.

Table 4.6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.701[a]	.492	.486	1696.2

a. Predictors: (Constant), FAR, b. Dependent Variable: PRICESQM

The significance value of the F statistic is at 0.000 and highly significant, therefore the null hypothesis that house prices are not linearly interrelated to the floor area ratio variables can be rejected. The t statistics for FAR are all significant at the 95 per cent confidence interval as shown in Table 4.7. The FAR is depicted by a positive value in Table 4.7 suggesting that a unit increase of this variable will result in R 6533.37 increase in house price of properties in this neighbourhood. The coefficients of the excluded variables are shown in Annexure B.

Table 4.7: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	3507.700	346.371		10.127	.000			
	FAR	6533.371	733.043	.701	8.913	.000	.701	.701	.701

a. Dependent Variable: PRICESQM

4.2.2 Neighbourhood 2: Uniepark

The Uniepark neighbourhood is characterized by four significant explanatory variables; FAR, lot sizes, building coverage area, and the availability of a garage. The R^2 value of 0.26 in Table 4.8 indicates that the combination of these four variables (including the FAR) explain 26 % of the variation in the housing prices in this neighbourhood.

Table 4.8: Model Summary

	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.320[a]	.102	.099	634.7
2	.425[b]	.180	.174	607.7
3	.468[c]	.219	.210	594.1
4	.510[d]	.260	.249	579.3

a. Predictors: (Constant), ERFAREA b. Predictors: (Constant), ERFAREA, BCA c. Predictors: (Constant), ERFAREA, BCA, FAR d. Predictors: (Constant), ERFAREA, BCA, FAR, GARAGE
e. Dependent Variable: PRICEPSQM

The null hypothesis that there is no relationship between housing valuation price and the statistically significant explanatory variables can be rejected because the F statistic is significant at the 95% significance level as shown in Annexure C. It is important to note that the variable of interest in this study, the FAR has a very small influence in predicting the house price in this neighbourhood (3.9%). In addition, since building density is also described by building coverage (BCA), the combine effect of the two variables can be considered important in predicting the variation in housing prices in this neighbourhood. Coefficients of the significant variables are shown in Table 4.9. The Uniepark model shows a negative coefficient in FAR which means the effects of this variable in this neighbourhood tend to decrease in housing price. This may be explained by the fact that residents may prefer environmental factors such as spaciousness as compared to the increase of building density in this neighbourhood.

Table 4.9: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
4	(Constant)	5485.953	373.999		14.668	.000			
	ERFAREA	-2.478	.310	-.912	-7.999	.000	-.320	-.443	-.425
	BCA	5.910	.981	1.846	6.024	.000	.201	.349	.320
	FAR	-6151.220	1186.643	-1.573	-5.184	.000	.259	-.305	-.275
	GARAGE	-330.915	86.653	-.244	-3.819	.000	-.021	-.230	-.203

a. *Dependent Variable: PRICEPSQM*

4.2.3 Neighbourhood 3: Mostertsdrift

The most significant variables that explain the variation in house valuation prices in this stepwise regression model are (in the order of significance) floor area ratio (FAR), lot size (ERFAREA) and distance to the central business district (DISTCBD). Table 4.10 shows that R = 0.593, which is the multiple correlation coefficient and indicates a strong correlation between the observed and predicted values of the housing prices. The R^2 value of 0.351 which is the coefficient of determination, shows that about 35% of the variation in housing prices in this neighbourhood is explained by these three variables. Although, in this case these variables do not provide a very good fit to the model, the specific variable of interest, the FAR, predicts approximately 28.7% of the variance in the model. Although this shows the importance of this variable in explaining the housing prices in this neighbourhood, there are clearly other factors that also affect house prices but are not included in the model.

Table 4.10: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.541[a]	.293	.287	1762.1
2	.571[b]	.326	.315	1727.5
3	.593[c]	.351	.336	1701.2

a. Predictors: (Constant), FAR b. Predictors: (Constant), FAR, ERFAREA, c. Predictors: (Constant), FAR, ERFAREA, DISTCBD

The significance value of the F statistic as depicted in Annexure E indicates significance at the 95% significance interval. The null hypothesis can thus be rejected because there is a statistically significant linear relationship between the housing prices and the three significant explanatory variables. Coefficients of the significant variables are shown in Table 4.11 and FAR variable indicates a positive value therefore an increase in FAR unit results in the increase in property price in this neighbourhood whereas the negative values of the variables ERFAREA AND DISTCBD suggest that these two affect the house price negatively meaning that the location of this neighbourhood plays an important role in the prediction of house prices where the further away from the CBD results in the decrease in price. The excluded variables in the model are shown in Annexure G.

