CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Transportation and property are important in physical and economic development of towns and cities all over the world. Property and land values tend to increase in areas with expanding transportation networks, and increase less rapidly in areas without such improvements. Rapid and continued rise in housing and land prices are expected in cities with transportation improvements and rapid economic and population growth (Goldberg, 1970).

Man, nations, regions and the world would be severely limited in development without transportation, which is a key factor for physical and economic growth (Oyesiku, 2002). Transportation systems and land use are interdependent. Indeed findings of earlier studies indicate compelling and consistent connections amongst them (Ewing and Cervero, 2001; Polzin, 2004). According to Bailey, Mokhtarian, and Littlel (2008), transportation route is part of distinct development pattern or road network and mostly described by regular street patterns as an indispensable factor of human existence, development and civilization. The route network coupled with increased transport investment result in changed levels of accessibility reflected through Cost Benefit Analysis, savings in travel time, and other benefits. These benefits are noticeable in increased catchment areas for services and facilities like shops, schools, offices, banks, and leisure activities.

Road networks are observed in terms of its components of accessibility, connectivity, traffic density, level of service, compactness, and density of particular roads. Level of service is a measure by which the quality of service on transportation devices or infrastructure is determined, and it is a holistic approach considering several factors regarded as measures of traffic density and congestion rather than overall speed of the journey (Mannering, Walter, and Scott, 2004).

Access to major roads provides relative advantages consequent upon which commercial users locate to enjoy the advantages. Modern businesses, industries, trades and general activities depend on transport and transport infrastructure, with movement of goods and services from place to place becoming vital and inseparable aspects of global and urban economic survival. Developments of various transportation modes have become pivotal to physical and economic developments. Such modes include human porterage, railways, ropeways and cableways, pipelines, inland waterways, sea, air, and roads (Said and Shah, 2008).

According to Oyesiku (2002), urbanization in Nigeria has a long history in its growth and development. Extensive development being a feature of the 19th and 20th centuries, with concentration of economic and administrative decision-making in Lagos, Ibadan, Kaduna, Jos, and Enugu, and high degree of specialization and larger population associated with greater specialization of goods and services. Wyatt (1997) states that urban areas have tendency to develop at nodal points in transport network and places with good road network will possess relative advantage over locations having poor network. Urban locations with such relative advantage are found where different transport routes converge with high degree of compactness, connectivity, density, length and accessibility exhibited within the intra- and inter- urban road networks.

Ikeja is a typical example in the history of growth and development of cities in Nigeria. The city became capital of Lagos State in 1976 with improved road networks developed to cater for increase in concentration of pedestrian and vehicular movements. Similarly, commercial activities like banking, retail/wholesale businesses, and professional services congregated to take advantage of nearness to seat of governance. Concentration of activities attracted consumers and ancillary service providers. This partly caused increase in demand for commercial space and its concomitant effects on commercial property values along arterial roads in the metropolis.

The present position concerning commercial properties in Ikeja is that majority are located along arterial roads that deliver much of the vehicular and pedestrian movements. There have been increases in rental values along the individual arterial roads although not at equal rates. It is against this background that this research analyzed the arterial roads, determined the levels of accessibility, connectivity, traffic density of the individual arterial roads, examined the pattern of commercial property values and the relationship between the explanatory variables of the road network in Ikeja Nigeria.

1.2 Statement of the Research Problem

The relationship between transportation and urban property values has been the focus of many studies (for example, Dewees, 1976; Damm et al, 1980; Wolf, 1992; Singh, 2005). Some of the earlier studies returned positive relationship between transport and property values while others showed negative relationship. For instance, in a study on the relationship between rail travel cost and residential property values, a replacement of streetcar with subway increased site rent at a location that is perpendicular to the facility within a one-third mile walk to the station (Dewees, 1976); and there was positive influence of permanent transportation improvements on land values (Wolf, 1992). It was established that there was statistically significant relationship between distance of a parcel of land to the nearest Metro station and land price (Damm, Lerner-Lam, and Young, 1980), while there was evidence that residential property prices decrease immediately around the transport investment or station value uplift through changes in land values (Singh, 2005).

