SELINUS UNIVERSITY
OF SCIENCES AND LITERATURE

"Assessment of Criminal Activities on Land and Property Value: The Case of the City of Francistown, Botswana"

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A DISSERTATION

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Dedication

I dedicate this work to my Wife, Shirley Banks who has supported me throughout my studies. My Wife unreservedly supported me as I spent sleepless nights working on my thesis. I would also like to extend my profound gratitude to Dr. Vincent Basupi the Lecturer at Botswana International University of Sciences and Technology for his advice as I went along with my thesis. Furthermore, I extend my many thanks to the respondents of the questionnaires distributed that culminated in to this paper. Moreover, my appreciation goes to my supervisor Dr. Salvatore Fava of the Selinus University of Sciences and Literature who would peruse through my thesis for subsequent certification.

Declaration of Originality

I do hereby attest that I am the sole author of this thesis and that its contents are the result of the readings and the research that I have done in fulfilment of the MPhil / PhD Thesis. All quotations that have been used in this thesis have been indicated by quotation marks. All other sources of information that have been used to fulfil the requirements of the thesis have all been acknowledged at the bibliography.

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Abstract

This paper investigates the impact of criminal activities on residential property value in Francistown. With regard to criminal activities, the paper emphasises on the contribution of each component of property crime. One thousand (1000) sets of structured questionnaires were administered on the residents of residential estates within Francistown out of which 467 were considered useable after the data screening. Purposive and systematic sampling techniques were used while logistic regression was used to determine the impact of each component of property crime on housing investment. The results showed the P-values of 0.000, 0.322, 0.335, 0.545 and 0.992 for violent crime, incivilities and street crime, burglary and theft, vandalism and robbery respectively. However, the R^2 which represents the generalisation of the impact of neighbourhood crime on housing investment was 44% and the aggregate P-value was 0.000. Using the Hosmer and Lemeshow (H-L) test of goodness of fit, the model had approximately 89% predictive probability which is considered excellent. This indicates that the alternative hypothesis is upheld tat residential neighbourhood crime is capable of impacting on residential property value. The policy implication of this result is that no effort should be spared in combating residential neighbourhood crime in order to boost and encourage housing investment.

Chapter 1

1.0 Introduction

The importance of housing to humanity cannot be over-emphasized. It ranges from security, social services, investment, recreation and its enormous contributions to the national economy. Housing is however bedevilled by a number of risks which include property crime. The consequences of residential neighbourhood crime affect residents, entire neighbourhood, governmental activities and in particular housing investment.

The essence of going into housing investment is to make profit which could reflect in whether the value of the property in question is appreciating or depreciating. There is no doubt that Literature have diverse views on the impact of property crime on property values, prominent among the views is the fact that majority see property crime which is otherwise called residential neighbourhood crime as having a significantly negative impact on the property while a few other researchers see the omnibus affirmation to be inadequate since there exists different types or levels of property crimes. These include burglary and theft, incivility and street crime; vandalism; robbery and violent crime among others. Their position is that there could be variance in the contributions of each of the components of property crime and probably would give a better direction to the government on which to place priority on. In view of the forgoing, the intention of this research is to predicatively determine the impact of residential neighbourhood crime as an entity, as well as its sub-variables (burglary and theft; incivility and

street crime; vandalism; robbery and violent crime) on residential property values with the view to boosting housing investment. This paper is structured as follows;

- Section (2) two discusses literature review
- Section (3) three dwells on methodology
- Section (4) presents data analysis
- Section (5) centres on the summary, conclusions, recommendations and future actions

1.1 Research Background

Crime is a social phenomenon, as observed by Baumann and Friehe (2013). Crime is adversely affecting many individuals by minute. Indeed, crime is consistently placed at or near the top of the list of social maladies (Helsley and Strange 1999). In response, potential victims go to considerable length in order to address the crime risk by taking private action. Such private precautions include not only minor expenses such as walking a detour to avoid a dark alley but also sizeable investments such as security systems to safe guard the private home, allowing for the same order of magnitude as public expenditures (Shavell 1991) as cited by Baumann ad Friehe (2013). Crime and the fear it generates are among the most important determinants of individual welfare and of expected returns on many economic activities. In particular, robbery, theft, breaking and entering and the fear of these crimes inflict many direct and indirect costs on city residents, including the monetary value of property stolen or damaged; insecurity, anxiety and the lack of safety; and an impact on property values (Buonanno, Montolio and Raya-Vilchez, 2012). The effect of crime on housing prices is well documented

in the literature. Evidence from the last three decades confirms that crime has a significant impact on house prices.

A high crime rate is strongly and negatively associated with neighbourhood quality, having a marked impact on the prices home buyers are willing to pay for the house. In other words, as crime is perceived as detrimental, individuals may be discouraged from buying a house and this behaviour is, in turn, reflected in the market property price. Moreover, as Gibbons (2004) notes, the fear of crime through its indirect effect on housing prices may also “inhibit local regeneration and catalyse a downward spiral in neighbourhood status (2012). In the words of Linden and Rockoff (2008), understanding the relationship between property values and local crime risk is useful for measuring the willingness of individuals to pay to reduce their exposure to crime risk.

1.2 Statement of the Research Problem

It is clear that safety, or the feeling of safety, is a recondition for a neighbourhood to be considered desirable. No one wants to live in a place that feels unsafe. Safe and clean environments attract families and incentivize investment. Unsafe environments repel investment and attract criminal behaviour. This feeling of personal safety is a precondition for revitalization of a high crime neighbourhood; a fundamental fact that no flashy commercial developments can appreciably alter. Researchers have long suggested that high crime levels cause communities to decline. This decline may translate into an increasing desire to move, weaker attachments of residents and lower house values. This is because buyers are willing to pay more for living in neighbourhoods with lower crime rates or, alternatively, buyers expect

discounts for purchasing properties in neighbourhoods with higher crime rates (Ceccato and Wilhelmsson, 2011). A number of studies have examined the effect of crime on property values.

1.3 Research Objectives

(i) To identify the main types of security threats (crime) in suburban Francistown.

(ii) To examine the impact of crime on property value.

(iii) To come up with recommendations on what can be done to manage urban crime.

1.4 Research Questions

(i) What are the main types of crime in suburban Francistown?

(ii) How does crime affect neighbourhood quality and property values?

(iii) What can be done to manage urban crime?

I shall attempt to answer the above-mentioned questions through out this paper as the basis of my thesis derived from the questionnaires and interviews.

1.5 Significance of the Research

There is an enormous body of literature that examines crime. There are studies that explore who and what causes crime. There are studies that explore when and where crime occurs. There are studies that explore why crime occurs. This dissertation fits into the library of studies that look at what happens once crime has occurred. Crime affects not only the victims of crime, but also indirectly affects everyone. One of the indirect impacts of crime that affects everyone is through neighbourhood quality. Increases in crime result in decreases in neighbourhood quality, which are reflected in the prices that people are willing to pay for homes.

Numerous studies have examined the effect of crime on housing prices. Most of the studies use the level f crime, and more recent studies have begun to look at changes in crime. Some studies use the average crime rate for a city and others use localized crime rates of neighbourhoods within a city. The results of studies vary from strong relationships between crime and house sale prices to weak or no relationship. The thing that ties all of the studies together is the se f measured crime statistics to measure the effect of crime. But the measured crime rate based on reported crime is different from the actual crime rate. Both the measured rime rate and actual crime may be different from the crime rate that is perceived by homebuyers and sellers. The research presented in this dissertation extends the literature on housing and crime by recognizing that measured crime may not be the same as how crime is perceived and by examining the effect of these perceptions.

1.6 Delimitations

The research focusses on the City of Francistown only and the study is limited to urban crime. The study is on the impact of crime on property value.

1.7 Chapter Summary

The chapter was on introduction, study background and research problem. The next chapter will give a scholarly view on the research topic.

Chapter 2

2.0 Literature Review

2.1 Theoretical Framework

In this Chapter, major theories propounded and found relevant to this study are discussed. These include concepts of property and property values, accessibility and complementarity, graph theory, urban rent determination model, and theory of urban location are discussed in relation to this study. Research works on the consequences of residential property crime have revealed the need to pay better attention to its ultimate control, if not end. The effect is found to be devastating. This cuts across the residential neighbourhood itself. Effect of neighbourhood crime on the neighbourhood take the form of neighbourhood decline, effect on housing sustainability, residential mobility and the negative impact on the housing investment. The burden of property crime also rests on the residents in that it is found to be capable of in- creasing family budget in the quest of searching for alternative security; property crime is capable of causing psychological fear, poor health and sudden death. Next to this is its negative effect on the general economy and the society at large. This is manifested in the increase in public budget as there may be need to procure more police, judges and also the need to build more prisons. Street incivility had also been found to be capable of negatively affecting governance; government revenue may be reduced especially income from property related tax which by extension may affect the general economy. This chapter entails scholarly views on the subject.

2.2 Concept of Property and Property Values

The concept of property has no single or universally accepted definition and various academic disciplines like law, economics, anthropology, and sociology treat the concept more systematically and within or between the different disciplines and fields definitions vary. In common use, property may be regarded as simply one's own thing and it is the relationship between individuals and the objects, which is seen as being the holders' "own" to dispense with as they see fit.

The social scientists conceive property as a bundle of rights and obligations. They stress further that property is not a relationship between people and things but a relationship between people with regard to things, and it is often conceptualized as the rights of ownership defined in law, and may be private or public property - the latter belongs to an individual while the former belongs to a community collectively or a State.

Property rights encourage holders to develop the property, generate wealth, and efficiently allocate resources based on the operation of the market to produce more wealth and better standards of living. Property may be classified into real estate, immovable property, estate in land, real property, tangible and intangible, personal property, interests in land and improvements. Personal property may be tangible such as cars, clothing, animals, and intangible or abstract (e.g. financial instruments such as stocks and bonds), which includes intellectual property (patents, copyrights, trademarks).

Real property in common law systems refers to land or any permanent feature or structure above or below its surface. Immovable property is any immovable object or item of property that cannot be

moved and includes premises and property, houses, land and associated goods and chattels. In common law systems, personal property may be called chattels, and distinguished from real property or real estate, while in civil law systems personal property is called movable property or movables indicating any property that can be moved from one location or another. In distinction with immovable property or immovable, such as land and buildings, property may be classified in variety of ways, such as goods, money, negotiable instruments, securities, and intangible assets.

There is further distinction between personal and private property. Personal property refers to things that an individual has an exclusive right to use but only while they are in use or used regularly. It differs from private property, which refers to things owned by an individual regardless of whether he is using them and has a right to prevent others from using what he does not use or has no intention of using. Real estate or immovable property is a legal term that encompasses land together with anything permanently affixed to it. Real estate (immovable property) is synonymous with real property otherwise called realty, in contrast with personal property (also sometimes called chattel) (Wikipedia, 2007a).

In respect of value, market value is the price at which an asset would trade in a competitive setting, and it is usually interchangeable with fair market value or fair value. The legal definition of market value is the most probable price at which a property would trade in an arms-length transaction in a competitive and open market. In this case, each of the buyer and seller is expected to act prudently and knowledgeably, the price being not affected by any special relationship between them. In distinguishing between market value and price, a price is obtained for

specific property under specific transaction and may or may not represent the property's market value when special considerations such as a family relationship between the buyer and seller are present (Wikipedia, 2007a).

Fair market value and fair value are commonly used as accounting terms while the equivalent appraisal term is market value. Market value is defined as a type of value stated as an opinion that presumes the transfer of a right of ownership or a bundle of such rights at a certain date, under specific conditions set forth in the definition of the term identified by the appraiser as applicable in an appraisal. Implicit in the definition is the consummation of a transaction at a specified date and the passing of title from seller to buyer under conditions whereby buyer and seller are typically motivated, both parties being well informed or well advised and acting in what they consider best with reasonable time allowed for exposure in the open market.

In this study, attention will be on market value of commercial property, which is the amount of money obtainable for an interest at a particular time from persons that are able and willing to purchase it on the basis that value is not intrinsic. The results from estimates made subjectively by able and willing purchasers of the benefit or satisfaction that is derivable from ownership of the interest, which may be for profit making, speculative, pre-cautionary, or prestige motives (N.I.E.S.V.,1985; Johnson, Davis and Shapiro, 2005).

2.3 Accessibility, Complementarity Theory and Property Value

Ingram (1971) played a key role in putting accessibility into operational form when sub-dividing the concept into relative and integral

accessibility. He classified relative accessibility as “the degree to which two places or points on the same surface are connected” and integral accessibility as “the degree of inter-connection with all other points on the same surface”. A number of researchers, (Pirie, 1979; Guy, 1983; Song, 1996; Handy and Niemeier,1997; and Kwan,1998) have carried out reviews on accessibility measures. In the studies, the common standpoint is that pattern of movement in an urban grid is determined by spatial configuration itself, and particularly by distribution of spatial integration in the axial map of the system. According to Hillier (1996), axial map is “the architecture of the urban grid itself that is chiefly responsible for the pattern of movement, not the positioning of ‘attractors’ and ‘magnets’ as has commonly been believed.”

Accessibility evaluates the net economic costs of moving persons and goods between one place and another. It is not only concerned with distance to be travelled between two places but also with the time taken to travel that distance. It does not affect solely the real costs incurred by movement but the real benefits which include the total revenue received by the business or firm influenced by the number of customers purchasing that firm’s goods or services as well as the amount each customer buys (Lean and Goodall, 1977). The theory states that with the underlying conditions of supply remaining fixed the supply of possible sites in an urban area is a function of existing transport network; and given transport system, movement will be concentrated along particular lines so differentiating between sites in terms of accessibility advantages. Sites along main transport route will have relative advantage over sites that are off the route, and sites located at route intersections will possess greater relative advantage. It further states that greatest relative advantage belongs to sites at the focus of urban

transport system and business users will seek the location that maximizes pecuniary profits.

The complementarities aspect states that once a number of sites in a given area has been developed there will be strong bearing on the use to which the remaining sites will be put. If office or any other particular use surrounds a site, this will determine what will be the highest and best use of that site. Departmental stores or offices located next door to each other will stimulate sales because of opportunity for comparison, so leading to interdependence of like uses and the advantage of complementarity. This brings clustering of like and unlike uses, and importantly the urban site is related to the degree of accessibility.

In urban land rent theory, classical theories of residential land rent rely principally on complementarity of land rent and transportation costs. When the influences of accessibility and complementarity are combined, it is possible to illustrate the way in which the pattern of urban land use is determined and the earning capacity of some firms depends upon their ability to be in a particular area. As urban area grows, the position of greatest accessibility and complementarity grows both laterally and vertically. When this happens, high land values appear and as one moves away from the position of greatest accessibility and complementarity land values fall increasingly reflecting the disadvantages of the positions with regard to accessibility and complementarity.