Table 4.11: Coefficients

Coefficients[a]									
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
3	(Constant)	6828.739	1274.126		5.360	.000			
	FAR	9106.845	1516.538	.466	6.005	.000	.541	.475	.434
	ERFAREA	-1.229	.440	-.219	-2.794	.006	-.363	-.243	-.202
	DISTCBD	-877.524	396.754	-.162	-2.212	.029	-.124	-.195	-.160

a. *Dependent Variable: PRICESQM*

4.2.4 Neighbourhood 4: Simonswyk

The stepwise regression highlighted three significant explanatory variables that explains the housing prices in this neighbourhood: floor area ratio, lot size and the distance to the central business district. Table 4.12depicts the R^2 value of 0.802 which is the coefficient of determination, indicating that about 80% of the variation in housing prices is explained by the three variables. In the Simonswyk neighborhood, the significant variables provide a very good fit to the model and the variable of interest (FAR), predicts approximately 76% of the variance in the model.

Table 4.12: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.872[a]	.760	.758	1369.9
2	.891[b]	.794	.790	1276.
3	.895[c]	.802	.796	1256.8

a. Predictors: (Constant), FAR, b. Predictors: (Constant), FAR, ERFAREA, c. Predictors: (Constant), FAR, ERFAREA, DISTCBD d. Dependent Variable: PRICEPSQM

The significance value of the F statistic is at the 95% significance interval and highly significant, therefore the null hypothesis that there is no relationship between the house prices the three significant variables can be rejected (Table 4.13 and Annexure H). Table 4.13 indicates a positive value of the FAR which suggests that a unit increase in FAR results in the increase in property price in this neighbourhood, however the negative coefficients of ERFAREA AND DISTCBD suggest that these two affect the house price negatively. This maybe largely attributed to the location of this neighbourhood and the preferences of the residents where house prices tend to decrease as one moves further away from the CBD and home owners preferring large parcels of land over compact plots.

Table 4.13: Coefficients

model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
3	(Constant)	5759.018	2003.250		2.875	.005			
	FAR	10033.697	835.014	.698	12.016	.000	.872	.764	.527
	ERFAREA	-1.645	.393	-.222	-4.189	.000	-.642	-.382	-.184
	DISTCBD	-1476.304	721.135	-.102	-2.047	.043	-.494	-.198	-.090

4.2.5 Neighbourhood 5: La Colline and Krommerivier

Almost all the independent variables are significant in explaining the variation in house prices in this neighbourhood as shown in the model summary (Table 4.14). The R^2 value suggests that the model is very good fit and explains 93 % of the housing prices in this neighbourhood. The available of a swimming pool, however, shows to be lagging in significance in this model. This may be explained by the low average plot size in this submarket where residents may prefer to optimally utilize the available space for house construction rather than installing a swimming pool. Properties in this neighbourhood would prioritize functionality over aesthetics to maximize the usage of the limited space. Furthermore, the location of this neighbourhood (DISTCBD) seems to have little effect in the prediction of house prices because the scarcity of affordable housing may influence households to locate in this neighbourhood. In this submarket, the significant variables provide a very good fit to the model with the distance to school predicting about 51% of the housing prices while the variable of interest, the FAR, predicts approximately 18% of the variance in the model.