The urban areas all over the world offer a number of advantages in terms of concentration of people followed by demand for commercial properties and transportation. Ikeja is a classical example of a city that has developed rapidly since 1976 when it became the Lagos State capital. Construction of roads increased substantially with the opening up of residential precincts that also benefitted from increasing demand for lettable spaces in commercial properties. Many private companies, retail stores, commercial banks aggregate in the metropolis to take advantage of opportunities afforded by locations near the seat of governance thus attracting complimentary services. This led to high concentration of vehicular and pedestrian movements especially along the access roads.

The roads exhibit a number of nodes and linkages to form networks of both arterial and minor routes along which commercial properties locate. Commercial users displaced residential users, causing sites to be at highest and best uses with concomitant increases in the values of commercial properties. Accessibility within the road network is affected by the compact nature of various routes that sometimes impede volume of traffic. The road network is made up of nodal points and links that determine the degree of connectivity and accessibility in the network.

A number of factors affect values of properties. These factors may be intrinsic or extrinsic. The extrinsic factors include increase in demand for lettable space, location, condition of adjoining properties, nearness to park and leisure, local and national economic conditions. External factors are due to natural characteristics of the property which affect the city where the property is located. Intrinsic factors arise from within the nature of the property itself and relate to the physical attributes, including size of room, state of repair, decoration, and facilities. Other attributes that increase or decrease the amount that users are willing and able to pay in an open market transaction include physical characteristics of the structure, change in taste and demand, effect of adjacent activities, economic activities, inflation, and changes in legislation. The demand for commercial properties itself is affected by changes in population, planning and development schemes, legislation, and availability of good road networks (Hendon, 1971; William, Davies, and Johnson, 1980; Richmond, 1982; Millington, 1982; Olayiwola, Adeleye and Oduwaye, 2006).

Earlier theorists (Burgess, 1925; Hoyt, 1939; Harris and Ullman, 1951; Lean and Goodall, 1977) generally believe that sites adjacent to main transport routes have relative advantages over those located some distance away, and other sites located at route intersections possess relative advantage with greater advantages belonging to sites located at focus of transport system. These advantages are determined in relation to accessibility, which has different characteristics in relation to individual sites thus differentiating between sites in terms of accessibility advantages.

Many of the aforementioned studies emphasized the effects of the factors on values of properties generally with little consideration given to road network pattern and its effects on values of commercial properties. Possible relationships between road networks, location attribute, demand and supply, and accessibility and commercial property values have therefore elicited the interest of the researcher in this direction. The relationship cannot be determined without due consideration given to the explanatory variables on one hand and commercial property values on the other. The use of roads leads to a study of urban areas in relation to land uses, especially commercial properties. It is against this background that this study was conceived.

1.3 Research Questions

The foregoing has elicited a number of questions in terms of road network analysis and values of commercial properties in Ikeja, Nigeria to which answers are to be proffered. The relationship between arterial road network and commercial property values cannot be determined without due consideration given to variables that make up the network, especially those that relate to arterial roads and other explanatory variables and values of commercial properties. Some pertinent questions to enable the study attain its stated objectives are as follows:

1. What is the pattern of arterial roads in Ikeja?
2. What are the spatial pattern and trend of commercial property values in the study area?
3. What are the relationships between commercial property values and arterial road network in the presence or absence of other explanatory variables?
4. What are the individual contributions of the explanatory variables to variability in commercial property values?
5. What are the models to explain and predict the relationship between the explanatory variables and commercial property values?

1.4 Aim and Objectives of the Research

The aim of this research is to analyze the network of arterial roads and other explanatory variables and commercial property values in Ikeja, while the specific objectives are to:

a. Analyze the arterial road network pattern in the study area;
b. Examine the spatial pattern and trend of demand, supply and values of commercial properties in the study area;
c. Determine the relationships between commercial property values and road network, in the presence or absence of other variables, in the study area;
d. Determine the contributions of individual explanatory variables to variability in commercial property values in the study area;
e. Derive models for predicting variability in commercial property values in relation to the explanatory variables.

1.5 Research Hypotheses

Consequently, the following hypotheses were postulated:

1. There is no significant relationship between commercial property values and independent explanatory variables in the study area.
2. There are no differences in individual contributions of explanatory variables to variability in commercial property values in the study area.