Complementarity brings clustering of like and unlike uses to cluster on adjacent sites but where the site cannot be subdivided to provide a particular user with sufficiently small site that user may combine his

demand with other users and locate on more accessible site than would otherwise be the case. It is possible to illustrate the way in which pattern of urban land use is determined with firms for whom accessibility is critical and who are willing to pay high prices for such sites. Thus, sites next to major roads or nodal points are likely to be more accessible than sites some distance from main roads, and demand for the advantageous sites will cause values to be higher than in the surrounding area (Soot, 1974).

According to Lean and Goodall (1977), factors like accessibility and complementarity increase the usefulness of sites to potential users, thereby increasing the demand, and in economic literature emphasis is placed on the importance of demand in determining the value of developed real property and hence the value of land. Accessibility and complementarity themselves are dependent on combination of capital and land, with land being altered to increase the factors and roads and other means of transport being built and building constructed.

According to Makri and Folkesson (2007), accessibility is a slippery notion and one of those common terms that everyone uses until faced with problem of defining and measuring it. The import of this statement is that accessibility is a daily use amongst people of various backgrounds and inclinations giving way to many definitions. In transportation, accessibility refers to ease of reaching destinations. People in places that are highly accessible would reach many other activities or destinations quickly and people in inaccessible places can reach many fewer places in the same amount of time, so that nearer or less expensive places are weighted more than farther or more expensive places.

Accessibility, in general terms, describes degree to which a system is usable by as many people as possible. It is the degree of ease with which to reach certain locations from other locations and viewed as the ability to access functionality and possible benefit. In transportation, accessibility refers to ease of reaching destinations with people in places that are highly accessible reaching many other activities or destinations quickly, while people in inaccessible places can reach fewer places in the same amount of time (Wikipedia contributors, 2008). Accessibility as a property of location and may be grouped into general and special accessibility. According to Harvey (1999), general accessibility refers to nearness to rail termini, bus stations and motorways transport facilities, labour, customers and service facilities such as banks and post office, and special accessibility exists when complimentary uses are in close proximity to each other. In this case, the net economic cost of movement will be lower in terms of distance, time and convenience in addition to greater comparative advantages given greater accessibility of a location (Balchin et al, 2000).

Handy and Niemeier (1997) identified “place accessibility” which is derived from patterns of land use. Place accessibility implies spatial distribution of potential destinations, magnitude, quality and character of activities found there. It is derived from transportation system in terms of distance, time taken, and cost of reaching each destination by different modes of transport. According to Kwan (1998), measures of place accessibility normally consist of two elements: a transportation (or resistance or impedance) element and an activity (or motivation or attraction or utility) element. The transportation element comprises the travel distance, time, or cost for one or more modes of transport, while

the activity element comprises the amount and location of various activities.

A number of studies have been carried out on the significance of accessibility. Banister and Berechman (2005) stated that possible explanation for small and variable impact of urban rail investment is “ubiquitous” accessibility found in urban areas with little impact on overall accessibility and additional infrastructure where network is already well developed. However, Cervero (1998), and Cervero and Wu (1998) concluded that accessibility increasingly shapes metropolitan location decisions and it is people’s desire for location advantages and real estate developers’ awareness of those desires that give rise to urban form. They state further that under conditions of ubiquitous accessibility, monumental transport improvements have little effect on location (Wegner, 1995:159).

It has generally been agreed in earlier studies (Haig, 1926; Alonso, 1960; McQuaid and Grieg, 2003) that accessibility has important roles to play in the determination of property values but the studies failed to recognize the part played by road network that primarily delivers the accessibility. Few of the studies established the relationship that exists between property value and pattern of road network. These studies on land and property values in relation to accessibility centred mainly on transportation and transportation schemes. They neglected the fact that it is not only movements of people by rail, sea, inland waterways, air, and roads alone that matter but also how patterns and modes of movements affect demand for activity centres and consequently values of properties.

McQuaid and Grieg (2003) opined that little is known about the real links between transport and economic development with policy supported by anecdote, ignoring displacement and expectations of the links rather than firm evidence. The implication is that while there is understanding of the effects of transportation on economic and physical developments such understanding is based on mere theory without empirical or scientific analysis to give firm evidence, especially as it relates to values of commercial properties.

Classical urban location and rent theory by Alonso (1964) states that rents decline outwards from the Central Business District (CBD) to set off the declining revenue generation-capacity and higher costs such as cost of movements. The layout of a metropolis is determined by a principle termed minimization of costs of friction and land uses are able to derive advantage in terms of revenue generation from sites that are most accessible to customers (Haig, 1926). This theory relates distance to rental value. In other words, those land uses that are close to the Central Business Districts tend to generate higher revenue than locations farther away, and implies that lower cost of movements will result in higher land and property values. The theory explains causes of different land values within an urban area and suggests that value depends on economic rent, while rent depends on location, location on convenience, and convenience on nearness. It concluded that value depends on nearness. In a mono-centric urban area, the centre is where transport facilities maximize labour availability, customer flow and proximate linkages that attracts highest values and rents (Kivell, 1993).

The classical Von Thunen’s agriculture land use model states that market forces largely allocate supply of sites among alternative uses

within urban area, and rent differentials are reflected among homogeneous sites. This is explained by rising transport costs and differentiation among sites and arises because quality factors are determinants of economic rent. According to the urban location theory, lower transport costs will result in higher land and property values. Similarly, the Ricardian theory states that rent differentials arise because of differences in use capacity, and urban sites vary in rent and value because of use capacity as well as location. This conclusion is based on theoretical parameters limiting the relationship to an individual piece of transport infrastructure in a mono-centric city ignoring the operations of several transport modes and isolating the impact, that pattern of road network might have on the values of commercial properties.

Muth (1961) and Wingo (1961) based their studies on the Alonso's (1960) model. They found that market equilibrium results in spatial equilibrium and firms or households have no incentive to change location because profits and other objectives are maximized. This results in optimization of output and maximization of city efficiency. The city as a productive unit results in structure of land uses that reflect institutional arrangements including zoning ordinances, network of road and transportation system. The location of firms and households within the structure depends upon competitive bidding for specific sites, with rent differentials resulting in maximum utilization or highest and best use.

Some works by Kivell (1993), McQuaid and Grieg (2003), focused mainly on movements of people, goods and services with reasons proffered for such movements in terms of inter-linkage of various modes of transportation, accessibility in terms of distance, urban rent, highest and best use, friction and their impacts on land use and property values.

Soot (1974) established the impacts and relationships between movements and residential land use and value in United States of America; while Omoogun (2006) noted that accessibility has great impact on property values and properties located at the point where two or more roads meet command greater value than those located off the nodal points or major roads. This assertion, however, lacks empiricism and the conclusion based on intuition, which this study will resolve. In a study of the effects of improvements in transportation on accessibility and land value in San Francisco Bay Area, Wendt (1958) concluded that areas that grew most rapidly in terms of value of land and improvements were those opened up because of transportation improvements. The study concluded that San Francisco showed 1.3 per cent increase in assessed value of land and improvements, Marin County opened up by Golden Gate Bridge experienced 162.4 per cent and with the advent of San Francisco-Oakland Bay Bridge, Contra Costa County witnessed 141.7 per cent increases in assessed land values due to increased accessibility over the same period.

Alonso (1964) argued that individuals not only choose residential locations in order to maximize the sum of rent and transportation costs but maximize the size of the site with rent, accessibility, and size of the site, being three considerations in location decision. Consequent upon this, Goldberg (1970) investigated the relationship between transportation, land values, rents and price elasticity of demand. He tested the hypothesis that general improvement in transportation results in declined economic rents and found that a 10-percent increase in population density leads to 2.3 per cent decline in per capita land values. He went further to state that transportation improvement has effect of bringing new land into an urban area. This is evident in increasing

aggregate land values in a growing urban region with land and property values much more rapidly increasing in the central areas than in any other area as congestion in the area has the effect of shrinking the size of central areas, diminishing competition, and putting great pressure on prices.

Analysis of the effects of metro station on residential property values in Washington, D.C. estimated hedonic price equation in which average property value for each area is the dependent variable. Dummy for the area less than one-quarter mile from the station was amongst the independent variables, the study revealed significant relationship between the opening of metro stations and residential property values in the study area (Grass, 1992). In other words, these studies have set out to express relationship between transportation and physical and economic development as noticeable in the effects on property values.

According to Srour, et al (2001), Wachs and Kumagi (1973), Leake and Huzayyin (1979), and Niemeier (1997) rents paid to purchase land may make great sense as measure of access, which is capitalized into its value with accessibility essentially inferred from the value. Accessibility indices ranged from simple minimum travel-time to measures of cumulative opportunities within specified distance or time thresholds to maximum utility measures. Access to transit confers profound benefits on values of commercial properties and increased number of customers leading to differential firm’s access to business activities that cluster and thereby eliciting significant effects on commercial land markets.

The consequence is property value per unit land becoming a function of both property specific traits and effects of its location

attributes. The property traits consist of building attributes (age, area per floor, elevator, parking, et cetera) and location attributes of main and secondary business centre accessibility and a set of location traits, which consists of local service and transportation access, location prestige, worker amenities and land supply constraints. According to Sivitanidou (1996), centre accessibility is measured as distance to each centre with transportation access measured as distance to the closest major airport and freeway.

In estimating the impact of transit routes on commercial property values, hedonic price model was used with sets of attributes, which include distance to traffic and estimated coefficient on the variable in a study on Washington, D.C. The benefits of transit on commercial property values in the study area was derived with key findings including distance to the closest Metro Station entering the model with negative sign. It found that the shorter the distance between a commercial property and the Metro Station, the higher the value of property, with commercial property value affected by proximity of transit (Hickling L.B. Inc. and KPMG Peat Marwick, 2002). A study was carried out on the city of Milwaukee to determine the relationship between land sale prices and distance to Central Business District (CBD) using regression of distance to shopping centre, traffic level on Main Street, area population, median income, amenities, and area dummies. The findings explained substantial portion of variations in commercial land value and indicate significance of associated coefficients and substantial distance (Downing, 1973).

Many of the studies relate to urban residential areas carried out in many parts of the world. It suffices to state that they reflected social,

cultural, economic and political situations different from the Botswana situation. Their adoption for use in the Botswana situation may not provide perfect explanations but will be useful as guides. This study will therefore contribute to knowledge in this direction and fill the gap found in respect of dearth of empirical research geared towards determination of the impact of road network on values of commercial properties in the study area. The studies were limited to residential property values. This study intends to examine the impact of arterial road network on commercial property values thereby also contributing to knowledge in this regard.

Transportation is the conveyance of goods and people over land, across water, and through the air. It is also the movement of people and goods from one place to another by land (by road, rail, human porterage, motorized and non-motorized vehicles), across water (ship, canoe, boat, etc.) and through the air (helicopter, light and heavy aircraft, etc.). One thing is clear, transportation or transport involves the movement of people, goods and services from origin to destination either by road, air, sea, rail, human porterage, animals, pipeline and even telecommunication or combination of these modes to bring inter-modal essence of final movements of such goods, people or services (Wikipedia contributors, 2008).

The importance of transportation cannot be over-emphasized. Transportation centrally affects the relationship between physical space and society, and changes in transportation affect the organization of human activity in urban and regional space. It structures the built environment, spurs urban growth, as well as orders relationships among cities in a national urban system (Yago, 1983).

In a study on urban transportation issues in both India and North America, Singh (2005) stated that due to increases in population brought about by both natural increase and migration from rural areas and smaller towns, availability of motorized transport, increases in household income, and increases in commercial and industrial activities have added to transport demand. The expected effect on residential and commercial property markets was positive, but the range of impacts vary from marginal to over 100% in the commercial sector from the North American evidence.

In another study on UK, Singh (2005) found that the impact of road transport was positive particularly regarding capital increase in residential property values. However, the study put less emphasis on exact values, and some of the observed increase may be due to optimism of the markets rather than actual effects. Similarly, there is also some evidence that residential property prices might decrease immediately around the transport investment or station. Value increase was determined in the study in a narrow way and mainly through changes in property and land values whereas wider range of measures ought to have been used. The measures should have included changes in accessibility, ownership patterns for land and property, site consolidations, numbers of transactions and yields as well as composite measures such as density of development.

In terms of connection between transportation and supply of land, transportation changes extend the supply of urban land for settlement and urban expansions were promoted through transportation advances in addition to evolution of national urban system. As one mode of transportation reached technological limits in extending urban space

another takes its place (Berry and Garrison, 1958; Isard, 1960; Berry and Horton, 1970; Pred, 1974), and changes in urban physical structure are linked with transportation technology (Richardson, 1972).

According to Dickey (1975); Balchin, Kieve, and Bull (1991); urban road transportation system is one of the important factors responsible for shaping the urban centres, based on the assumption that consumers rationally choose a form of transportation, according to their social and spatial position within the urban market. They opined that the urban road transportation system acts as basic component of urban areas' social, economic and physical structure it plays an essential role in the determination of the scale, nature and form of urban areas.

Urban areas naturally develop at nodal points in the transport network and areas with good transport access to other areas have relative advantage over locations with poorer transport facilities. The locations with relative advantages are found where different transport routes converge and a general improvement of transport facilities will increase the size of population, whose effective demand can be tapped and therefore increase the amount of specialization and exchange that takes place (Lean and Goodall, 1977). In respect of transportation, accessibility and property value, Washington, D.C.'s Metro rail system encouraged more downtown development than would otherwise have occurred with the metro rail converging downtown from all directions; thus, concluding that market for office and other space within a business centre is to build more off-road transit facilities to serve it (Downs, 1992).

Contemporary land market theory established that differential firm's access to business activity clusters elicit significant effects on commercial land market as exemplified in firms valuing main and

secondary centres accessibility in the urban areas (Sivitanidou, 1996). In a study on land value determinants in medium density residential neighbourhoods of metropolitan Botswana, Oduwaye (2004) found that access roads, good drainage, electricity, public water supply and telephone are essential and where facilities are adequately available, land values will be high. He stated that road network is one of the factors that influence property values and established that improvement in transportation facilities especially roads brought about improved accessibility. Using the Spearman's correlation analysis, he found that there was correlation coefficient of 0.177 for transport improvement at 0.01 level of significance. These aforementioned works only showed the relationship between growth in transport development and improvements in accessibility. However, the study did not empirically determine degrees and levels of accessibility and connectivity of each nodal point within the studied network. In addition, it also did not consider the effects of demand, supply and location on commercial property values.

Urbanization requires coordination and geographical concentration of specialized economic activities, with such coordination between urban centres, and concentration of population within regions advanced or retarded by changes in transportation and communication technology. Preliminary concentrations of such population in urban centres are made possible by inter-regional transportation followed by population dispersals as centralized economic activities spill over into broader metropolitan regions through further intra-urban transportation developments (Pred, 1974). Changes in transportation affect organization of human activity in urban and regional space, structuring the built-environment, spurring urban growth, ordering the relationships

amongst cities in a national urban system; as one mode of transportation reached its technological limits in extending urban space and another takes its place (Yago, 1983).

A study on changes in relative values along routes perpendicular to particular streets, through simulation of door-to-door access costs before and after construction of a subway discovered that there was an increase in rent gradient near the subway stations. The study differed from many other studies by modeling price effects around a subway station rather than the distance to the Central Business District (CBD). The higher the price paid for land, the more the capital applied to it, thereby increasing its productivity and intensity of use and consequently its value (Dewees, 1976).