Table 4.14: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.717[a]	.514	.511	1776.6
2	.837[b]	.700	.697	1398.7
3	.950[c]	.902	.901	800.2
4	.956[d]	.913	.912	754. 3
5	.960[e]	.922	.920	719.7
6	.963[f]	.927	.925	697.2
7	.964[g]	.930	.927	686.0

Model 1. Predictors: (Constant), DISCTSCHOOL, Model 2. Predictors: (Constant), DISCTSCHOOL, FAR, Model 3. Predictors: (Constant), DISCTSCHOOL, FAR, BCA, Model 4. Predictors: (Constant), DISCTSCHOOL, FAR, BCA, ERFAREA, Model 5. Predictors: (Constant), DISCTSCHOOL, FAR, BCA, ERFAREA, GARAGE, Model 6. Predictors: (Constant), DISCTSCHOOL, FAR, BCA, ERFAREA, GARAGE, DISTCBD, Model 7. Predictors: (Constant), DISCTSCHOOL, FAR, BCA, ERFAREA, GARAGE, DISTCBD, SWMPOOL h. Dependent Variable: PRICESQM

The significance value of the F statistic is at the 95 per cent significance interval and highly significant, therefore the null hypothesis that there is no relationship between the house prices the three significant variables can be rejected (see Annexure K). The t statistics for the variables are all significant at the 95 per cent confidence interval as shown in Table 4.15.

Table 4.15 indicates positive values for all the predictors in the model except for BCA, suggesting that for every unit increase of each variable, the house price can be expected to increase in this submarket. The negative coefficient of BCA suggests that a unit increase in building coverage results in the decrease of house prices by R 9.68.

Table 4.15: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	-1150.938	420.230		-2.739	.007			
DISCTSCHOOL	817.997	295.483	.076	2.768	.006	.717	.188	.051
FAR	10541.327	405.368	1.125	26.004	.000	.672	.874	.476
BCA	-9.677	.487	-.879	-19.864	.000	-.241	-.808	-.364
GARAGE	638.434	109.567	.120	5.827	.000	-.204	.373	.107
ERFAREA	1.348	.301	.157	4.478	.000	-.714	.295	.082
DISTCBD	792.489	196.300	.085	4.037	.000	.527	.268	.074
SWMPOOL	610.281	216.303	.053	2.821	.005	-.034	.191	.052

a. Dependent Variable: PRICESQM

5. CHAPTER 5 - SUMMARY AND CONCLUSIONS

5.1 SUMMARY OF FINDINGS AND REFLECTION ON RESEARCH OBJECTIVES

The study explored the relationship between building density and residential property prices in Stellenbosch through two specific research objectives: Firstly, to determine the effect of density (floor area ratio, floor coverage and building height) on housing prices and secondly, to identify the relationship of housing density variables with other independent variables in the determination of house prices for the submarkets (neighbourhoods).

The analysis of the study is restricted to residential properties, other land uses fall outside the scope of the study. The property valuation data for the period 2014 to October 2018 obtained from the 2018 valuation roll was utilized in the study. The study is composed of three main parts: Initially, a theoretical framework is constructed for analyzing the residential prices variations in relation to housing density where it is assumed to be one of the principal determinants of residential property prices. Housing density is measured by employing variables such as floor area ratio and building coverage and a hedonic model is constructed based on physical characteristics, locational characteristics and neighbourhood characteristics. An attempt is made to provide explanations on the determinants of housing density and their importance in the model and the hedonic theories on analyzing housing markets are discussed.

The hedonic model was constructed to identify the effect of building density as represented by floor area ratio (FAR) and building coverage area (BCA) as significant determinants of housing price for the residential property in Stellenbosch. The hedonic analysis is carried out with the data on location, physical characteristics and neighbourhood characteristics of the residential properties were collected from the 6 neighborhoods in Stellenbosch. Therefore, the housing price and its variations in the residential sector of Stellenbosch could be explained to a large extent using this model.

The hedonic price function is specified for the supply-side attributes of the residential properties and the valuation price from the municipality is adopted as the dependent variable expressed in the price (Rands) per square meter. The hedonic equation is specified in the linear functional form and the supply side features of the residential properties, which is identified as location, physical characteristics and neighbourhood characteristics are represented by 15 variables in the overall sample and by seven variables in each neighbourhood.