1.6 Justification and Rationale for the Research

It is trite amongst earlier studies on accessibility in relation to property values that profitability and utility are determined by accessibility. The greater the accessibility of a location the greater the comparative advantage, and the greater the comparative advantages the greater the demand for property at the location. Lean and Goodall (1977), for instance, stated that urban areas naturally develop at nodal points in the transport network and those locations with good transport access to other areas have relative advantage over locations with poorer transport facilities and that urban locations having such relative advantages are likely to be where transport routes converge. Similarly, Estate Surveyors/Valuers and Planners believe that accessibility has great impacts on property values, with properties along major roads and at nodal points having greater values (Ogunsanya, 1986; Oduwaye, 2004; Omoogun, 2006). However, accessibility discussed in these studies was based on intuition without empirical basis to justify what relative accessibility advantages the locations have.

This study borrows techniques found useful in other fields like operational research, geography, transportation and urban planning to explain and analyze road network for purpose of determining the relative accessibility of each of the arterial roads. It is believed that the techniques used in these fields can be extended to studies in estate management, thereby making cross-fertilization of research ideas across various fields possible. In this regard, this research has become relevant in determining the relationship between arterial road network and values of commercial properties in Ikeja.

In addition, it is essential to establish a technique that may be useful for determining relative accessibility of locations in the network of arterial roads. Even when relative advantages are determined, there is need to develop models that will be useful for predicting commercial property values in Nigeria. The model may become tool for professional Estate Surveyors and Valuers to change their practice of using intuition to determine relative accessibility of locations in a road network. Similarly, there is the need to predict the supply of, demand for, and fair market values of commercial properties by developers, Estate Surveyors and Valuers, and feasibility and viability appraisers in present day's risks and uncertainty in property development. This has underscored the importance of this study.

Based on complexity of commercial, industrial, real estate activities and degree of urbanization exemplified by the study area, deductions and findings from the study may be applicable to other cities in Nigeria. The study will also arouse the interest of researchers in estate surveying and valuation particularly along transportation valuation, an aspect that probably has not been explored in Nigeria.

A review of literature showed that studies on Nigerian intra-urban road network using the graph-theoretic concept to determine accessibility effects on commercial property values are scanty, available ones were on USA and U.K. This study will therefore contribute to empirical studies on intra-urban road network and its influence on commercial property values in Ikeja, Nigeria.

1.7 Scope of the Study

Roads may be classified as international, inter-city or intra-city. International and inter-city roads are usually major or arterial roads, while intra-city roads are routes within a city and may be minor or major (arterial). The study focused on arterial roads in the intra-urban network of Ikeja. There are ninety roads in Ikeja out which thirty-seven are arterial. From the thirty-seven arterial roads in the study area, only twenty traverse the commercial axes while others serve institutional, industrial, and residential neighbourhoods. This study therefore covered all major roads serving the commercial axis and inner areas of Ikeja to the exclusion of inter-city roads such as Lagos/Abeokuta Expressway, Oworonsoki/Apapa Expressway, Ikorodu Road, and Lagos/Ibadan Expressway that form rings around the study area.

Preliminary study revealed that there are five types of commercial properties in the study area. These are retail shop premises, banking spaces, office properties, warehouses, and non-specific commercial properties. In respect of this research, focus was on offices, shops, banking spaces and other types of commercial users along the arterial routes to the exclusion of residential, industrial, and non-specific type of commercial properties.

Due to the magnitude, terrain and complex nature of Lagos State roads, the study was limited to Ikeja intra-city roads. Ikeja is the predominant component of Ikeja Local Government, which itself is one of four zones identified within the larger Lagos metropolis. The four zones (Lagos Island, Apapa, Lagos Mainland, and Ikeja) represent commercial hubs of Lagos metropolis, which as revealed by preliminary observation, shows activity areas where employment, commercial, transportation terminals, and other businesses are concentrated (Oni, 2008).

Road network analysis was carried out to determine the levels of accessibility and connectivity of nodal points as well as road and traffic densities in the hope of predicting commercial property values along each arterial road. In doing so, only the arterial roads identified as commercial axes in the study area were the focus of the research to the exclusion of secondary connector roads, while the relationship between arterial roads and commercial properties in the study area were examined.