The relationship between accessibility, property values and land use patterns were the pre-occupation of earliest theorists. The theories indicate that travel costs were traded off against rents and accessibility in more complicated phenomena that require treatment that is more sophisticated. Increase in accessibility leads to reduction in relative transport costs of a site directly through transport subsidy or indirectly through public transport investment and its manifestation. This was proved in increased demand that triggered land and property values, intensity of land use, and values with substantial changes (Henneberry, 1998).

In correlating location values of shops with accessibility index, however, Wyatt (1999) used expert system heuristics to select comparable properties from a database with questions asked about the subject property. He adjusted the values of the comparables to account for differences between them and the subject property, and similarly for

values of comparables to account for physical differences. The result was displayed on Value Maps after the values have been reconciled for differences except those attributable to location. It was concluded that configuration of route network and impedance for traversal along the routes affect accessibility and locational value using network model with implication for transport planning and its effects on property values.

According to Kivell (1993), in a mono-centric urban area, the centre that attracts highest values and rents is where transport facilities maximize labour availability, customer flow and proximate linkages, while rent is the charge that owner of a relatively accessible site can impose because of saving in transport costs which the use of the land makes possible. The better the transport network the less the friction and the higher will be the rent, which is the payment to overcome the friction of space.

One of the fundamental relationships in the study of transportation and its linkage with land use (Meyer and Miller, 1984). Land use generates traffic carried by transport and land use-transportation system exists in socio-economic environment while change in road network stimulates change in land use. This leads to altering of flows on roads and consequently land values. Land use-transportation model attempts to relate the different levels of accessibility provided by the transport system to changes in land use in terms of population and employment growth and consequence the multiplier effects in the value of the land use (McLoughlin, 1973).

Urban road transportation system consists of socio-economic environment with close relationship to land use and land value. The provision of transportation and development of land have taken many

forms with research ranging from site-specific studies of impact of a transportation facility on property values to regional studies of the impact of changes in transportation accessibility on density of land development (Meyer and Miller, 1984; Sexana,1989).

Dunse, Brown, and Fraser (2002) studied Fort Worth/Dallas and tested the effects on property value of physical characteristics, national market conditions, local market conditions, interest rates and location variables. Four measures were tested which are distance to CBD, distance to airport, distance to nearest major road, and access to rail network. The major findings indicate that local market conditions, physical characteristics and location of the property are primary sources of value or industrial property. However, the location variable and distance to the CBD were not significant. The study left confusion on the role of location, partly because of the variation in the definition of location variables and partly because of the study area as definitions were not clearly set within the core of a traditional mono-centric city.

In addition to the aforementioned studies, Colwell and Munneke (1997) examined the spatial pattern of vacant industrial land prices in Chicago. He found that prices have negative concave relationship with distance from the CBD, and that the airport had a significant positive effect but only within three miles radius with price varying in relation to spatial sectors of the city. Grimley et al (2004) in a study commissioned by the Scottish Executive aimed at developing a methodology by which land value uplift can be captured around improved transportation facilities. The key factors considered in the study included treatment of time in five yearly gaps in assessing land value change, accessibility changes, and distance from the station interchange with catchments

areas between 800 and 1000 metres, shorter for businesses and commercial activities and longer for residential activities. The outcome was the development of T-IMPROVE (Transport-Investment and Measurement of Property Value Enhancement) methodology based upon a three- stage process.

The T-IMPROVE method was designed to quantify scale of change in land value arising out of a transport investment at local level using individual property and land value transaction data. The purpose was to understand complexity of linkages between transport investment and property markets so that the transport related factors could be isolated from all other factors (e.g. economic and housing cycles, inward investment, local economic factors etc.). However, detailed application of T- IMPROVE method to one transport scheme does not prove the linkage, as value uplifts occurred in other schemes in different locations, types and scales, as well as in form.

Wacher, Thompson and Gillen (2001) used geographical data to improve valuation outcomes in reviewing major contemporary issues in real estate valuation. They argued that spatial nature of real estate data allows the development of specialized models that increase the likelihood for better predictions in real estate valuation. Similarly, Du (2007) used Geographically Weighted Regression (GWR) model that addresses issue of spatial effects in studying the relationship between transport accessibility and increases in land value in Tyne and Wear. The study embodied spatial coordinates with set of local estimates into regression model using weighted least squares process that link weights to distance of observation and location of the regression point and found relationship between transport accessibility and land value varies over

space. The study carried out for Dallas-Fort Worth region of Texas on property valuations for single-family dwelling and commercial units considered the relationship between residential land prices and location choices with general accessibility indices adopted. The study also considered household residential location choices using combination of Hedonic models to assess the importance of access on property valuations controlling for improvement attributes and size of land parcel. It found that relationship between transport accessibility and land value varies over space (Du, 2007).

Srour, Kockelman, and Dunn (2001) used the multinomial logit model to derive log-sum measures of accessibility and impact of access on location choices in Texas, USA. The study controlled for household demographics using three specifications of access measures of job accessibility (a proxy for work and other opportunities), access to park space (a proxy for availability of outdoor recreational activities), and access to retail jobs (a proxy for shopping opportunities). It found that job accessibility positively impacts residential land values in statistically and economically significant ways.

Pickett and Perrett (1984) in a study on the effect of Tyne and Wear Metro concluded that existing urban areas showed remarkable increase in land value when new routes are opened and area that is already served by rail routes showed only small increase in land value when another route is added. The study found that new routes shift values rather than increasing aggregate land value and new routes actually increase land value in the centre at the expense of periphery. In respect of properties in districts through which a rail line passed with the objective of determining whether improved accessibility due to public

transport investment in the area had effect on residential property values. The study found an average of about two percent increase in values of properties located near the Metro stations.

Following the opening of Victoria Line in London in 1969 a study was carried out to determine the effects of the Line on property values. It was estimated that values in the catchments area of the Line increased between one and five percent compared to properties outside the catchment area relative to general price increases of over ten percent per annum during the study period. Another study on impact of Lindenwold High Speed Line on residential property values in Philadelphia equally confirmed that there was positive impact of the line on values of residential properties using sales data obtained for the corridor through which the line passed (Allen and Boyce, 1974).

The overall implication of these studies is that accessibility to a mode of transport directly affects values of residential properties. The T-IMPROVE method although provides important empirical assessment has not proved to be a predictive tool. Apart from this, the earlier studies have focused on impact that single rapid transit system has on residential property values. Many of them focused on studies carried out overseas while few studies were carried out on the impact of road network on commercial property values in Botswana. Even the few studies carried out in Botswana (for example, Omoogun 2006; Olayiwola, Adeleye, and Oduwaye, 2005) do not provide in-depth analysis on road transport network, location attributes, demand and supply and impact on commercial property values, rather they made sparse references to availability of transport and accessibility as determinants. This study will therefore fill this gap by relating the impact

of arterial road network in the presence of location attribute, accessibility, demand for and supply of commercial properties to commercial property values in Francistown, Botswana. It will also bring out a model that would be useful in predicting the commercial property values in the study area.

2.4 Patterns of Road Network and Property Values

Pattern refers to the characteristics and properties found in repeated and regular manner within one object, or between a number of objects with such repetition in the form of shape, density, distribution, linkages, connection or orientation. These occur among the same kind of objects or different kinds of objects or within an object, or between objects that are repeated with sufficient regularity. Such repeated properties may be shape, orientation, connectedness, density or distribution and the frequency of such patterns enables development of prototypical views of geographical processes (Mackaness and Edwards, 2002).

Zacks and Tversky (2001) examined the idea of events as objects and argued that patterns themselves are objects bounded in space, organized hierarchically and recognizable by a set of distinctive qualities. The qualities can be emphasized through process of abstraction and symbolization, viewing patterns as complexes of primitive objects and relationship between the primitives giving shape, extent, orientation, density, topology and configuration (which refers to collection of objects that comprise the pattern) as their intrinsic properties. Topology, according to Xie and Levinson (2006), is extrinsic relations, referring to the properties between different patterns, and topology is an

arrangement and connectivity of nodes and links of measuring the spatial structure of road networks. In analyzing the road network, it partitioned into different parts before roads inside each part is extracted and its density calculated using indirectly related parameter. This is a network density indicator, which is the number of connections to describe the density differences in road networks. The parameter records how many roads connect to each road in a network. For two roads with the same length, the one in dense area will connect to more roads than that in sparse area, and the connection differences will indicate the density differences to some extent; this is by number of connections to show the differences in density among a network (Zhang, 2004). Similarly, Inforain online (2008) states that the road density may be determined by dividing the total length of all known roads by the total land area in a road network.

Spatial network is a network of spatial elements, which in physical space includes urban or building space derived from maps of open space within the urban context or building. Space map is usually broken into units of road segments and likened to the negative image of standard map with open space cut out of the background buildings or walls. The road segment is called nodes of the graph that are connected into a network through their intersections known as edges of a graph. Connectivity is a fundamental concept widely utilized in spatial ecology and has long been recognized as fundamental factor determining species distributions (Moilanen and Nieminen, 2002; Doak et al, 1992; Taylor et al, 1993; Lindenmayer and Possingham, 1996; Schumaker, 1996; With et al. 1999; and Tischendorf and Fahrig, 2000). It measures are widely used in spatial ecology with further applications in transportation and other disciplines (Moilanen and Hanski, 2001).

In explaining patterns of property values, Lean and Goodall (1977) opined that the centre of an urban area is the position of greatest accessibility where transport routes and systems converge. Competition between firms whose revenue is high when in such a position will force up rents and land values above those in the remainder of the urban area. Firms will compete to locate in the centre to take advantage of complementarity, which to large extent, is a function of accessibility. The larger the urban area the more distinct will the clusters of complementary uses become, for instance, the office centre will separate from the shopping centre. Similarly, the higher the degree of accessibility and complementarity, the larger the urban area and the higher the land values in the centre are likely to be. As accessibility decreases from the centre it is expected that the value of commercial property will decrease, that is, where main and secondary roads are placed will be major determinant in the location of the commercial uses.

Commercial uses can normally attract land away from industrial uses, so that the general pattern will be the highest land values for commercial uses, the next highest for industrial uses, and the lowest for residential accommodation. Complementarity or incompatibility of properties may be an important factor that determines land values in parts of an urban area. If land in a given part of a town is put into complementary uses, this will likely enhance the land values whereas if they are incompatible with each other it may lower the land values. Developments in transport routes or systems may lead to changes in land values in an urban area. By such developments, some land values may rise as accessibility increases while others may fall as incompatible uses move nearby causing general pattern of land uses and values in the urban areas.

2.5 Road Network Classification and Analytical Measures

Road classification and hierarchy are dominant considerations in design of road network and road hierarchy is a particular form of road classification in which each type has a ranked position with respect to whole set of types (Marshall, 2005). Road hierarchy has to do with the functional efficiency of traffic flow, safety, amenity and environmental quality of urban areas and road may be classified according to form by which a route might change along its length each time there was a change in some physical property.

Classification may also be founded on some criterion such as “trip length”, population size, traffic flow, and those based on changes in the road network itself. Those criterions based on changes in road network are most stable over time than other types of road classification. They are classified by network function and changes when the network changes. In this case, the classification of various sections of road refers to its relationship with the rest of the network, and the choice of strategic routes will be informed by factors, which show all strategic routes connecting in a particular way based on specific structural property known as “arteriality”.

Arteriality is a form of strategic contiguity whereby all “top tier” elements join up contiguously and it implies that each route connects to either a route of the same status or higher. The route network pattern is analyzed using variety of techniques, which include urban morphology (Cozen, 1969; Whitehand, 1981; Moudon, 1997), fractal analysis (Batty and Longley, 1994), cellular automata (Batty, 1997), traffic pattern

analyses (Vaughan, 1987; Taylor, 2000), and graph theoretic approach (Muraco, 1972).

The graph theory is a branch of combinational topology and versatile language that allows basic structure of transportation networks to be disentangled (Lowe and Moryada, 1975). A graph is a set of discrete points joined by lines respectively referred to as vertices and edges, and in a graph, it is the topological arrangement between elements that is important rather than the absolute geometry or scale of the elements represented (Marshall, 2005). Typology is an arrangement and connectivity of nodes and links of a network long-standing interest in measuring spatial structure of road networks driven by inherent impact of network structure on performance of transportation systems with subsequent effects on land use and urban form (Xie and Levinson, 2006).

Some earlier works (Garrison and Marble, 1960; Kansky, 1963; Harggett and Chorley, 1969) exclusively focused on topologic measures adopting graph-theoretic network analysis but were constrained by limited data, computational power, and modeling techniques. Subsequent work (Vaughan, 1987) explored the effects of various geometric network structures on traffic flows and travel pattern and with widespread availability of travel demand models.

There are two kinds of analysis that are based on graph theory; these are conventional transport network analysis and syntax - a method of analyzing urban spatial structure (Thompson, 1948: 989; Berge, 1958; Hagget and Chorley, 1969; March and Steadman, 1971; Kruger, 1979; Hillier and Hanson, 1984 and Broadbent, 1988). In transport network analysis, when a transport network is represented conventionally as a

graph, the links in the network becomes edges in the graph and the nodes (junctions) are vertices. It is therefore possible to use various graph- theoretic indicators to analyze network structure and capture properties such as connectivity. In general, graph theoretic analysis uses vertices to represent the primary elements, and edges to represent the primary elements, and edges to represent the relationships between those elements. In the case of transport network, the primary elements could be the nodes which are joined by lines of movement, joining at nodes (junctions) and both are represented by a graph in which the nodal points are vertices and line of movements are edges.

According to Muraco (1972), accessibility is associated with geographic notion of situation and relating to the elements of spatial relationships, interaction, and connectivity. Accessibility index in the study was derived through three analytical phases, which included the use of finite graph theory to define the geometric structure of the study network. In analyzing the graph, the edges were defined by major thoroughfares intersecting to provide vertices. In dealing with the intra-urban road network, not all roadways may be included but major thoroughfares that reflect relevant linkages of the transport network. This involves an analysis of the incidence structure for the networks to provide initial set of accessibility measures and binary connectivity matrix prepared from where Shimbel index showing measure of nodal accessibility. The element of Shimbel distance matrix indicates the linkages to other nodes in the system, and nodes that are characterized by large number of linkages to other nodes may be assumed to be most connected than those having only few linkages. Similarly, in measuring accessibility the number of links in the shortest path from a particular

node to its remote node is determined; the lower the associated number of a node the higher the accessibility level of that node to the system.