The neighborhood of Die Weides illustrates the highest average housing price per square meter followed by the Mostertsdrift neighbourhood. when compared with the other submarkets indicating the property prices are relatively high in this neighbourhood in relation to the overall sample (refer to Table 5.1). In terms of the lot size, the Mostertsdrift submarket portrays high average values suggesting that this neighbourhood is commonly large residential plots a characteristic of a low density neighbourhood. The lowest average of plot size of 479.5 square metres (refer to Table 5.1) is associated with the La Colline and Krommerivier submarket which is typical of medium and high-density residential areas. The average floor area ratio (FAR) value of 0.416 (46%) in the La Colline and Krommerivier submarket (refer to Table 5.1) confirms that this submarket has increased densities portraying the highest average FAR when compared with other neighbourhoods. Therefore, this submarket likely to attract higher densification interventions because of the relatively small plots sizes and the high demand for affordable housing as it is not an affluent neighbourhood when compared with the other neighbourhoods such as Mostertsdrift.

The Uniepark neighbourhood reveals the lowest FAR average (refer to Table 5.1) but the second highest average in terms of plot size which can be translated to a neighbourhood characteristic of a medium density neighbourhood. The average housing price in this submarket reveals that properties are relatively affordable and has the potential to improve densification and improve the supply side of housing to maximize the residential land use in this neighbourhood.

Table 5.1: Descriptive statistics for the respective neighbourhoods

Descriptive Statistics										
	La Colline & Krommerivier		Uniepark		Simonswyk		Die Weides		Mostertsdrift	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
PRICESQM	4463.7	2541.8	2812.9	668.6	3481.5	2782.5	6117.1	2365.7	5962.8	2087.3
ERFAREA	479.5	295.1	1232.9	246.1	1024.4	375.8	1210.0	613.5	1323.9	371.4
FAR	.42	.27	.27	.17	.31	.19	.40	.25	.29	.11
BCA	198.3	230.9	381.7	208.8	313.3	185.6	579.0	636.7	442.9	162.2
DISTCBD	2.07	.27	3.29	.23	2.51	.19	2.00	.36	2.14	.38
DISCTSCHOOL	.50	.23	1.05	.22	.91	.17	1.56	.26	.86	.40
SWMPOOL	.051	.22	.57	.50	.31	.46	.26	.44	.56	.50
GARAGE	.65	.48	.59	.49	.69	.46	.63	.49	.94	.24
N		218		267		107		84		128

The results of the models indicate that FAR generally increase housing prices and BCA is not statistically significant in most of the models. Therefore, building density as measured in terms of FAR in the overall Stellenbosch sample explains about 32.2 per cent of the housing prices while the combined effect with the other significant variables is attributed to 64% of the variance in the model. The FAR variable was found to be significant in all the models including the overall and the submarkets models. It is particularly important in the Simonswyk sub-market where the R^2 value of 0.758 in relation to explaining the variance in the model is much higher than the R^2 value of 0.32 in the overall sample. The Uniepark model shows a very low R^2 value which suggests that even though FAR is significant in predicting house prices in this submarket, it explains only a limited proportion of the variance in the model.

Table 5.2: Summary for the regression analyses of the neighbourhood models

Variables	**Die Weides**				**Uniepark**				**La Colline and Krommerivier**				**Mostertsdrift**				**Simonswyk**			
	B coeff	**Std Error**	**t-stat**	**p-value**	**B coeff**	**Std Error**	**t-stat**	**p-value**	**B coeff**	**Std Error**	**t-stat**	**p-value**	**B coeff**	**Std Error**	**t-stat**	**p-value**	**B coeff**	**Std Error**	**t-stat**	**p-value**
Constant	2470.7	474.4	5.208	.000	3846.0	136.7	28.126	.000	-1702.5	386.0	-4.410	.000	7425.9	1254.7	5.918	.000	5759.0	2003.2	-1.623	.108
FAR	7307.1	1040.0	7.026	.000	0.081	-	.723	.471	11091.8	369.3	30.028	.000	9025.5	1534.6	5.881	.000	10731.6	773.8	12.016	.000
ERF AREA	-.073	-	-.820	.414	-1.155	.124	-9.347	.000	2.210	.101	21.909	.000	-1.424	0.434	-3.280	.001	-1.645	.393	-4.189	.000
BCA	-.045	-	-.316	.752	0.643	.144	4.469	.000	-10.334	.445	-23.245	.000	0.115	-	0.578	0.564	-.007		-.068	.946
DIST CBD	-.035	-	-.406	.685	0.013	-	.150	.881	749.123	199.541	3.754	.000	-1036.673	393.666	-2.633	.010	-1476.304	721.135	-2.047	.043
DIST SCHOOL	.101	-	1.209	.230	.072	-	1.380	.169	1070.405	288.957	3.704	.000	-0.002	-	-0.025	0.980	-.036		-.814	.417