Many factors have dictated the choice of Ikeja. First, it is the capital of Lagos State of Nigeria and a socially heterogeneous city with variety of local, state and federal government roads. Second, the property market in the study area is well developed and it is possible to identify and analyze variations. Comprehensive data are available on commercial property values in Ikeja, which is one of the few cities in Nigeria offering opportunity for comprehensive survey of its commercial properties, with enlightened occupiers of commercial premises thereby making data collection possible. Third, a number of property magazines are in circulation in the city where professional Estate Surveyors and Valuers advertise commercial properties available for sale or letting. This makes the property market very active and up-to-date with stakeholders, prospective tenants, property owners, and investors versatile and knowledgeable about the goings-on in the market. Fourth, judging from what is applicable in Nigeria, the Ikeja road network is one of the most complex in terms of linkages, human and vehicular movements with availability of computerized and up-to-date data and satellite images of the road network.

1.8 Limitations of the Study

The study focused on analysis of arterial roads and commercial property values in Ikeja. It did not attempt to investigate the structural stability of the arterial road network or assess the methods and accuracy of methods adopted by respondents in fixing the values of commercial properties in the study area. It simply analyzed accessibility, connectivity, arterial road network, distance to most central place in the study area, demand and supply of commercial properties in relation to commercial property values in the study area. Graph theoretic technique was used to analyze the arterial road network while opinions of Estate Surveyors and Valuers practicing in the study area were relied upon. The accuracy, or otherwise, of such opinions although not in doubt was not investigated.

Some challenges were encountered during the study. By virtue of the busy nature of Estate Surveying and Valuation practitioners and “carefulness” of occupiers of the sampled commercial properties, there was considerable reluctance on their parts to volunteer information. Some of the respondents, especially Estate Surveyors and Valuers, delayed in completing the questionnaires and it took personal influence of the researcher (as their colleague) and assistance of the Lagos State Branch Chairman of the Nigerian Institution of Estate Surveyors and Valuers to obtain their eventual impressive responses. In addition, the researcher took time to allay the fears of Occupiers by educating them about the essence of the research, that it would in no way expose them to imposition of levies or charges or any liability to the Lagos State Government.

The populations of commercial properties and occupiers in the study area were indeterminate. The study population was too large and there was no census available to ascertain them thereby making determination of their number somewhat tasking. The researcher however found a way out of the challenge by using a form of sampling based on estimated population of occupiers and adopting direct observation of the sampled properties to determine the average number of occupiers. These limitations however neither affected the quality of data collected nor the conclusions drawn from it.

The various opinions of Estate Surveyors and Valuers were relied upon, in some cases, to the exclusion of those of occupiers especially in respect of questions that required a form of professional opinion. This was consequent upon the findings from the pilot tests earlier conducted which showed that the occupiers found such questions too technical. Hence, questions like rating of the roads in the study area in terms of accessibility, supply and demand of commercial properties were subsequently limited to the Estate Surveyors and Valuers.

1.9 The Study Area

Ikeja city is a large component of the Lagos metropolis. Lagos itself is the largest city in Nigeria, located at 6°34′60″N, 3°19′59″E along the West African coast and was the capital city of the country before it was replaced with Abuja on 12th December, 1991. However, Lagos remains the commercial nerve centre of Nigeria. The city is a typical example in the history of growth and development of urban areas in Nigeria. The Western Region administered the city along with Agege, Mushin, Ikorodu, Epe, and Badagry until Lagos State took off as an administrative entity, and in 1976 Ikeja replaced Lagos Island as the capital of Lagos State; consequently, more roads were constructed.

In the general context, Lagos State is made up of twenty local government council areas out of which sixteen form the metropolitan Lagos and Ikeja Local Government area is one of them. Ikeja is both the administrative capital and Headquarters of Ikeja Local Government Council Area of Lagos State. Ikeja Local Government Council Area is located in the north-central part sharing boundaries with Ifako-Ijaiye, Agege, and Alimosho Local Government Council Areas in the western perimeter; Kosofe, and Mushin Local Government Council Areas in the eastern side, while Oshodi-Isolo Local Government Council Area forms the boundary in the southern part and Ogun State in the north as shown in Fig. 1.1

Fig.1.1: Map of Metropolitan Lagos Showing the Location of Ikeja
Sources: Map - Bohr (2006)