An alternative method of configuration analysis is the space syntax. Space syntax recognizes that the ‘link’ elements in a layout may have significant spatial presence. In urban structure, land use zones and roads may be represented separately as nodes and links but in traditional urban street network streets are significant spatial entities. They used axial lines and convex spaces as the spatial elements. The axial line is the longest line of sight and access through open space, and a convex space is the maximal convex polygon that can be drawn in open space. Each of these elements is defined by geometry of the local boundary in different regions of the space map, the translation of such map into a complete set of intersecting axial lines or overlapping convex spaces produces the axial map or overlapping convex map respectively. The resultant axial map thus allows a network amenable to graph mathematics to be carried out in a well-defined manner and makes possible the analysis of the urban networks. The basic method of analysis boils down to identifying axial lines (which have some correspondence to lines of movement, or physical routes) and transforming the lines into the vertices of a graph while the axial intersections become the edges. This transformation creates a graph structure underlying the network structure. The resulting graph may be analyzed using the conventional graph-theoretic measures (Marshall, 2005).

In addition to concepts of connectivity, space syntax makes use of concept of depth, which is a measure of network ‘distance’ – steps of adjacency – between network components. The depth of any axial line may be more related to continuity of roads and paths as routes, than on

their inter-visibility across space. This, according to Batty (1999), has opened up the question of what might be the most appropriate elemental units for representing the “active ingredients” of movement structure.

A transport network can be considered as a topologic graph with three parameters from which quantitative measurements may be computed as a basis for objective description, comparison and evaluation of the network. The parameters include a number of separate non-connecting sub-graphs in the network represented by G, the number of links (or edges) in the network (E) and the number of nodes (or vertices) in the network (V). A number of topological approaches of road network structure measure the connectivity of a road network. There are four of such measures, namely, Beta Index, Chromatic Number, Alpha Index, and Gamma Index. They are defined on the basis of three parameters of network topology, that is, the number of edges (road segments) (e), the number of vertices (nodes) (v), including road intersections, travel origins and destinations, and the number of maximally connected components (g) (Cole and King, 1968; Hay, 1973; Hodder and Lee, 1982; Rallis, 1988).

Connectivity has been long been recognized as fundamental factor determining species distributions (Doak et al. 1992, Taylor et al. 1993, Lindenmayer and Possingham 1996, Schumaker 1996, With et al. 1999, Tischendorf and Fahrig, 2000). Its measures are widely used in spatial ecology and different disciplines may use them in slightly different contexts (Moilanen and Hanski 2001). The connection and arrangement of a road network is usually abstracted in network analysis as a directed planar graph G = {V, E}, where V is a collection of nodes (vertices) connected by directional links (edges) E (links are directional when a link from node R to S is distinct from a link from S to R). A planar network

may be unconnected but consists of connected pieces called “maximally connected components” or “connected components”. Given a network G = {V, E}, its sub-graph S = {V^1, E^1} is a maximally connected component if all vertices (V^1} of S are connected by edges in {E^1}, and no vertex can be added to S so that S will still be connected. The total number of connected components g in a network can be counted using graph algorithms.

The Beta Index is a measure of connectivity in terms of the average number of links per node within the network; and the value of this index ranges from zero (0) to three (3). A value of 0 shows that no network exists and higher values result from increasingly complex networks. The beta index is obtained using the formula:

 = E V

where,

 = Beta Index;

…Eqn.3.1

E = number of edges; and,

V = vertex

The Chromatic Number (CN) indicates the number of circuits within a network, and where there is no complete loop, CN will be equal to zero (0) and where the result is one (1) it indicates one (1) loop, up to any number that thus corresponds to the number of loops using the formula:

CN = E – V + G. …Eqn. 3.2

The Alpha Index (□) measures the ratio between observed number of circuits (the chromatic number) and the maximum number of circuits that may exist in the network. It ranges from zero (0) with no circuits to one (1) when the actual number of circuits is equal to the maximum number, and so the index is expressed as a percentage thus:

$$\text{Alpha Index } (\square) = \frac{(E - V + G) \times 100}{(2V - 5G)} \quad \ldots \text{Eqn.3.3}$$

The Gamma Index (□) measures the ratio of the observed number of links and the maximum number of links in any network. This ranges from zero (0) indicating no links to one (1) indicating that every node in the network has a link connecting it to every other node, and it is expressed as a percentage.

$$\text{Gamma Index } (\square) = \frac{E \times 100}{3(V - 2G)} \quad \ldots \text{Eqn.3.4}$$

These indices are concerned with network analysis that yields valuable measures of accessibility of individual nodes. Such measure is derived from the Connectivity Matrix, which represents the arrangement of links between the nodes of a network in a matrix form. In the matrix, a figure of one (1) indicates that there is one inter-nodal link while zero (0) indicates that there is no link. The distance between pairs of nodes is expressed as the number of intervening links along the shortest path that connects them. The total of the figures in the row for each node is a measure of its accessibility in terms of the measure of the total size of the network and total number of links. This measure known as dispersion value of the graph and average length of path in the network

is obtained by dividing the row sum by the total number of positive values in the row (Hay, 1973).

Marshall (2005) states that route structure analysis is built on three basic route-properties, namely, continuity, connectivity and depth. Continuity is the number of links that a route is made up of or the length of a route measured in links, and reflects number of junctions a route is continuous through. Connectivity refers to the number of routes with which a given routes connects, and reflects both the number and nordality of joints along a route. Depth measures how distant a route is from a particular “datum” measured in number of steps of adjacency, the more steps distant a route is from the datum, the “deeper” it is and the fewer steps distant the “shallower”. The route analysis is considered in terms of relative continuity, connectivity and depth, this is referred to as connectivity analysis. Continuity and depth are to do with connectivity: continuity relates to internal connecting up of links that form each route while depth relates to relative connective position of a route in the network.

Different accessibility measures often show different approaches to accessibility. Pirie (1979) and Kwan (1998) focused on individual accessibility, while many others (Geertman and Ritsema van Eck, 1995; Song, 1996; Handy and Niemeier, 1997) more or less focused on place accessibility. Handy and Niemeier (1997) claimed that the best approach to measuring accessibility does not exist and that different situations and purposes demand different approaches. They identified four inter-related issues to be resolved, namely the degree and type of disaggregation, definition of origins and destinations, measurement of travel impedance and measurement of attractiveness. Three types of disaggregation were identified namely spatial, socio-economic, and purpose of the trip or the

type of opportunity. Spatial disaggregation is the grouping of individuals and households by zones, the smaller the zone the greater the disaggregation.

Kwan (1998), however, argued that spatial disaggregation fails in solving two problems. The first is the effect of multi-purpose trips and the second is that the significance of spatio-temporal constraints tends to be ignored by integral measures irrespective of spatial disaggregation. Differences in socio-economic characteristics were considered by disaggregation of different segments of population, for example, by income, driving licence holders, gender and age. Disaggregation by the purpose of the trip or the type of opportunity distinguish, for example, between work and non- work opportunities or select one single type of opportunity such as shopping establishments.

According to Handy and Niemeier (1997) and Kwan (1998), most measures focus on home-based indicators excluding multi-purpose trips and trip chaining with the issue of origin and destination inter-related with the degree and type of disaggregation. The set of destinations depend on assumptions of potential destinations perceived by residents as available to them and the residents' need of opportunities. They claimed that the choice set for different socio-economic groups would reflect the actual choices available to each group, measured by existence of particular opportunity and estimated as the number of opportunities with consideration for the opportunities' physical or economic size. Factors such as quality and price of products and services would be incorporated into a measure of attractiveness, which are highly subjective and made difficult to specify and calibrate the accessibility measure.

Ingram (1971) and Handy and Niemeier (1997) pointed out that place accessibility is derived from patterns of land use, that is, the spatial distribution of potential destinations and the magnitude, quality and character of activities found there. It is derived from the transportation system, namely the distance, the time taken and the cost of reaching each destination by different modes of transport. Measures of place accessibility consist of two elements: a transportation (or resistance or impedance) element and an activity (or motivation or attraction or utility) element. The transportation element comprises the travel distance, time, or cost for one or more modes of transport, while the activity element comprises the amount and location of various activities (Handy and Niemeier, 1997; Kwan, 1998).

Place accessibility may be operationalized in several ways depending on the issue at hand, the area of the application, and means and limitations concerning resources and feasible data. This is by integral measures comprising cumulative- opportunity measures, gravity-type measures, and utility-based measures. Irrespective of what kind of integral measure chosen, the measure is calibrated to reflect how individuals and households perceive the travel and destination choices available to them. Distance approach is the simplest accessibility measure involving counting the distance from one location to different opportunities and measured as average distance, weighted area distance or distance to the closest opportunity. The estimation of these distances is performed in several ways, from simple straight-line distances to more complicated impedance formulations (Ingram, 1971; Handy and Niemeier, 1997). The simple straight-line distance approach involves counting of distance from one location, for instance, the central business district, to a given destination, and the closer the destination to

the CBD the higher the accessibility (Song, 1996). This assumption is either that all opportunities are located in the destination area or that the residents only value accessibility to opportunities.

Measuring accessibility by average distance estimates either the average distance to one destination from all departure points in the area, or the opposite, the average distance to all destinations from one departure point or zone. The attraction of the destinations is not included in this measure. Weighted average distance makes up for this drawback by including the attractiveness of the destination while application that is somewhat more comprehensive is the “shortest distance” measure. The shortest distance is determined by household mean-expenditure and the mean for weighted distances divided by total expenditure on goods and services (Guy, 1983).

Another approach is the gravity-based measures, which is derived from denominator of the gravity model for trip distribution (Geertman and Ritsema, 1995). The gravity-based measures are based on law of physics and arguments from statistical theory used to support an exponential form of the model. The measures are obtained by weighting opportunities in an area and such measure indicates their attraction and discounting them by an impedance measure (Geertman and van Eck, 1995; Handy and Niemeier, 1997; Kwan, 1998).

The graph theoretic approach was used in this study to define road network on basis of weighted and non-weighted, static and geometric criteria. The theory is applicable to the research for its simplicity yet analytical features that enable conversion of qualitative data to quantitative measures. The approach was not adequately considered by

previous measures of accessibility and its adoption in this study will therefore be a great contribution to knowledge.

2.6 Models of Road Classification and Hierarchy

According to Lawal (2000), most transport systems are hierarchical, they are purposely designed to suit specified requirements. The principal functional categories are local, intra-city, intra-regional, inter-regional, inter-continental, and intra- continental. Roads may be classified into those constructed as highway primarily for purpose of acting as traffic routes, and those laid out by developers primarily to give access to building plots. Road may be classified based on function and from traffic point of view, by three generic types of roads which are arterial, sub-arterial and local. In arterial and sub-arterial types, the interests of traffic are regarded as absolute while traffic consideration is entirely subordination to needs of frontages, local population and pedestrian in the local category, which is also known as minor. The classification and nomenclature of road according to functions are arterial road, through road, and local through. Arterial roads serve the whole region of a country and linking up the main centres of population with the various regions through road carries traffic with origin outside the town and its destination inside the town or vice versa while local through carries traffic with origin in one part of town and its destination in another part. Roads consist of a number of structural components some of which constitute carriageway, footpath, haunch, channel, kerb, width, quality, length, and density. A street is a road that has urban characteristics or as urban place, serving as a right of way and having variety of official designations and other possible bases for distinction

(Marshall, 2005), while ICE (1996) opines that any particular street will tend to have “multiple personalities”, consisting variety of different characteristics that are present simultaneously.

The Florida DOT Quality/Level of Service Handbook classifies roads into three functional classification as Arterials – connecting major areas, long trips (50- 100 miles), high speed (60-70 mph); Collectors – characterized by intermediate trips (5-15 miles), high speed (50 mph); Locals – with local access, short trips (less than 5 miles, lower speeds (30-45). All of the trips are by auto or truck and not pedestrians in the critical functional definition and measure of the Level of Service. According to Wikipedia contributors (2008), Level of Service (LOS) is a classification system, which uses the letters A, B, C, D, E, and F to describe the quality of the mobility that transportation system provides for automobile traffic, pedestrians, bicyclists, and transit. LOS A represents the highest level of mobility, while LOS F represents the worst. LOS is closely related to the concept of capacity, which measures the quantity of traffic moving across a given point.

Urban road network consists of arterial and collector roads classified according to their levels of service. Transportation level of service system is used to classify the arterial roads, using letters A to F in the classification. Letter A represents the best and F the worst. Level of service A describes the conditions where traffic flows at or above the posted speed limit and all motorists have complete mobility between lanes. Level A occurs late at night in urban area, frequently in rural areas. B represents a slightly more congested road some with impingement of manoeuvrability, and motorists are forced to drive side-by-side, limiting lane changes. Level of service C has more congestion than B, and ability to pass or change lanes is not certain, the roads are

efficiently close to capacity and posted speed maintained. Level of service D represents a busy shopping corridor in the middle of a weekday, or functional urban highway during commuting hours, speeds are reduced, and it is sometimes the goal for peak hours. Level of service E is marginal service state with traffic flow being irregular and at rapidly varying speed, which rarely reaches posted limit. Level of service F is the lowest measurement of efficiency for a road's performance. Traffic flow is forced, vehicles move in lockstep with the vehicle in front, and with speed dropping to nearly zero km/h (Mannering, et al 2004).

The Level of Service concept propounds that for arterial streets and vehicular level of service, areas of interest are divided into two categories, namely, intersections and street segments. For intersections, the quality and level of service control the overall quality and level of service for the broader arterial street. The intersections, particularly those signalized, are the points of greatest conflict and greatest safety risk for all modes of travel. The intersection quality and level of service is expressed for delay experienced at the intersection. It is important to recognize that most traditional evaluation methods are auto-oriented and do not account for the relationship between automobiles and other modes of travel. Street segments on the other hand are the sections of the arterial street between the intersections.

The quality and level of service for street segments is expressed by the average speed by which vehicles can travel along the particular segment of the arterial street, although the efficiency (or lack thereof) of the intersections will control the capacity and level of service of the arterial as a whole. As with intersections, street segment evaluation methods focus on vehicular level of service, which is a concept by which transportation planners and traffic engineers determine the quality of

transportation devices or infrastructure. Whilst the motorist is interested in speed of his journey, level of service is a holistic approach that considers several other factors including traffic density and is therefore regarded as measure of traffic density (or a measure of congestion) but closely linked to transportation time (the shorter, the better).

By the concept, transportation level of service system uses the letters A through F, with a being best and F being worst. Level of Service A is the best, described as conditions where traffic flows at or above the posted speed limit and all motorists have complete mobility between lanes. Level of Service A occurs late at night in urban areas, frequently in rural areas, and generally in car advertisements. B is slightly more congested, with some impingement of manoeuvrability; two motorists might be forced to drive side-by-side, limiting lane changes. Level of service B does not reduce speed from Level of Service A.

Level of Service C has more congestion than B, where ability to pass or change lanes is not always assured. Level of Service C is the target for urban highways in many places. At Level of Service C most experienced drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Level of service D is perhaps the level of service of a busy shopping corridor in the middle of a weekday, or functional urban highway during commuting hours: speeds are somewhat reduced and motorists hemmed in by other cars and trucks.

In busier urban areas, this level of service is sometimes the goal for peak hours, as attaining Level of service C would require a prohibitive cost in bypass roads and lane additions. Level of service E is a marginal service state. Flow becomes irregular, speed varies rapidly,

but rarely reaches the posted limit, and it is consistent with road over its designed capacity on highways. Level of service F is the lowest measurement of efficiency for a road's performance. Flow is forced and every vehicle moves in lockstep with vehicle in front of it, experiencing frequent drops in speed to nearly zero mph.