SWIM POOL	.159	-	1.935	.056	250.351	73.920	3.387	.001	652.517	220.002	2.966	.003	0.040	-	0.508	0.613	.073		1.590	.115
GARAGE	-.089	-	-.956	.342	-.070	-	-1.352	.178	640.064	111.672	5.732	.000	.017	-	0.230	0.819	.069		1.515	.133
R	.585				0.540				.963				0.608				0.895			
R2	0.342				.292				.927				0.37				0.802			
Adjusted R2	0.335				0.284				.925				0.355				0.796			
F-Statistics	49.364				36.388				385.342				24.487				138.842			
Std Error of Estimate	2477.0				599.8				699.1				1722.1				1256.8			
Durbin-Watson	2.029				1.733				2.101								1.907			
N	97				269				219								107			

Additionally, the results of areas such as Simonswyk and Die Weides infer that residential properties that are in close proximity to the University attracts developers who are keen on maximizing their profits by means of densification and that the inhabitants of these areas are willing to live in relatively denser surroundings largely because there is a high population of students in such areas. The building density in neighbourhoods such as La Colline and Krommerivier suggests that due to the scarcity of affordable properties in Stellenbosch, the residents tend to maximize the utilization of available land for housing needs and amenities such as garage and swimming pools are not very important factors in these neighbourhoods. The FAR results also suggest that there is a huge potential for densification specifically to address the limited affordable housing supply and maximize the land use in these neighbourhoods and future densification measures by the municipality or developers should be encouraged in these areas as they already show higher housing densities as compared to other neighbourhoods. In contrast, larger-scale development with higher FAR and higher densities are not always desirable for consumers without compromising other factors such as environmental factors and this can be understood in the context of the Mostertsdrift model where the observed impact of FAR on the estimation housing prices is significantly lower than other neighbourhoods such as Simonswyk.

For the second research objective, the models indicate that there is linear relationship between housing prices and the other variables that were considered (refer to Tables 5.2). The overall model indicates that the availability of a garage and swimming pool are insignificant in the overall model but the remaining ten variables including FAR, BCA, DISTCBD, DISTSCHOOL, ERFAREA, and the six neighbourhood variables, were significant in estimating house prices in Stellenbosch. It is important to note that the FAR in the Die Weides neighbourhood appeared to be the only significant predictor variable in the estimation of housing prices. In model 3 (Uniepark), it is evident that four variables were considered significant including lot size, building coverage, floor area ratio and the availability of a garage. Model 4 (Mostertsdrift) and Model 5 (Simonswyk) portray the following variables as significant predictors of the housing price: floor area ratio, lot size and distance to CBD. Model 6 (La Colline and Krommerivier) highlights all the seven variables as significant and the adjusted R^2 value suggests that the model is very strong when comparison is made with the other models.

5.2 VALUE AND POLICY AND PRACTICAL IMPLICATIONS OF RESEARCH RESULTS

This study is likely to be the first where an attempt is made to examine the impact of building density and other location and neighbourhood characteristics on the housing prices in the Stellenbosch housing market. The stepwise regression procedure employed in the analyses of the overall sample and the submarket samples summarizes the impact of the most effective hedonic variable on housing price. The findings of this study indicate that building density in terms of floor area ratio (FAR) has a significant influence on housing prices in Stellenbosch combined with other variables that were found to be statistically significant in the models such as the distance to school, distance to central business district, building coverage area, lot size and the availability of a swimming pool.

The results of this study can be used to improve the understanding of the planning interventions that can influence the supply side of housing market in Stellenbosch. Regarding the vision of the Stellenbosch SDF that highlights the need to integrate low-, middle- and high-income accommodation and minimize the development of isolated settlements and gated communities through densification, the results of the study can inform development interventions and incentives that will encourage inclusionary housing initiatives that will include the low- and middle income residents in areas that are close to the central business district and educational facilities. However, care should be taken not to propose a single density target and narrative as this may not be practical because the different neighbourhoods would require different densification interventions, depending on their accessibility to opportunities, infrastructure and transport systems, land values and the conservation potential of existing and historical buildings as noted by Turok (2011). Density plans need to consider the varied potential of the different sub-markets.