Described in terms of its operational structures, Ikeja is divided into seven sectors. Sector One lies in the north-central part of the metropolis and consists mainly of residential neighbourhoods with occasional commercial users of banks and service offices, and Isheri-Agege Road is the only arterial road traversing the Sector. Sector Two is of predominantly industrial concerns around WEMPCO, ACME and Lateef Jakande Roads; Sector Three is almost centrally located in the study area and consists of Oba Akran Avenue, Adeniyi Jones, Aromire Avenue, and Obafemi Awolowo Way that serve as demarcation between Sectors Three and Five. The sector is predominantly residential interspersed by few industrial concerns and commercial outfits that over the years have displaced residential users along the arterial roads.

Sector Four lies in the eastern part of the study area served by Secretariat Road, Ikosi Road, Oregun Road, 7-up Road and bounded by Lagos/Ibadan Expressway and Ikorodu Road. Sector Five, which is bounded, by Sectors Three, Four and Six consists of Allen Avenue, Opebi Road, Ola Ayeni Street, Toyin Street, Olowu Street, Kodesho Street, Simbiat Abiola Road, Otigba Street and Opebi Link-Road. The sector is characterized by concentration of commercial properties and represents the main commercial sector of the study area (Fig. 1.2).

Also from Fig. 1.2, Sector Six occupies the southern part of the study area and consists of Government Residential Area (G.R.A), and institutional properties (Army Barracks, Police Barracks, High and Magistrate Courts, Lagos State Administrative Centre, Passport Office and Nigeria Telecommunication Limited). Properties along the major roads in the Sector have undergone a change from residential to commercial use. Roads within the Sector include Mobolaji Bank-Anthony Way, Adekunle Fajuyi Way, Isaac John Street, Oba Akinjobi Street; while Sector Seven which lies at the western part consists of Murtala Muhammed International Airport.