Technically, a road in a constant traffic jam would be below Level of service F. This is because level of service does not describe an instant state, but rather an average or typical service. For example, a highway might operate at LOS D for the AM peak hour, but have traffic consistent with LOS C some days, LOS E or F others, and come to a halt once every few weeks. However, LOS F describes a road for which the travel time is unpredictable. The Highway Capacity Manual and AASHTO - Geometric Design of Highways and Streets ("Green Book") list the following levels of service: A = free flow; B = reasonably free flow; C = stable flow; D = approaching unstable flow; E = unstable flow; F = forced or breakdown flow. The level of service characterizes the operating conditions on the facility in terms of traffic performance measures related to speed and travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience."

Road hierarchy includes freeways and expressways, arterial or primary distributors, collectors or local distributors, local access, and cul-de-sac. Each of the road hierarchy has different carriage-way: freeways and expressways have 20m of carriage-way; arterial or primary distributors have 15m; collectors or local distributors have 10m; local access, 6m; and cul-de-sac having 6m.

Road classification has become a dominant consideration in the design of any road network, urban or inter-urban, and road hierarchy is a

particular form of classification of roads in which each type has a ranked position with respect to the whole set of types. The conventional road hierarchy is to do with functional efficiency of traffic flow, safety, amenity and quality also taking into consideration non-traffic considerations in the urban context. Such classification is arterial route, which is a constitutionally defined type of route, forming the upper tier in an arterial network such that the set of arterials forms complete contiguous network that takes different forms, like arterial roads. In this context, arteriality is the manifestation of strategic contiguity in networks, in which each route is connected to another route of the same tier or higher tier forming a single contiguous system (Marshall, 2005).

The overall conventional classification or hierarchy was based on network topology having contiguous network of strategic routes, which depends on route characteristics (Morrison, 1966: 21; and Marshall, 2005); while road pattern type is set apart by complexities of shape, width, traffic flow, connectivity, density and structure from other objects of transport analysis. Road width is a linear quantity and traffic flow a simple ratio (vehicles per hour), and the issue of density boiling down to straightforward ratio and there is no standard or straightforward descriptor used to capture street pattern. Some descriptors refer to the configuration of streets, others to the shape of the interstices, and the alignment of the routes (Marshall, 2005).

The patterns of road network are so many in terms of complexity, connectivity, and characteristic structure. The variety of networks may not be a statistically representative sample of urban networks in general but some of the traditional, inner urban layout, which is rich in route diversity and structural complexity, are found to be significant to network analysis. In addition, Marshall (2005) in a study of thirty-six cities and

towns across the world identified road network pattern with the aim of compiling representative samples of urban patterns and demonstrating that any diverse kind of pattern is capable of analysis and interpretation. He developed series of qualitative descriptors that culminated in systematic classification and identification of fifty-six road network patterns. The traditional type is characterized by mixtures of regularity and irregularity, streets typically of consistent width, curved or rectilinear formations mostly meeting at right angles; frontage of buildings are built with setback in space astride arterial routes.

2.7 Determinants of Property Values

Plethora of studies focused on impacts of transport and transport routes on developments. For instance, in Central London, Canary Wharf Group Plc commissioned a study to analyze the core area cross-rail route running from east to west through central London with the sole aim of understanding the property market effects of major infrastructure projects. The study gauged the extent to which value enhancements were captured and contributions secured towards infrastructure funding. The study anticipated that about 10.87 million square metres of additional commercial floor space would be realized by 2025 with little over 5 million generated by redevelopment. It found that a levy of two pence in the pound for commercial occupation would result in value capture of approximately £1.4 million per annum by 2010 (Parker, 2002). The study did not however provide quantified assessment of property value impact of Cross-rail but used a priori assumptions of value uplift with the value surface derived to fund transport improvements.

Banister and Berechman (2005) reviewed the impacts of high-speed rail and minimal impacts of developments at existing stations and found that new stations at peripheral sites had substantial local impacts. Impacts were found at network level relating to substantial increase in accessibility to key national and international markets with local level relating to presence of buoyant local economy taking advantage of new opportunities of accessibility. On the other hand, the study had modest impact in localized and uneven pattern, thus confirming that development impacts were not uniform and occurs only where other economic conditions favour development.

According to Hall, Marshall, and Lowe (2001), there are evidences that challenge conventional assumption of “land-use/transport feedback cycle” with conclusion that conventional assumption may not work for peri-urban or ex-urban cases where accessibility is scarce and brute mechanics of distance and transport cost are less important. They stated that the assumption might work for big congested traditional cities and settlements where transport infrastructure is generally lacking and in “advanced” transport network contexts where there are “bottlenecks”.

Some earlier studies (Weinstein and Clower, 1999; Nelson, 1999; Hack, 2002; Fejerang et al, 1994; Hillier-Parker, 2002; Chesterton, 2002; Cervero, 1994; Sedway Group, 1999; Cervero and Duncan, 2002; Weinstein and Clower, 1999; Diaz, 1999; and, A.P.T.A., 2002) concluded that properties near rail stations, metro line and roads gain slightly higher value compared with properties farther away. They remarked further that such impacts were greater where transport infrastructure was poor.

Other studies such as Pharoah (2002) found that sites close to stations were more attractive to commercial and mixed-use developments and those farther from stations are more attractive for residential developments with sites close to station sought for commercial developments. However, some studies (Landis, et al, 1995; Damm, et al 1980; Bollinger et al, 1998; Dabinett, 1998) showed that the impact of nearness to mode of transport on property values returned negative, negligible or no impact.

However, in the earlier studies, accessibility is determined relative to location distance of land uses. Some of the studies focused on mono-centric cities whereas different locations have varied degree of accessibility in multi-centric cities. The studies revealed that expected effect on both residential and commercial property markets is positive but the range of impacts vary from marginal to over hundred percent in the commercial sector in North American evidence. In the UK, the impact is positive particularly regarding the capital uplift in residential property values with no indication of impacts on exact values, and some of the observed uplift may be due to optimism of the markets rather than actual effects. The studies adopted different methodologies thereby making comparison of the results very difficult with no common basis upon which comparisons could be made. Thus, the need for greater depth of investigation to look at data, definitions, methods and actual cases to unravel what effects can be attributed to the transport investment.

According to Thabo (2003), a number of factors affect property values in Botswana. These include population change, change in fashion and taste, institutional factors (culture, religious belief, and

legislation), economic factors, location, complementary uses, transportation and planning control. He stated further that good spread of road network has tendency to increase accessibility with certain areas becoming less accessible as a result of traffic congestion thereby causing value to shift to areas that are accessible. Stratton (2008) conducted a study of the spatial concentration of office uses and how their combination with other land uses affects value of office properties; this was to determine the relationship between spatial clustering of office uses and office property values. The variables used were cluster size, regional location and relationship to transportation infrastructure, internal land use mix, and transportation network. The study revealed that recent office development has continued to benefit economically from agglomeration. In addition, office property values were positively affected by intensity of office development, a central regional location, and clustering or agglomeration of office parcels.

Furthermore, where a building is located will determine how easy it will be to attract customers or how easy it will be for employees to get to work. Buildings within city limits are more valuable than those outside the city and those closer to the centre of town and major roadways are worth more than those on small or obscure side streets. The neighbourhood within which such buildings located also determines the value and profitability of the real estate. Potential income of an office space is another factor. An investor will calculate the amount of money that a property is likely to bring each month from renting the property. This is an important part of the commercial property analysis. Check out nearby properties to discover if they have good rates of renting and retaining tenants. Zoning law is another factor, each city has its

own set of zoning laws setting forth how certain areas of town are allowed to be used.

Cloete and Chikafalimani (2001) in a study on property industry in Malawi agreed with Stratton (2008). The study identified eight factors that affect property value, which are architectural design, quality of finishing, maintenance condition of the property, size of property, security, condition of the street, and location. Hendon (1971) studied the effect of a park on property values, found that park had stabilizing influence on residential property values, especially among high-valued residential properties, and lower with less-valued ones.

From the aforementioned studies, it is evident that many of them came from the USA, Canada, UK and Europe and with much concentration on residential properties. In UK and Europe, there were evidences of impacts of transportation on property values varying with analysis of open market price and the impacts of transportation studied in terms of changes in demand without concentrating on the property market, land and effects of transportation on property value uplift.

Also, from the studies, a number of factors that determine property values were identified, which include infrastructural funding, impact of high-speed mode of transportation especially at new station in peripheral sites where the impact is highest; nearness to rail stations, metro lines, and roads especially where transport infrastructure is poor. Other factors identified in the studies include accessibility relative to location-distance of land uses, change in population, change in fashion and taste, institutional factor, economic factor, location, transportation, complementary uses, road transport network, political factor, planning

regulation, environmental quality, aesthetics, and growth pattern of land use.

In the Botswana context, earlier studies focused on land use and urban development with considerable works carried out by scholars in various disciplines to explain the determinants, structures and effects of residential land use and land values in the urban areas. They gave little attention to the effects of supply and demand, which interplay to determine values. In this study, attention will be on accessibility, road network explanatory variables, distance to the most central part of the study area, demand and supply factors to determine variability in commercial property values.

The next Chapter offers a framework for analyzing the relative impacts of these various factors with a view to providing a tool for the specific measurement of the impact of arterial roads in particular.

2.8 Conceptual Framework

2.8.1 Housing/Property Markets

Markets are a place (not necessarily a physical place) where buyers and sellers come together to exchange goods. The result of competitive markets is that efficient prices are set for the good being exchanged. At this price, sellers will produce the efficient quantity of the good and buyers will buy that same efficient quantity of the good. There are several assumptions that must be met in the classical definition of a competitive market. It is assumed that buyers and sellers are price takers, there is homogeneity of goods, firms have freedom of entry into or exit from the market, and that buyers and sellers have perfect information. These assumptions work together in a theoretical

framework that results in competitive markets. In reality, markets do not fully comply with the assumptions necessary for a perfectly competitive market, but many markets come close enough that they can be considered competitive with efficient prices. For instance, although housing markets do not exactly fit the classical competitive efficient market model (Case and Shiller, 1989; Gau, 1984; and Linneman, 1986), they are a good approximation and function essentially as an efficient market (Guntermann and Norrbin, 1991). The most glaring violation of the housing market is that the goods are not homogeneous. In fact, houses are not only not homogeneous, they are each a unique good. Even two houses built identically at the same time by the same builder occupy a different piece of land, rendering it unique from all other houses.

Markets do not always function according to the assumptions listed above. Market failures lead to the inefficient allocation of resources. There are a multitude of market failures, but this research addresses one particular market failure in the housing market, the lack of perfect information. The assumption of perfect information is unrealistic in the market for any good. For instance, in the stock market, government rules require the periodic reporting of company information so that stockholders and potential stockholders have the data to assess what the stock price should be. But recent scandals at large corporations such as Enron, Tyco, and WorldCom due to accounting irregularities and insider trading of Worthington Foods stock by Roger Blackwell and ImClone stock by Samuel Waksal (made famous by Martha Stewart's conviction related to obstruction in the case) and even legal insider trading, have shown that despite best efforts by government regulators, significant information asymmetries remain. The information

asymmetries mentioned above also exist in housing markets, as the seller of a house almost always has more information than the buyer of the house. In the housing market, there are many factors that affect the price of a house. Structural characteristics, such as the number of bedrooms and bathrooms and the condition of the roof, can affect price.

There are also locational characteristics that affect the price such as proximity to parks, schools, busy streets, and hazardous waste sites. In addition to these physical locational attributes, there are attributes related to public services where the house is located. All of this information is used by the homebuyer in determining what price to pay for the house. The problem is that having perfect information on these aspects is impossible. Many of these attributes are difficult to determine, especially for the potential buyer that is not as familiar with the house or specific neighbourhood as current residents. Other attributes are difficult to determine regardless of familiarity. The level of crime is an important neighbourhood attribute that is difficult for potential homebuyers and even current residents to assess. Reported crime statistics can help inform decisions. However, consumers must face the difficulty of accessing this information, and it is often reported at a scale that is too large to know about crime in the neighbourhood of interest. Even if the information was provided at a more appropriate scale for home buying decision, for a variety of reasons, not all crime is reported to the police. Therefore, consumers of housing must make assumptions about crime in the neighbourhoods that they are considering. They build opinions of different neighbourhoods from what they see when visiting the neighbourhood and in the media. Using this information, they make decisions. It is not perfect information. This market failure causes inefficiencies in the price of housing that affect the value of the large

investment that homebuyers make. Housing markets are used to investigate the effect of a variety of policies and social and environmental conditions. Variations in policies that are enacted by governments and the socioeconomic or environmental circumstances are capitalized into housing values resulting in different prices for housing in different neighbourhoods. One way to untangle the effect of these conditions is the use of hedonic modelling.

2.8.2 Neighbourhood Quality

Threats to investing in homeownership may be due to potential changes in neighbourhood quality. If aspects of neighbourhood quality decline, house prices may also decline. Crime is frequently cited by the media as an important criterion used by homebuyers to determine where to buy and what price to pay for a home. As this neighbourhood quality indicator signals a decline in the desirability of a neighbour, sale prices (and the return on a homeowner's investment) will decline as increases in crime are capitalized into house values. In this way, examination of the effect of crime on house values measures the impact of crime on neighbourhood quality and desirability.

The Tiebout (1956) hypothesis models the efficient allocation of public goods and services at the local level. In Tiebout's model, households sort themselves into different local jurisdictions based on a utility maximization concept. Each jurisdiction offers a specific public service package for a given tax. Given its budget constraint, each household chooses the service-tax package that maximizes its utility. With a large number of jurisdictions offering a continuum of service-tax packages, the households reveal their preference for public goods and services by locating in a particular jurisdiction, or voting with their feet.

The efficient provision of these goods by the jurisdiction comes from competition among the jurisdictions just as competition among private firms brings efficiency to the private market.

Even within a large jurisdiction that offers the same public service package to all residents, there is sorting into different neighborhoods based on other factors such as demographics. This sorting explains why there is a certain homogeneity among the populations of different neighbourhoods. Like-minded people (as far as public service and taxes coupled with income are concerned) come together. Many times this segregation occurs roughly according to household income. Remembering that tax revenues are not generated via a head tax, with concentrations of wealth in some areas and poverty in others, the result will be that some local governments will have greater fiscal capacity than others, both in terms of the bases of income and property taxes because higher income households tend to own more valuable housing. Regardless of income, it seems that people are looking for at least some similar services from their government, for instance, a safe place to live and a good education for their children. It is in the local government's best interests to provide amenities to attract wealthy households who consume expensive properties which provide high amounts of property tax revenues that pay for amenities that everyone in the community consumes. Factors that affect neighbourhood quality are the amenities or disamenities offered by the neighbourhood. Amenities and disamenities can take the form of natural, environmental, social, or public service characteristics.