Furthermore, urban planners and policy makers can apply the results to improve the understanding of the variations in housing market within the town of Stellenbosch and its potential application elsewhere in South Africa. The study offers a glimpse of the current situation in the housing market of Stellenbosch and the factors that influence housing prices in the general area of Stellenbosch as well as the different neighbourhoods (submarkets) as they indicate different dynamics that influence the prices and the supply of housing. The study can also assist in determining appropriate housing densities that can be explored and implemented to address the policy ambitions of the municipality in proving affordable housing and derive acceptable densities that will meet the needs of consumers as well as developers without compromising property values.

5.3 LIMITATIONS OF STUDY AND POTENTIAL FURTHER FUTURE RESEARCH

Despite the value of the findings, several limitations of this study need to be recognized. Firstly, it is hard to generalize the results of the study because the focus was restricted to only six neighbourhoods of Stellenbosch and hence it would be difficult to generalize the findings of this research to the entire housing market of Stellenbosch. Secondly, time constraints and data limitation in terms of the readily available data for this research did not allow for the consideration of other potentially relevant variables such as the age of buildings, height of buildings, and socio-economic attributes that would have enhanced the performance of the hedonic models. A more comprehensive study can be conducted in future to also consider the potential variables highlighted above and to investigate the impact of densification on the costs of housing and the evolvement of urban spatial structure.

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ANNEXURES

1. REGRESSION RESULTS FOR DIE WEIDES

Annexure A: Analysis of Variance

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	228556871.057	1	228556871.057	79.436	.000[b]
	Residual	235935194.849	82	2877258.474		
	Total	464492065.906	83			

a. Dependent Variable: PRICESQM, b. Predictors: (Constant), FAR

Annexure B: Correlations

Correlations									
		PRICESQM	ERFAREA	FAR	BCA	DISTCBD	DSTSCHOOL	SWMPOOL	GARAGE
Pearson Correlation	PRICESQM	1.000	.284	.701	.589	.109	.020	-.052	-.395
	ERFAREA	.284	1.000	.367	.807	.311	-.384	-.188	-.379
	FAR	.701	.367	1.000	.809	.230	-.123	-.117	-.443
	BCA	.589	.807	.809	1.000	.353	-.333	-.162	-.453
	DISTCBD	.109	.311	.230	.353	1.000	-.508	-.046	-.125
	DSTSCHOOL	.020	-.384	-.123	-.333	-.508	1.000	.244	.021
	SWMPOOL	-.052	-.188	-.117	-.162	-.046	.244	1.000	.231
	GARAGE	-.395	-.379	-.443	-.453	-.125	.021	.231	1.000
Sig. (1-tailed)	PRICESQM	.	.004	.000	.000	.163	.429	.318	.000
	ERFAREA	.004	.	.000	.000	.002	.000	.043	.000
	FAR	.000	.000	.	.000	.018	.133	.145	.000
	BCA	.000	.000	.000	.	.000	.001	.070	.000
	DISTCBD	.163	.002	.018	.000	.	.000	.340	.129
	DSTSCHOOL	.429	.000	.133	.001	.000	.	.013	.425
	SWMPOOL	.318	.043	.145	.070	.340	.013	.	.017
	GARAGE	.000	.000	.000	.000	.129	.425	.017	.
	GARAGE	84	84	84	84	84	84	84	84

2. REGRESSION RESULTS FOR UNIEPARK

Annexure C: Analysis of Variance

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
4	Regression	30973847.576	4	7743461.894	23.071	.000[e]
	Residual	87935006.850	262	335629.797		
	Total	118908854.426	266			