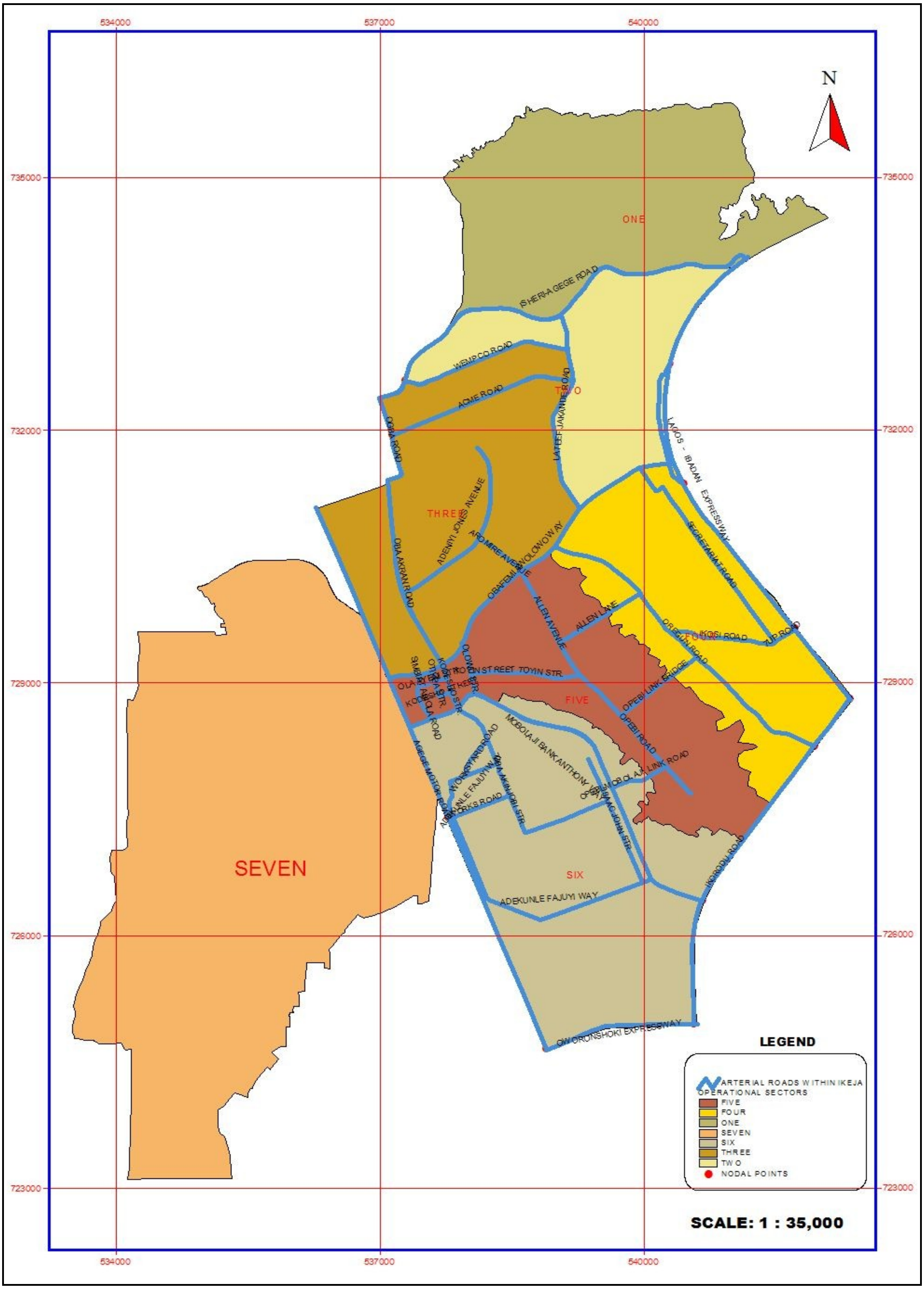

Fig. 1.2: Satellite Image of Operational Sectors in Ikeja Metropolis
Source: Lagos State Planning Information Centre, Ikeja

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this Chapter, available literature was reviewed along subject matter of the research project, which are arterial road network and commercial property values; the central theme being road transport, accessibility and commercial property values. To address the theme, this Chapter undertakes a review of literature on individual components of the central theme and combinations of such individual components, as basis for developing the researcher's ideas on the general concept of the study. The review of literature, in addition, aims at providing detailed account of earlier studies in order to identify the gap that exists in the literature, which the thesis attempted to fill. Literature from extant disciplines such as land economics, transportation management, and regional planning, amongst others found useful for addressing the central themes were studied. Specifically, emphasis was on previous writings on transportation, road network pattern and analysis, intra-urban accessibility, centrality and urban land value, and commercial property value.

2.2 Road Network Pattern and Analysis

Road network consists of large number of interwoven roads exhibiting many patterns ranging from star-like to grid-like with irregular patterns becoming recognized (Zang and Lund University, 2004). It consists of large amounts of roads that interweave with each other to exhibit a pattern. Patterns are defined as 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 repeated with sufficient regularity. Such repeated properties may be shape, orientation, connectedness, density or distribution. The frequency of such patterns enables development of prototypical views of geographical processes (Mackaness and Edwards, 2002).

The route network is a set of nodes representing spatial locations and displays topological and geometric variations, while topology itself refers to the arrangement and connectivity of nodes and links of a network (Wyatt, 1997). The route network consists of primary and secondary roads known as arterial and minor roads respectively. Arterial roads are moderate or high-capacity roads that are below highway level of service, carrying large volumes of traffic between areas in urban centres and designed for traffic between neighbourhoods. They have intersections with collector and local streets, and commercial areas such as shopping centres, petrol stations and other businesses are located along such roads. In addition, arterial roads link up to expressways and freeways with inter-changes (Wikipedia contributors, 2008).

According to Aderamo (2003), road network constitutes an important element in urban development as roads provide accessibility required by different land uses and the proper functioning of such urban areas depends on efficient transport network, which is a backbone to their very existence. The analysis of the road network involves the recognition of the patterns and qualities of the roads. 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 the process of abstraction and symbolization, by which pattern is viewed as complexes of primitive objects and relationship between the primitives. This gives the shape, extent, orientation, density, topology and configuration as their intrinsic properties. Topology, according to Xie and Levinson (2006), is an arrangement and connectivity of nodes and links of measuring the spatial structure while configuration refers to collection of objects that comprise the pattern of road networks.