2.8.3 Crime and Places

International research has long shown evidence that crime makes communities decline (e.g. Skogan, 1990; Wilson & Kelling, 1982). This decline can be seen in the presence of crime in public places as well as in minor signs of physical and social disorder. These environmental cues translate into residents' increasing desire to move away, also motivated by weakened social ties among residents (Cancino, 2005; Sampson, Raudenbush, & Earls, 1997). This negative process decreases the demand for properties in the area (Buonanno, Montolio, & Raya-Vílchez, 2012; Ceccato & Wilhelmsson, 2011; Congdon-Hohman, 2013; Ihlanfeldt & Mayock, 2010; Lynch & Rasmussen, 2001; Phipps, 2004) and consequently reduces housing values. This process happens partially because buyers are willing to pay more to live in a neighbourhood with less crime. Although research has shown evidence of the effects of crime and disorder on a housing market (for a review, see Ceccato & Wilhelmsson, 2018), little is known about what happens to housing values when properties are close to places with disproportionally high concentrations of crime, that is, hot spots.

Crime hot spots are places characterized by high crime frequency, and although the boundaries of these spots may not be visible to the eye, their extent and presence tend to be stable over time (Weisburd & Amram, 2014). This temporal and spatial stability has attracted the attention of many scholars to the point that some provide clear evidence of the so-called 'law of crime concentration at places' (e.g. Andresen & Malleson, 2011; Curman et al., 2014; Weisburd & Amram, 2014), which is thought to have an effect on housing markets and more directly on the

mechanisms linking people's appraisals of prices to housing and neighbourhood qualities.

Crime hot spots are different from other places in the city because they have the capacity to attract and/or generate crime (Brantingham & Brantingham, 1995) or to be crime radiators and/or crime absorbers (Bowers, 2014). When compared with one another, crime hot spots share a number of commonalities in terms of socio-spatial dynamics (for instance, concentrations of violence in city centres) that can be helpful in crime control.

Moreover, property prices are vulnerable to factors other than crime that, together with crime, help pull prices down and need to be controlled for (Ceccato & Wilhelmsson, 2011). For instance, high crime areas may also have few environmental amenities and poor accessibility to services, which also affect the perceptions of buyers. Thus, crime hot spots must be considered; otherwise the impact of crime on real estate prices may be overstated. However, it is not easy to assess the influence of different land uses on property values. One reason is that certain types of land use may affect a place both positively and negatively, making it difficult to assess. For example, although it is expected that urban parks increase property values, Troy and Grove (2008) show that parks' desirable effects are not incorporated into pricing in the housing market in a homogeneous way and are actually counteracted by crime at the park. The same applies to features such as transport nodes or schools (Bowes & Ihlanfeldt, 2001; Kane, Riegg, & Staiger, 2006).

Another reason for this difficulty is that different types of land use attract, generate and/or radiate different types of crime. Some crimes

are bound to affect one area more than others. Lynch and Rasmussen (2001), for instance, weighted the seriousness of offences by the cost of crime to victims and showed that, although cost of crime had no impact on house prices overall, properties were cheaper in high-crime areas. In London, vandalism had the strongest impact on prices, while in Stockholm municipality residential burglary seems to have a similar effect (Ceccato & Wilhelmsson, 2011; Gibbons, 2004). Vandalism has a significant and independent effect on flat prices in Stockholm municipality even after the impact of fear of crime is controlled for. Therefore, it is hypothesized that the effects of crime vary by type of offence and housing type. Based on previous research, it is expected that hot spots of residential burglary and vandalism will have the strongest effect on prices.

2.8.4 Hedonic Modeling

The concept of hedonic pricing models was first introduced by Court (1939) in the 1930s for the automobile industry. Hedonic modeling is used to develop pricing schedules for differentiated goods. Differentiated goods are, as the name implies, all different. For instance, no two houses are exactly like. Even if they are built identically, they each occupy a unique location. Therefore, this violates the assumption that a well-functioning market trades identical goods. But this problem can be worked around by recognizing that the price paid is a composite of the prices of the various attributes of the good. In the 1970s, Rosen (1974) improved hedonic modeling techniques for housing markets. The basic structure of a hedonic model is to take the market price for a good (in this case the selling price of a house) as the dependent variable and take all of the characteristics that come together to make the good as

the independent variables. The coefficients for the various characteristics are the implicit prices of the variable in question. For the housing market, the independent variables can be grouped into two categories: the structural characteristics and the neighbourhood characteristics. The structural characteristics are a physical description of the property itself, such as the lot size, the number of rooms, and the number of stories. The neighbourhood characteristics are the bundle of goods that are purchased along with the physical characteristics. These variables include socio-economic characteristics of people living near the property, public services provided by the jurisdiction where the property is located, and the effect of other objects in the environment.

The effects of all of these externalities are capitalized into the price of the house. This makes hedonic modeling a tool for finding prices of intangible goods such as neighbourhood characteristics where there is no well-functioning market. It allows us to find the implicit willingness to pay for a variety of policies such as pollution control and criminal justice that are not traded in markets. While the procedures involved in developing hedonic pricing models can seem straightforward, great care must be taken in specifying the models. The neighbourhood characteristics that are capitalized into housing prices are interpreted by homebuyers and then translated into a dollar amount. These dollar amounts may vary across neighbourhoods since residents have sorted themselves into different groups that may value a particular characteristic differently. Therefore, it is not simply enough to measure characteristics. How those characteristics are perceived (accurate or not) by homeowners are important facets of creating a hedonic model because it is what the potential buyer thinks the characteristic is, not the

actual measured characteristic, that is used to determine the price offered for a home.

2.8.5 Perceptions

It is evident from the literature that perceptions are often different from more objective measures of “reality,” especially in the case of crime (Skogan, 1986). For example, Wolman, et al. (2004) found that urban and economic development experts’ perceptions differed significantly from objective data in assessments of which US distressed central cities successfully revitalized between 1990 and 2000. Likewise, Sampson and Raudenbush (2004) examined factors underlying perceptions of neighborhood disorder and found that race and poverty were stronger predictors of perceived disorder than more objective investigator-observed indicators of “true” disorder such as graffiti, litter, drug paraphernalia, and security fencing on commercial buildings for example. Indeed, there is a related literature that attempts to disentangle perceptions of race. For example, Harris (1999) finds support for the argument that race is a proxy for other factors that likely drive observed relationships between racial composition and housing values.

If perception deviates from reality, then it is likely that households and businesses make location decisions based predominately on their perceptions, and it is the perception of an amenity that is subsequently capitalized into property values. In measuring the whether or not amenities matter, it is vital to understand that it may not matter what the actual amenity is. It could be that what the households and businesses considering the amenity think it is that matters. It is the perception of the amenity that is capitalized into property values and is used in locational decisions. People make decisions in a world of bounded rationality

(Simon, 1982). They only know what they think they know. For instance, in a survey of recent movers in Central Ohio conducted by Morrow-Jones (2003), several respondents stated that they relocated from one community to another for better schools. But some of these respondents actually moved into districts with schools that have lower marks on a variety of commonly used measures of school quality. The reality of the amenity can be quite different than the perception. The concept that perception of risk varies from actual risk can be seen in the greater fear inspired by the 3,000 deaths in the September 11, 2001, terrorist attacks than the at least 10 times greater number of fatalities from auto accidents that occur every year in the United States (Mueller, 2004, 2005). An increase in the perceived risk of hazardous waste sites (not the actual risk) reduced housing values in a study by McClusky and Rausser (2001). Another study investigating the effect of shipping nuclear waste in South Carolina on the value of residential property neighboring the transport route found that while property values remained largely unaffected for rural portions of the route, in urban areas where nuclear waste transport was a highly visible issue, homes within five miles were found to decrease in value by approximately three percent (Gawande and Jenkins-Smith, 2001). This study finds that it is the public's perception of risk, regardless of the accuracy of the perception, that is capitalized into property values. As discussed below, one such amenity where reality and perception can be very different is crime. Not only are there problems in measuring crime, but there are also problems in the transmission of information regarding the levels of crime and risk posed by to the public. Armed with less than perfect information, people set out to make decisions about where to live and how much to pay for that housing partially based on their perception of crime.

2.8.6 Crime and Housing Value

The literature that seeks to quantify the societal costs of crime examines both the direct costs imposed on victims and the indirect costs imposed on non-victims. One class of indirect costs is related to the altered activities of both victims and non-victims due to neighbourhood changes in crime, and therefore the safety of the neighbourhood. For instance, commuters may choose longer, both in terms of mileage and time, routes to work, households may relocate to another neighbourhood, or even purchase security devices such as alarm systems or guns, all in order to avoid crime and unsafe situations (Cohen, 2005). The cost of these alterations to activities includes actual dollar costs associated with a longer commute and moving expenses, but they also include the cost associated with making a sub-optimal decision due to crime. There is evidence that crime does alter the household location decision. Victims attacked near their homes have an increased probability of moving (Dugan, 1999), and households that have already decided to relocate will consider safety issues in selecting a new location (Frey, 1979; 20 Morrow-Jones, 2000).

The cumulative effect of household relocation decisions result in longer-term neighbourhood changes. Higher income households are more likely to relocate than lower-income households (Cullen and Levitt, 1999), leaving neighbourhoods with higher concentrations of poverty. Increases in crime also lead to greater racial segregation among neighbourhoods. In a study of crime rates in Chicago, crime induced moves of both white and black residents, but increases in homicide led to more whites leaving and higher concentrations of blacks remaining (Morenoff and Sampson, 1997). On a higher geographic level, over a

40-year period, a relationship between violent crime rates and racial composition of was found in a sample of U.S. cities (Liska and Bellair, 1995). As households continue to relocate away from crime ridden neighbourhoods, the demographic composition of those neighbourhood changes, leaving an increased concentration of poverty. These conditions can breed increases in crime, which leads to even greater concentrations of poverty as other households (that can afford to) relocate (Miethe and Meier, 1994). Unfortunately, these increases in poverty for the most part also mean increases in minority populations in these neighbourhoods.

As the demographic composition within neighbourhoods becomes more homogeneous, the pool of households shopping for a home in that neighbourhood may also become more homogeneous (and smaller). A smaller number of homebuyers (with less money to spend on a house) in a neighbourhood represents a decrease in demand which leads to reduced sale prices for homes (Flippen, 2004). Also, an increased number of households fleeing these neighbourhoods means an increased supply of homes on the market also serving to depress sale prices. Falling sale prices decreases the ability of households to relocate, as the proceeds of the sale are necessary to purchase a new home (Chan, 2001). While anecdotal evidence and conventional wisdom point to a relationship between crime and housing values, the academic literature also finds such a relationship (Burnell, 1988; Buck, et al., 1991; Buck and Hakim, 1989; Dubin and Goodman, 1982; Haurin and Brasington 1996; and Thaler, 1978). But not all the research agrees with another. Manning (1986) found that crime had no significant impact on the appreciation of housing values, and Lynch and Rasmussen (2001) found little impact on housing sale prices

2.9 Empirical Studies

2.9.1 Depressed Home Values Due to Crime

The correlation between high crime and low property values is well established, particularly when it comes to violent crime. According to a 2012 study by the Center for American Progress, “Violent crimes … impose large costs on communities through lower property values, higher insurance premiums, and reduced investment in high-crime areas.” Additionally, a study of housing values and crime rates by Rasmussen has shown that home values in high crime areas are steeply discounted 40% relative to those in safe neighborhoods. Homebuyers and renters at all income levels clearly prefer safety, and that preference is reflected in home values (Numeritics, No Date). The effects of crime on property values have been a long-standing focus of economic research as they are one of the best measures available for the value people put on safety.

The accuracy of high valuations found in early studies using cross-sectional data is questionable because of the problem of omitted variable bias. Specifically, crime is not randomly assigned to neighbourhoods and it is likely correlated with unobservable qualities that may also be correlated with home values. In an attempt to minimize this source of bias, recent research on a number of localized events has begun identifying the difference in responses between those affected most and those who also live nearby but are not affected as intensely by the event in question. This approach has been identified in some studies as a “quasi-experimental approach” because of the assumed random assignment of the location of an event within a narrowly defined

neighbourhood, even though the selection of the neighborhood is not assumed to be random (Congdon-Hohman, 2011).

The price of a house is an indicator of its utility to current and future residents. Crime has been shown to depress home values in several empirical studies. For example, Lynch and Rasmussen (2001) built a hedonic price model of home sales in Jacksonville, Florida, in which the level of crime in the home's police beat is used as an independent variable. While overall the effect of crime on home prices is insignificant, the study finds that houses in very high crime police beats are discounted significantly below their counterparts in areas with fewer crimes. The paper suggests that there is some threshold at which high crime begins to negatively impact people's preferences. Gibbons (2004) also studied the impact of property crime in London on local house prices, and his study shows a significant and negative correlation between crime levels and home values.

In Pope and Pope's (2012) study, they exploit the dramatic, nationwide decrease in crime that occurred in the 1990s to examine the relationship between changes in crime rates and property values. To do this, they compile information on changes in property values and crime during the 1990s in nearly 3,000 urban zip codes. Throughout the U.S. Using a fixed-effects framework as well as an instrumental variables strategy, their analysis implies a large and statistically significant association between crime and property values. Both the empirical analysis and a graphical analysis suggest that causality runs from decreasing crime to increasing property values. Their results imply that the crime drop was a major contributor to the recent resurgence of cities.

2.9.2 Neighbourhood Crime and Housing Values: Exploring and Identifying Important Gaps in the Literature

In the words of Ihlanfeldt and Mayock (2009), there are many hedonic price studies that have included a measure of neighborhood crime among the explanatory variables. Most of the studies find a negative, statistically significant relationship between one or more measures of crime and house value. Among the few studies that did not find a negative effect, one (Case and Mayer 1996) finds a positive, statistically significant effect.

Overall, the fact that almost 80 per cent of extant studies find that crime has a negative effect on property value makes it safe to conclude that crime matters to people and that they are willing to pay a higher housing price in order to avoid it (Ihlanfeldt and Mayock, 2009).

Unfortunately, however, little can be said regarding which crimes matter most based upon the studies that have been done. Seven of the 14 studies that find a negative crime effect measure crime with a single variable (four use total crime, two use property crime, and one uses homicides). The seven studies that have more than one crime variable yield highly mixed results. In particular, there appears to be little consensus on whether violent crime is more or less important to people than property crime (Ihlanfeldt and Mayock, 2009). In the light of these criticisms, to avoid obtaining biased estimates, the preferred approach is to include measures of the incidence of each type of crime in the hedonic model. At a minimum, separate violent and property crime variables should be included. The problem, of course, as alluded to above, is that violent and property crimes are highly collinear; hence, multi-collinearity makes it difficult to separate out their separate

influences. One solution to this problem is to have panel data and first differentiate the data (Ihlanfeldt and Mayock, 2009).