e. Predictors: (Constant), ERFAREA, BCA, FAR, GARAGE

Annexure D: Correlations

Correlations									
		PRICESQM	ERFAREA	FAR	BCA	DISTCBD	DSTSCHOOL	SWMPOOL	GARAGE
Pearson Correlation	PRICEPSQM	1.000	-.320	.259	.201	-.045	.148	.174	-.021
	ERFAREA	-.320	1.000	-.087	.222	.199	-.173	.084	-.183
	FAR	.259	-.087	1.000	.931	.018	.026	.019	-.141
	TGFA	.201	.222	.931	1.000	.098	.002	.132	-.090
	DISTCBD	-.045	.199	.018	.098	1.000	.689	.048	-.007
	DSTSCHOOL	.148	-.173	.026	.002	.689	1.000	.015	.103
	SWMPOOL	.174	.084	.019	.132	.048	.015	1.000	-.046
	GARAGE	-.021	-.183	-.141	-.090	-.007	.103	-.046	1.000
Sig. (1-tailed)	PRICEPSQM	.	.000	.000	.000	.231	.008	.002	.367
	ERFAREA	.000	.	.078	.000	.001	.002	.085	.001
	FAR	.000	.078	.	.000	.386	.334	.377	.011
	BCA	.000	.000	.000	.	.054	.488	.015	.072
	DISTCBD	.231	.001	.386	.054	.	.000	.219	.453
	DSTSCHOOL	.008	.002	.334	.488	.000	.	.405	.046
	SWMPOOL	.002	.085	.377	.015	.219	.405	.	.229
	GARAGE	.367	.001	.011	.072	.453	.046	.229	.

Annexure E: Excluded Variables

Excluded Variables								
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
4	DISTCBD	-.020[e]	-.373	.710	-.023	.948	1.054	.030
	DSTSCHOOL	.056[e]	1.033	.302	.064	.948	1.054	.030
	SWIMPOOL	.035[e]	.561	.575	.035	.717	1.396	.022

e. Predictors in the Model: (Constant), ERFAREA, BCA, FAR, GARAGE

3. REGRESSION RESULTS FOR MOSTERTSDRIFT

Annexure F: Analysis of variance

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
3	Regression	194440297.428	3	64813432.476	22.395	.000[d]
	Residual	358875161.620	124	2894154.529		
	Total	553315459.048	127			

d. Predictors: (Constant), FAR, ERFAREA, DISTCBD

Annexure G: Correlations

Correlations									
		PRICESQM	ERFAREA	FAR	BCA	DISTCBD	DSTSCHOOL	SWMPOOL	GARAGE
Pearson Correlation	PRICESQM	1.000	-.363	.541	.254	-.124	-.040	.163	.149
	ERFAREA	-.363	1.000	-.359	.371	-.137	-.083	.170	-.233
	FAR	.541	-.359	1.000	.667	.017	-.026	.314	.163
	BCA	.254	.371	.667	1.000	-.074	-.070	.497	.116
	DISTCBD	-.124	-.137	.017	-.074	1.000	.246	-.089	.026
	DSTSCHOOL	-.040	-.083	-.026	-.070	.246	1.000	-.109	.031
	SWMPOOL	.163	.170	.314	.497	-.089	-.109	1.000	.033
	GARAGE	.149	-.233	.163	.116	.026	.031	.033	1.000
Sig. (1-tailed)	PRICESQM	.	.000	.000	.002	.082	.327	.033	.047
	ERFAREA	.000	.	.000	.000	.061	.176	.028	.004
	FAR	.000	.000	.	.000	.425	.386	.000	.033
	BCA	.002	.000	.000	.	.202	.217	.000	.096
	DISTCBD	.082	.061	.425	.202	.	.003	.160	.386
	DSTSCHOOL	.327	.176	.386	.217	.003	.	.110	.364
	SWMPOOL	.033	.028	.000	.000	.160	.110	.	.358
	GARAGE	.047	.004	.033	.096	.386	.364	.358	.