In computing density, the network indicator approach was used to partition road network into different parts in reasonable way before the roads inside each part were extracted and the density calculated using indirectly related parameters. This results in number of connections to describe 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 ones in the dense area will connect to more roads than that in a 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). According to Inforain online (2008), road density can also be calculated as the total length of all known roads divided by the total land area in a road network.

Many techniques had earliier been used in analyzing road network patterns (Mackaness and Beard, 1993; Mackaness, 1995; Thomson and Richardson, 1995; Mackaness and Edwards, 2002; Jiang and Claramunt, 2004; and, Jiang and Harrie, 2004) namely, connectivity, shortest path spanning tree, and minimum cost spanning tree from graph theory to facilitate structural analysis and road selection in the road networks. Another approach based on perceptual grouping was equally used to group road segments according to continuation principle by ordering and selecting strokes into which the roads are segmented (Thomson and Richardson, 1995).

Modern techniques introduced for the explanation of the effects of accessibility on property values range from geographically weighted regression technique, multinomial logit models, to geo-spatial analysis adopting the Geographical Information Systems (GIS). For instance, a study on office rents in Berlin between 1991 and 1997 adopted a regression model to derive residual figure for rent not explained by non-location factors. The residuals were plotted based on the use of GIS and found that the street system is modeled as a network and calculated as accessibility values based on the relationship between individual streets and configuration of the system as a whole (Desyllas, 1998).

The multiple regression analysis was similarly used in the study on the effects on values of single family dwellings at three of six stations of the opening of the Bay Area Rapid Transit (BART) on properties in San Francisco; it found small but significant positive effects on the value of single family dwellings (Dvett, 1979). The same technique was used to analyze the impact of Glasgow underground rail system modernized between 1977 and 1980 by which it was found that there was positive effect on house prices in those areas associated with the new rail services (Martin Vorhees Associates et al, 1982).

Hedonic price model was used in many studies which have been confined to the United States. For instance, Hoag (1980) studied industrial property in an attempt to develop an index of real estate value and return based on four hundred and sixty-three transacted prices spanning five-year period between 1973 and 1978. The study tests the significance of property characteristics, national and regional economic indicators and location variables. Location variables were found to be significant although the paper did not define what were actually measured, many of the variables were discarded in the final model despite their statistical significance although the economic indicators were retained.

Ambrose (1990) concentrated on property specific factors ignoring location variables. The study relied on data from highly concentrated area of Atlanta metropolis with assumption that there will be no location bias. The study tested series of property characteristics that included size, office space, ceiling height, number of drive-in doors, number of high docking doors, presence of a railway siding, sprinklers and building age. It found that the variables produced result, which was significant at 0% level.

Another method is agent-based simulation of the amount of road use and selection of roads with high level of usage. The approach consists of algorithm base for road generalization adopted to create a version of network of roads that exhibits certain properties, which includes good connectivity, length of the roads, degree of continuation, and degree and frequency of usage (Morisset and Ruas, 1997).

It is pertinent to state that as good and exploratory as these approaches are, they do not guarantee that some important properties of road network are not distorted. Some of the approaches (Morisset and Ruas, 1997; Thomson and Richardson, 1995) ignore the analysis of road network patterns thereby losing its essential patterns. This therefore called for new techniques further developed by researchers. One of the techniques to ensure detailed analysis of the road network pattern is the graph theory.

Graph theory is a type of directed, weighted network which in relation to transport is typically network of roads, streets, pipes, aqueducts, power lines, or nearly any structure which permits either vehicular movement or flow of some commodity. Transport networks are spatial structures designed to channel flows from the points of demand to points of supply and so link the points together in a transportation system. They are useful for transport network analysis to determine the flow of people, goods, services and vehicles (Wikipedia contributors, 2008).

A graph-based approach in studying patterns of road networks involves the introduction of hierarchical structure of different graphs to reproduce different levels of details of the network. The basic graph contains nodes and lines, the nodes represent line intersections, edges correspond to lines, and topological structure of the graph results in patterns of the road network (Heinzle, Anders, and Sester, 2005). Similarly, spatial networks are derived from maps of open space within the urban context or building. The space map is likened to negative image of a standard map with open space cut out of the background buildings or walls and resulting space map is broken into units of road segments called nodes of the graph. The nodes are linked together into a network through intersections called the edges of a graph (Wikipedia contributors, 2008).