Turning now to the endogeneity of crime problem, there are at least five mechanisms whereby crime may be endogenous in a housing price model. First, neighborhoods with cheaper housing attract lower income individuals, and it is well known that income and the propensity to commit crime are inversely related. Evidence also exists which shows that criminals commit the vast majority of their crimes within their home neighborhood (Reppetto 1974; Pope 1980). The implication is that criminals self-select neighborhoods to reside in with lower property values and commit many of their crimes within these neighborhoods. Second, neighborhoods with more expensive homes attract criminals by offering higher expected payoffs in terms of the market value of stolen goods.

Third, crime statistics are limited to only those crimes that are reported to police. Reporting rates are known to be higher in more affluent neighborhoods (Skogan 1999). Fourth, some un-observables that increase the attractiveness of a property (e.g., large windows or a secluded back yard) also makes the property an easier target for crime as a matter of fact (Gibbons 2004 as cited by Ihlanfeldt and Mayock, 2009).

The above mechanisms all suggest that higher housing prices may raise neighborhood crime levels. A final mechanism that suggests that crime will be less prevalent in more affluent neighborhoods, is the deterrence provided by self-protection measures. Self-protection is expected to be greater in wealthier neighborhoods because property owners are more able to afford it and they have more at risk. As noted

above, while most studies have treated crime as exogenous to housing price, six studies have treated crime as an endogenous variable. However, only one of these studies (Gibbons 2004) fully validates the choice of instrumental variables (both first-stage regression results and, where equations are over-identified, tests of over-identifying restrictions were reported); and the instruments used by all studies are open to question (Ihlanfeldt and Mayock, 2009).

2.9.3 Rizzo's (1979b) Hedonic House Price Study

Rizzo (1979b) is the first study to instrument crime in a hedonic price model. He regresses the 1970 median contract rent or owner-estimated house value for 71 neighborhood communities (which are collections of census tracts) within the city of Chicago on the total crime rate reported for 21 police districts, with each neighborhood community assigned to a police district. To instrument the crime rate, the following variables are used: the proportion of the population between ages 15 and 24, median years of schooling, the unemployment rate, population density, the proportion of the population receiving welfare, ratio of males to females, and the labour force participation rate (Ihlanfeldt and Mayock, 2009). In both the rent and house value regressions, the coefficient on the crime variable using the instrumental variables estimator is substantially larger in absolute magnitude than the coefficient in the OLS model. Rizzo interprets his results as lending support to the position that simultaneity between crime and house value (rent) is a significant problem. Rizzo reports neither the first-stage regression results nor over-identification test results. Moreover, a number of his instruments proxy neighborhood quality and therefore probably should not have been excluded from his hedonic model. His

evidence and conclusions are herefore open to question (Ihlanfeldt and Mayock, 2009).

2.9.4 Naroff et al.'s (1980) Housing Price Study

Chronologically, the next study to instrument crime is by Naroff et al. (1980). Using

Boston census tracts as the units of observation, the authors jointly estimate two equations, one with the dependent variable equal to the median owner-estimated house rate. The two variables that enter the crime rate equation that did not appear in the value equation (and thereby serve as instruments for the crime rate) are the population density of the tract and a housing quality variable which is a combination of the percentage of the units which have more than one person per room and the percentage of the units that did not have complete plumbing facilities. The estimated elasticity of house value with respect to the crime rate is -1.67. However, little confidence can be placed in this result given the authors‟ choice of instrumental variables. In particular, it is baffling why the housing quality variable would enter the crime but not the house value equation (Ihlanfeldt and Mayock, 2009).

2.9.5 Buck et al. (1993) Study

The only study from the 1990s to instrument crime is by Buck et al. (1993). Their study is unique in that it is the first to use panel data. For the years 1972-1986 they have property value and crime data for 64 communities located in the Atlantic City region of New Jersey. Unfortunately, they choose not to exploit the panel nature of the data (by, for example, including community fixed effects) but instead they estimate pooled cross-sectional models (Case and Christopher, 1996).

Chapter 3

Methodology

3.0 Methodology (Introduction)

The chapter explores the research design, the sampling technique and data collection methods to be used in the study.

3.1 Research Design

The research adopted a mixture of qualitative and quantitative design because the subjects needs for both qualitative and quantitative data to reveal the impact of crime on property value.

3.2 Data Collection

A total of 1000 sets of questionnaires were randomly distributed to the residents (heads of household) of selected residential neighbourhood within Francistown. Out of the 1000 sets of questionnaires administered, 728 were retrieved and after the data screening (missing data, outliers and multicollinearity), only 467 sets of questionnaires were found to be clean data and as such were subsequently used for the analysis of this research.

3.3 Population and Sampling Procedures

Purposive and stratified multi-stage sampling techniques were adopted in the selection of the residential estates as well as the residential buildings from which the heads of the household were used to respond to the questionnaire. As regards the variables used for the analysis, the independent variables represented the various forms of RNC as earlier highlighted while the dependent variable represented the Residential Property Values (RPV).

3.4 Data Validity and Analysis

Content validity was adopted to ascertain the appropriateness of the research instrument. As regards the research instrument (questionnaire), the dichotomous approach was explored which was based on two sets of measurement variables: whether or not residents were aware of Residential Neighbourhood Crime in their estate and whether or not each of the components of RNC has impact on RPV. Logistics regression analysis was used to predict the degree of the impact of various forms of Residential Neighbourhood Crime (RNC) on Residential Property Value (RPV). The components of RNC as revealed in the literature included burglary and theft, incivility and street crime, vandalism, robbery and violent crime.

Chapter 4

Data Presentation and Analysis

4.0 Introduction

The chapter gives an analysis of the data in order to determine the impact of crime on property value. A regression analysis model is adopted to test the relationship between the two variables.

4.1 Data Analysis

The hypothesis of this research relates to testing the impact of Residential Neighbourhood Crime (RNC) on Residential Property Values (RPV). Simply put, “There is a significant and direct impact of residential neighbourhood crime on property values”. The hypothesis was tested by;

(i) Considering the impact of residential neighbourhood as an entity on property (housing) values and,

(ii) By measuring the contribution of the various elements of residential neighbourhood crime to the effect.

These sub-variables under RNC are Burglary and Theft (RNCRPV1); Incivility and Street Crime (RNCRPV2); Vandalism (RNCRPV3); Robbery (RNCRPV4) and Violent Crime (RNCRPV5). By implication, the independent variable is the residential neighbourhood crime (RNC) having its elements (burglary and theft, incivility and street crime, vandalism, robbery and violent crime) as sub-constructs while the

residential property values stood as the dependent variable (RPV). Residential property value is adopted as the dependent variable on the premises it remains the best parameter to measure the prosperity level of this housing investment in general.

The report of the analysis is demonstrated in the next section of this report (Table 1, Table 2).

All the predictors have the influences on Residential property Values (RPV), but the one with a statistical significance is violence crime with an odd ratio of 71.12522 and with parameter value of 4.2644 at 5% level of significance.

Predictive ability of the model is shown by Figure 1 (Page 87).

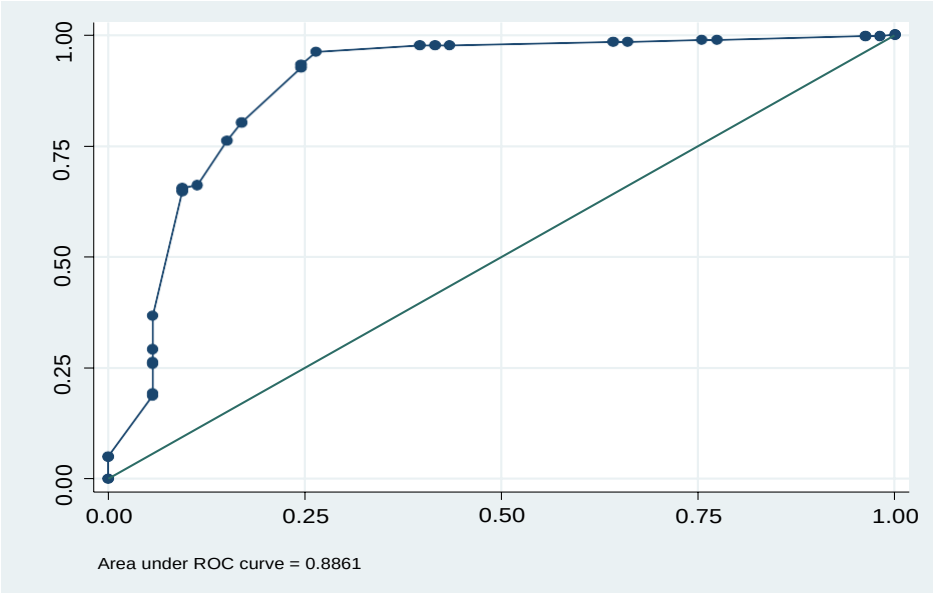
Table 1 – Logistic Regression Table Using Odd Ratio

RNC Aware	**Odd Ratio**	**Std. Error**	**(z)**	**P > (z)**	**95% Conf.**	**Interval**
RNCRPV1	.6286312	.3029263	-0.96	0.335	.2444651	1.616497
RNCRPV2	1.561428	.7025892	0.99	0.322	.6464133	3.771669
RNCRPV3	1.337629	.6422731	0.61	0.545	.5219448	3.428047
RNCRPV4	.994079	.6210787	-0.01	0.992	.292152	3.382462
RNCRPV5	71.12524	29.93818	10.13	0.000	31.16982	162.298
_cons	.3345003	.3210206	-1.14	0.254	.0509914	2.194301
Model	-0.4642RNCRPV1+0.4456RNCRPV2+0.2909RNCRPV3-0.0059RNCRPV4+4.2644RNCRPV5					
Number of observation	467					
Chi Square	144.9					
P-Value	0.000					
R^2	0.435					

Table 2 – Logistics Regression Using Coefficient

RNC Aware	Coef.	Std. Error	(z)	P > (z)	95% Conf.	Interval
RNCRPV1	-0.4642106	0.4818824	-0.96	0.335	-1.408683	0.4802615
RNCRPV2	0.4456007	0.4499658	0.99	0.322	-0.4363161	1.327518
RNCRPV3	0.2908987	0.4801579	0.61	0.545	-0.6501934	1.231991
RNCRPV4	-0.0059386	0.624778	-0.01	0.992	-1.230481	1.218604
RNCRPV5	4.264442	0.420922	10.13	0.000	3.439450	5.089434
_cons	-1.095118	0.959702	-1.14	0.254	-2.976099	0.7858637

Figure 1 – Logistics Model for RNCRPV Aware



Note: Number of observations = 467; area under ROC curve = 0.8861.

Interpretation: the model approx. 89% predictive ability which is excellent.

4.2 Results and Discussions

Precisely, the analysis was carried out based on the objective of the research which set out the hypothesis of predicatively determining the impact of the Residential Neighbourhood Crime (RNC) on the Residential Property Value (RPV). In line with the ethics of logistic regression, the questions were set out to suit the outcome of the analysis. The sub-variables of the RNC (burglary and theft; incivility and street crime; vandalism; robbery and violent crime) were set out against the RPV which gave rise to the development of the logic regression model. The model was found to be fit after meeting some of the parameters of fitness earlier on mentioned in the previous sections.

From the analysis, the following inferences could be made to support the fitness of the alternative hypothesis that residential neighbourhood crime has significant influence on the residential property values;

(i) The P-Value for the entire model showed 0.000 which is less than the requirement of ≤ 0.05.

(ii) The R^2 of the model which stood at 0.4385 or 44% which is considered adequate.

(iii) The predictive ability of the model shown through the ROC curve standing at 89% which could be defined to be excellent.

Furthermore, all the predictors have influences on Residential Property Values (RPV), but the one with a statistical significance is violent crime with an odd ratio of 71.1252 and with parameter value of 4.2644 at 5% level of significance. This, in agreement with Greenbaum & Tita

(2011) and Lynch & Rasmussen (2018) was due to the fact that violent crimes attract more fear of crime than burglary and other street incivilities. They affirmed that though residents believed burglary is more frequent in residential neighbourhood crime more than violent crimes. The effect of violent crime on residential mobility and neighbourhood decline was higher. From the foregoing, the relationship between the hypothesis and findings is that the result indicated that the alternative hypothesis should be upheld. That is, there existed significant impact of residential neighbourhood crime on residential property value. By implication, from the respondents' point of view the gravity of crime within a given residential neighbourhood is capable of determining behaviour of the values of such property which defines the buoyancy housing investment.

Chapter 5

5.0 Summary, Recommendations, Opportunities for Further Research & Investigations and Conclusion

5.1 Introduction

This chapter will summarize the findings and give an outline of conclusions drawn from findings. Areas for further research are also explored.

5.2 Summary of findings

This research was embarked upon with the purpose of making predictions as to the impact of different components of residential neighbourhood crime (burglary and theft; incivility and street crime; vandalism; robbery and violent crime) on residential property values. From the last two sections of this article (data analysis and discussion on research findings), it was revealed that there is support for the alternative hypothesis that residential neighbourhood crime has remarkable impact on the residential property values. This is shown from P-Value on the entire model (0.000) However, out of five sub-variables of residential neighbourhood crime under consideration, the one with a statistical significance is violence crime with P-Value of 0.000. This, however does not translate to the fact that other RNC variables have no impact on RPV but only that they are not as significant as violent crime. In terms of hierarchical arrangement of the sub-variables, it can be said to be in this order: incivility and street crime (0.322), burglary and theft (0.335), vandalism (0.545) and robbery (0.992).

5.3 Recommendations

(i) Neighbourhood policing has to be adopted to detect and deal with local crime manifestations.

(ii) The use of private security enterprises/ organisations to work with law enforcement agencies.

(iii) Adoption of technological surveillance systems for the detection of crime at the earliest possible time.

(iv) Coordination, Cooperation and liaison with the neighbouring countries as the City of Francistown is near the border with the neighbouring Republic of Zimbabwe.

An analytical mind will be required in an emerging professional terrain in which other professionals are currently challenging Estate Surveyors and Valuers over their relevance. However, the study found that most Estate Surveyors and Valuers have not been actively involved in the use of scientific techniques to measure accessibility in relation to property value. The propensity of error in judgement based on intuitive decisions is very high and the best way to reduce such misjudgement is to adopt scientific techniques. This study has tested and adopted the graph theoretical technique and found it a useful tool in analysing road network. Empirical decision-making process has become necessary judging from the importance of accessibility in real estate development

appraisals, particularly in advising on choice of best sites for the development of projects. It is therefore suggested that Estate Surveyors and Valuers should consider the use of scientific techniques to assist in making decisions that are reliable. This could be accomplished through seminars, workshops and conferences, while the curriculum in institutions offering Estate Management should be broadened to include road network analysis.

This is achievable through funding research in this regard. In UK, the Royal Institution of Chartered Surveyors (RICS) over the years has been funding research towards determining the impacts of rails, roads and air transportation on property values. Discussion of the results of such research works should be communicated to the Estate Surveyors and Valuers through Mandatory Continuous Professional Development Programmes. When carrying out feasibility and viability appraisal, attention must be given to the issue of accessibility and road network. Road network analysis must be given due consideration as part of the appraisal report when forming valuation opinion and accessibility assessed quantitatively rather than relying on intuition. It suffices to emphasize that Estate Surveyors and Valuers must consider road network, as major issue in valuation of properties in the study area for their opinion of value to be reliable.