Annexure H: Excluded variables

Excluded Variables						
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
3	BCA	.094[d]	.464	.644	.042	.128
	DSTSCHOOL	-.007[d]	-.090	.928	-.008	.934
	SWMPOOL	.049[d]	.611	.542	.055	.807
	GARAGE	.028[d]	.374	.709	.034	.938

d. Predictors in the Model: (Constant), FAR, ERFAREA, DISTCBD

4. REGRESSION RESULTS FOR SIMONSWYK

Annexure I: Analysis of Variance

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
3	Regression	657957175.115	3	219319058.372	138.842	.000[d]
	Residual	162701670.178	103	1579627.866		
	Total	820658845.293	106			

d. Predictors: (Constant), FAR, ERFAREA, DISTCBD

Annexure J: Excluded variables

Excluded Variables								
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
3	BCA	-.007[d]	-.068	.946	-.007	.187	5.348	.141
	DSTSCHOOL	-.036[d]	-.814	.417	-.080	.968	1.033	.570
	SWMPOOL	.073[d]	1.590	.115	.156	.908	1.102	.570
	GARAGE	.069[d]	1.515	.133	.148	.904	1.106	.568

d. Predictors in the Model: (Constant), FAR, ERFAREA, DISTCBD

Annexure K: Correlations

Correlations									
		PRICESQM	ERFAREA	FAR	BCA	DISTCBD	DSTSCHOOL	SWMPOOL	GARAGE
Pearson Correlation	PRICEPSQM	1.000	-.642	.872	.107	-.494	-.058	-.131	.250
	ERFAREA	-.642	1.000	-.562	.535	.268	-.053	.169	-.291
	FAR	.872	-.562	1.000	.299	-.476	-.028	-.186	.176
	TGFA	.107	.535	.299	1.000	-.173	.106	.104	-.073
	DISTCBD	-.494	.268	-.476	-.173	1.000	.151	.288	.007
	DSTSCHOOL	-.058	-.053	-.028	.106	.151	1.000	.025	.108
	SWMPOOL	-.131	.169	-.186	.104	.288	.025	1.000	.095
	GARAGE	.250	-.291	.176	-.073	.007	.108	.095	1.000
Sig. (1-tailed)	PRICEPSQM	.	.000	.000	.137	.000	.276	.089	.005
	ERFAREA	.000	.	.000	.000	.003	.293	.041	.001
	FAR	.000	.000	.	.001	.000	.389	.028	.035
	BCA	.137	.000	.001	.	.037	.138	.144	.228
	DISTCBD	.000	.003	.000	.037	.	.060	.001	.470
	DSTSCHOOL	.276	.293	.389	.138	.060	.	.397	.135
	SWMPOOL	.089	.041	.028	.144	.001	.397	.	.164
	GARAGE	.005	.001	.035	.228	.470	.135	.164	.

5. REGRESSION RESULTS FOR LA COLLINE AND KROMMERIVIER

Annexure L: Analysis of Variance

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	1303150873.794	7	186164410.542	395.588	.000[h]
	Residual	98826249.889	210	470601.190		
	Total	1401977123.683	217			

h. Predictors: (Constant), DISCTSCHOOL, FAR, BCA, ERFAREA, GARAGE, DISTCBD, SWMPOOL

Annexure M: Correlations of variables

Correlations

		PRICESQM	ERFAREA	FAR	BCA	DISTCBD	DISTSCHOOL	SWMPOOL	GARAGE
Pearson Correlation	PRICESQM	1.000	-.714	.672	-.241	.527	.717	-.034	-.204
	ERFAREA	-.714	1.000	-.361	.480	-.296	-.638	.051	.229
	FAR	.672	-.361	1.000	.500	.372	.381	-.035	-.130
	BCA	-.241	.480	.500	1.000	-.067	-.338	.071	.232
	DISTCBD	.527	-.296	.372	-.067	1.000	.387	-.085	-.116
	DISCTSCHOOL	.717	-.638	.381	-.338	.387	1.000	-.078	-.117
	SWMPOOL	-.034	.051	-.035	.071	-.085	-.078	1.000	.169
	GARAGE	-.204	.229	-.130	.232	-.116	-.117	.169	1.000
Sig. (1-tailed)	PRICESQM	.	.000	.000	.000	.000	.000	.308	.001
	ERFAREA	.000	.	.000	.000	.000	.000	.229	.000
	FAR	.000	.000	.	.000	.000	.000	.304	.028
	BCA	.000	.000	.000	.	.163	.000	.147	.000
	DISTCBD	.000	.000	.000	.163	.	.000	.105	.044
	DISCTSCHOOL	.000	.000	.000	.000	.000	.	.127	.042
	SWMPOOL	.308	.229	.304	.147	.105	.127	.	.006
	GARAGE	.001	.000	.028	.000	.044	.042	.006	.