The study has reinforced the importance of accessibility for development and investors wishing to embark on real estate development should be conversant with the level of accessibility of the arterial roads along which such development will locate. Decision on the location of such development project should be based on a pragmatic approach such that selected locations would bring he highest return that is adequate and sufficient to compensate investors in such projects.

A number of models were derived to explain relationships between commercial property value, road network and individual explanatory variables. The models would be useful for predicting commercial property values along the arterial roads in the study area. It may become tools useful to Estate Surveyors and Valuers in expressing valuation opinions, and predicting commercial property values especially in feasibility and viability appraisal. However, a tool may not be useful until it is put into proper use. It is recommended that practical approach be taken to adopt the models and assist in making reliable judgements that would stand the test of time.

The estate surveying and valuation profession in Botswana must be ready to find a way out of the cocoon of over concentration on conventional professional services. The professional practice of valuation, estate agency, property management, and development appraisal are currently the core area and other equally important aspects have remained untapped. One of such untapped aspects of professional services of Estate Surveyors and Valuers is transport and transport infrastructure management and valuation. For instance, facility management, which has become a new area of concentration in professional practice in recent times will be incomplete without due understanding of the management of road, air, marine, and rail transport infrastructure and how they relate to values of residential, industrial and commercial properties. The NIESV must realise the need to catch up with advances and new opportunities especially in transportation. It is therefore important for Estate Surveyors and Valuers to broaden their vista to become relevant and face emerging global professional challenges and opportunities.

The Botswana State Government has enacted the Land Use Change Law (2001) in an attempt to boost its revenue base. This study has shown that accessibility is an important variable in road network and its impact, in the presence of other variables, on commercial property values in the study area is great. Governments at all levels should consider the construction, maintenance, and rehabilitation of arterial roads to be of great essence. This is because land and land/buildings are measure of wealth of a nation and enhanced value through provision of good road network will be worthwhile. Since the amount of tax payable under the Land Use Change Law of 2001 is a function of property value, the Botswana State Government should increase its funding of road improvements including the construction, maintenance, and rehabilitation of the arterial road network. Once there are improvements in these variables, commercial property values would be enhanced and since the Law provides that the amount payable would be a percentage of the capital values of properties, enhanced values will lead to an increase in the amount payable. Essentially, the payer would be encouraged to pay and Government would be justified to collect such changes.

5.4 Opportunities for Further Research and Investigations

Though this study provides several appealing unfilled gaps, this literature analysis was only for international studies, and it is possible the same results will not only apply to other cities and towns nationwide or other countries in Africa such as Nigeria. Similar studies could be replicated or manipulated to fit the needs of other future studies for similar hedonic studies, or weighed cost of crime analysis (Goncalves,

2009). Ceccato and Wilhelmsson (2009) have argued that there is a need to extend the empirical evidence to include case studies embedded in more socially oriented forms of capitalism.

Furthermore, Ceccato and Wilhelmsson provides that one of the limitations of previous research is that the modelling section is based on the databases that are shallow in scope, which is too narrow a time period for drawing final conclusions on the relationship between the effect of crime rates and apartment prices. Moreover, they argue that future research should devote time to elucidate the processes through which apartment prices interact and are influenced by crime using long-term data series. Challenges for future research should also include the testing of crime ratios instead of crime rates (as applied in previous studies) or other denominators for burglary, such as total number of properties in the area. There is also a need to test the effect of different strategies to ensure the modelling robustness, such as testing different types of weight matrices (like such as distance based, instead of binary ones) and other instrumental variables (instead of homicide, as used in previous studies). Another remaining research question is to assess whether fear of crime has the same effect on apartment prices as do crime rates. Despite these limitations, it is believed that the results from previous studies can enhance current and future research on relationships between crime rates and apartment prices by providing empirical evidence.

This study is probably a pioneering research into the impacts of arterial road networks on commercial property value in Francistown, Botswana. Further research efforts need to be carried out in other cities of Botswana, to ascertain the general application of present findings. In addition, there are other modes of transportation, which definitely would

have various impacts on commercial property values. It is therefore important to further ascertain the influences of the modes of transportation on commercial property values in Botswana cities. Similar research exercise may be carried out on the impact of arterial road networks on residential and industrial property values to ensure a robust professional advice on property values in all part of the city.

From this study, opportunity for further research also exists in using scientific techniques to analyse road network jointly with professionals in the fields of computer software development. This will reduce the laborious steps involved in graph theoretic analysis and simplify the technique for determining accessibility and connectivity indices for the use of Estate Surveyors/Valuers and development appraisers in Botswana. This will become handy in feasibility and viability appraisal and site selection. Process for the development projects.

5.5 Conclusion

The arterial road network and values of commercial properties in Francistown metropolis were studied and specific objectives attained. The aim and objectives were achieved through the analysis of the arterial road network pattern in the study area; while the spatial pattern and trend of demand, supply and commercial property values were examined. In addition, the relationship between the explanatory variables and contributions of arterial road network and other explanatory variables to variability in commercial property values were determined and models for predicting the variability road network derived.

It is hopeful that the research would stimulate other studies particularly from the Estate Surveyors and Valuers and that the results and findings would be found to be useful contribution to knowledge. This study has expanded the research frontier in estate management by introducing new dimensions and concept in the area of transportation. In particular, it has reinforced the importance of accessibility, demand, supply, location and influence that road network has on commercial property in linking transport with estate management, valuation, and project development appraisal.

The researcher is also hopeful that the findings of this study would be of great assistance to Governments at various levels in the formulation and implementation of policies and measures that will effectively promote enhanced accessibility through increased development of road networks. Accessibility has great impact on values of commercial properties, which invariably are measure of growth and development of the urban economy.

Lastly, the graph theoretic approach used in this study to define road network on basis of weighted and non-weighted, static and geometric criteria was applicable to the research for its simplicity yet analytical features that enabled conversion of qualitative data to quantitative measures. The technique was neither adequately considered by previous measures of accessibility nor was there any earlier study in Botswana that adopted the technique as part of approach to measuring road network impact on commercial property values. This study is therefore a great contribution to knowledge in this regard and it is hopeful that it would open more research in this direction.

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LIST OF APPENDICES

Appendix I

QUESTIONNAIRE

Section A

1. Age (a) 20-40 ☐

(b) 41-60 ☐

(c) 61+ ☐

2. Gender (a) Male ☐

(b) Female ☐

3. Ownership Status (a) Mortgage ☐

(b) Full Ownership ☐

SECTION B

1. Where is the property located?

_____

2. Why did you choose the location?

_____

3. What is your perception of crime in the neighbourhood?

Condition	**Response, please make a tick (√)**
Safe	
Unsafe	
Moderately Safe	
Not Sure	

4. Crime does have an effect on the quality of neighbourhood.

Condition	**Response, please make a tick (√)**
Strongly Agree	
Agree	
Uncertain	
Disagree	
Strongly Disagree	

5. Level of crime affects property value.

Condition	**Response, please make a tick (√)**
Strongly Agree	
Agree	
Uncertain	
Disagree	
Strongly Disagree	

6. What do you think authorities should do to curb crime?

THANK YOU

Appendix II

QUESTIONNAIRE 1

(For Estate Surveyors and Valuers)

Dear Colleague,

This questionnaire is designed to obtain information on the topic – ***Assessment of Criminal Activities on Land and Property Value: The Case of the City of Francistown, Botswana,*** a thesis in the Department of Business and Media, Selinus University of Sciences and Technology, Italy.

I assure you that the information provided will be used strictly for academic purposes and will be kept confidential.

Therefore, kindly complete the blank spaces and put marks in the appropriate boxes as applicable.

Thank you.

SECTION A

1. Location of Office: _____

2. Gender (a) Male ☐ (b) Female ☐

3. Qualifications:

(a) Professional Qualification:

(i) ANIVS

(ii) FNIVS

(iii) Probationer

(iv) Other, please state: _____

(b) Highest Academic Qualification:

(i) BSc

(ii) MSc

(iii) Ph.D

(iv) Other, please state: _____

4. Post Qualification work experience as Estate Surveyor

(a) Less than 5 years ☐

(b) 5-10 years ☐

(c) 11-15 years ☐

(d) above 15 years ☐

SECTION B

5. Have locations along arterial roads (major roads) positively affected commercial property values in Francistown metropolis?

(a) Yes ☐ (b) No ☐

6. You must have rated certain locations in Francistown as more accessible and better connected in terms of road network than the others. Did you use any technique?

(a) Yes, I used a technique ☐

(b) No, I decided by intuition ☐

7. If Yes, please state the technique(s)

(a)_____

(b)_____

8. If No, why did you not use any technique?

(a) I am not aware of the technique to measure accessibility ☐

(b) I am aware of the techniques, but have never used it ☐

9. If you are aware of a technique are you aware of the following techniques for determining levels of accessibility in a road network? Please tick (√) as **many options** as applicable.

(a) Geographically Weighted Regression Technique ☐

(b) Multinomial Logit Models ☐

(c) Geo-spatial Analysis ☐

(d) Graph Theoretic Analysis ☐

(e) None of the above ☐

(f) Other technique, please specify: ☐

THANK YOU

Appendix III

QUESTIONNAIRE 2

(For Occupiers of Commercial Properties)

Dear Sir/Madam,

This questionnaire is designed to obtain information on the topic – ***Assessment of Criminal Activities on Land and Property Value: The Case of the City of Francistown, Botswana,*** a thesis in the Department of Business and Media, Selinus University of Sciences and Technology, Italy.

I assure you that the information provided will be used strictly for academic purposes and will be kept confidential.

Therefore, kindly complete the blank spaces and put marks in the appropriate boxes as applicable.

Thank you.

SECTION A

1. Location of Office: _____

2. Gender (a) Male ☐ (b) Female ☐

3. Qualifications:

4. Occupation:

   (a) Professional ☐

   (b) Commerce ☐

   (c) Others, please specify: _____

5. How long have you been in occupation of your present business premises?

_____

6. What is the net floor area that you are occupying?

_____ sqm.

7. How much are you paying as rent?

P_____ per annum.

SECTION B

8. How will you rate the access roads at your present commercial premises in terms of accessibility to major roads?

(a) Very Good ☐

(b) Good ☐

(c) Undecided ☐

(d) Poor ☐

(e) Very Poor ☐

9. How will you rate the access roads at your present commercial premises in terms of connectivity (linkages) to other roads?

(a) Very Good ☐

(b) Good ☐

(c) Undecided ☐

(d) Poor ☐

(e) Very Poor ☐

10. Would your business have performed better if you had located off the present location?

(a) Yes ☐

(b) No ☐

11. Is your present space a purpose-built or converted commercial property?

(a) Purpose-built ☐

(b) Converted ☐

12. What factors influenced your choice of the present premises? Please, select as MANY as possible.

S/N	Factor	Place a Tick(√)
1.	Location (relative to arterial road)	
2.	Road accessibility (nearness to road)	
3.	Road network pattern in the area (that makes movement easy for clients/customers)	
4.	Competition of uses(between different types of commercial uses)	
5.	Competition of uses(between commercial and other users like residential, etc)	
6.	Nature of business – goods/services that are provided to clients	

7.	Neighborhood characteristics(type and quality of adjoining properties, environmental quality of the area, etc)	
8.	Traffic congestion (which increases/decrease customer patronage)	
9.	Quality of roads(motor-ability, tarred surface, width of road, etc)	
10.	Cost of improvement (amount spent to repair, or upgrade existing property to modern standard)	
11.	Demand for commercial space	
12.	Economic attributes (local and national economic condition, and ability of tenants to pay)	
13.	Others, please state them:	

13. Have locations along the arterial roads affected commercial property values in Francistown metropolis?

(a) Yes ☐

(b) No ☐

14. Do you think that nodal points (where two or more roads meet) give better advantage to business than any other locations?

(a) Yes ☐

(b) No ☐

15. Please rate the following factors that might have dictated your choice of present location. (1 stands for the best, 2 next etc)

S/N	Factors	Rating (Please Tick ONE point for each street)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Location (relative to arterial road)													
2.	Road accessibility (nearness to road)													
3.	Road network pattern in the area that makes movement easy													
4.	Competition of uses(between different types of commercial uses)													
5.	Competition of uses(between commercial and other users like residential, etc)													
6.	Nature of business – goods/services that are provided to clients													
7.	Neighborhood characteristics (type and quality of adjoining properties)													
8.	Traffic congestion (which increases/decrease customer patronage)													
9.	Quality of roads(motor-ability, tarred surface, width of road, etc)													
10.	Cost of improvement (amount spent to repair, or upgrade existing property to modern standard)													
11.	Demand for commercial space													
12.	Economic attributes (local and national economic condition, and ability of tenants to pay)													
13.	Others, please state them													

16. Kindly express your opinion by responding to the questions in the Table below. Please tick ONE response for each question.

S/N	Question	Response				
		Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
1	Lower transport costs often result in higher commercial property values					
2	Improved transport facilities, especially roads, brings about improved accessibility.					
3	Commercial property values decreases outwards with increasing distance from the road					
4	Road junctions is a major cause of traffic congestion in Francistown metropolis					
5.	Locations at points where two or more roads meet have greater positive effect on commercial property values than locations farther from such locations					
6.	The better a transport network the less the friction and the higher the commercial property					
7.	Direct accessibility to road positively affects commercial property values					
8.	Physical attributes of commercial properties (land size, age, condition, parking, etc) affect					

	their values					
9.	Commercial properties along main road have relative advantage over those off the routes					
10.	Greater relative advantage belongs to commercial properties at the focus of road transport					
11.	The characteristics of a neighbourhood affect commercial property values					
12.	Competition amongst land uses affects commercial property values in Francistown					
13.	There is strong relationship between accessibility and commercial property values in Francistown					
14.	Location prone to attack by criminals will reduce commercial property values					
15.	Location near institutional or corporate building will increase commercial property values					
16.	There is no relationship between connectivity (where two or more roads meet) in Francistown road network and value of commercial properties					

17.	Predominant land uses in a neighbourhood will increase commercial property values					
18.	There is strong relationship between accessibility and commercial property values in Francistown metropolis					
19.	Commercial property users seek locations that maximize their pecuniary profits					
20	Once a number of sites have been developed, there will be strong bearing on the use to which remaining siteswould be put					
21	Locationsalong arterial roads positively affect commercial property values in Francistown metropolis					

17. What will be the impact of each of the factors on commercial property value? Please tick ONE impact for each factor.

S/N	Factor	Very important	Important	Undecided	Of less importance	Not important
1	Competition amongst uses					
2	Type of adjoining properties					
3	Traffic congestion					
4	Nearness to road junction					
5	Nearness to access road					

6	Demand for commercial properties					
7	Condition of					
8	Road network					
9	Neighbourhood					
10	Transport costs					
11	Traffic congestion					
12	Location					
13	Demand					
14	Accessibility					
15	Intensity of Land Use					

THANK YOU