In transportation network analysis, a common instance treats the road segments as edges and street intersections as nodes in the graph, and it is possible to derive useful descriptive indices by divorcing transport network from their inert spatial form. Network analysis also reduces complex transportation network to its fundamental elements of nodes making an evaluation of alternative structures possible through use of elementary mathematics from graph theory (Hodder and Lee, 1982).

Various studies have been carried out using the graph-theoretic concept, amongst which are Garrison and Marble (1960) and Nystuen and Dacey (1961). The former applied graph theory in measuring regional highways in the United States of America, while the latter analyzed functional connection between central places in Washington using communication flows in a network. In addition, Muraco (1972) used the concept in studying intra-urban accessibility in Columbus and Indianapolis, USA, and in estimating traffic flow in Barnsley, U.K. (Ogunsanya, 1986).

In Nigeria, Aderamo (2003) used graph theoretic analysis in studying the growth of intra-urban network in Ilorin. The study found various indices of network development for the periods 1963, 1973, 1982 and 1988 tracing the growth of the intra-urban network of the town between 1963 and 1988. The study also found relationship between road development and expansion of city, and significant effect on transportation planning and property development. Also, in Nigeria, the method was used to determine degree of accessibility and connectivity of nodal points within a road network using a university community as case study (Oni, 2007a), and similarly in the analysis of accessibility and connectivity in the road network of a metropolitan area also in Nigeria (Oni, 2007b).

These works, which were carried out on regional basis, succeeded in determining the degree of accessibility and connectivity of nodal points in the road network of the study areas but they did not relate the degree and levels of such accessibility and connectivity to property values. The important issue is to determine how such accessibility and connectivity relate to property values instead of mere deductions that certain roads are better accessible as posited in the studies. Apart from this, existing literature in Nigeria have not considered road transport in relation to commercial property values. This study therefore intends to fill the gap by applying the graph theoretic approach in analyzing road network and determining the effects and relationship between its explanatory components of accessibility, connectivity, density of road, density of traffic, level of road service, and values of commercial properties in Ikeja.

2.3 Transportation and Property Value

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 Lagos, 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 was 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 consequently, 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 impact 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 Nigeria. Even the few studies carried out in Nigeria (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 Ikeja, Nigeria. It will also bring out a model that would be useful in predicting the commercial property values in the study area.

2.4 Transportation and Accessibility

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). In this study, the empirical evidence supports hypothesis that greater accessibility to transportation increases land values.

In Nigeria, much of earlier works on accessibility and property values state that properties sited far away from major streets have poor degrees of accessibility and command low values (Omoogun, 2006). This assertion was based on mere intuition without any empirical investigation. In another study, Olayiwola et al (2005) attempted to explain the relationship between various land value determinants in metropolitan Lagos, using factor analysis and principal component techniques. They found that factors such as accessibility, rent, transport improvement, quality of neighbourhood, infrastructural facilities, and government regulations, have high level of co-variation. The score on the relationship between accessibility and transport improvement shows the highest positive association with a figure of 0.87 meaning that improvement in transportation facilities, especially roads bring about improved accessibility. Also, the relationship between transport and rent shows very high degree of positive relationship (0.732), quality of environment and zoning regulation (0.731) and, accessibility and rent (0.719) recorded very high degree of positive relationship. The implication is that improvement in transportation and accessibility bring about higher rents and the factors are basic to influence residential land values. This study appeared better in empiricism than that of Omoogun (2006) as it attempted to consider a number of factors exogenous to property in determining their relationship with rent.

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 Nigerian situation. Their adoption for use in the Nigerian 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.

2.5 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 Oyebanji (2003), a number of factors affect property values in Nigeria. 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. Other factors identified by Sada (1968) include the effects of political factors on geography of a study area noting that the emergence of Lagos as a livable city was as a result of the political decision that made it a capital city in 1914. The difference in jurisdictional areas within the city and the associated varying levels of resources, the city has become a complex city. He concluded that the supply of different services is bound to make the city differentiated along many socially related lines with concomitant effects of property values.

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 center 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 Nigerian 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.

CHAPTER THREE

THEORETICAL FRAMEWORK

3.1 Introduction

In this Chapter, major theories propounded and found relevant to this study are discussed. These include concepts of property and property values, accessibility and complimentarity, graph theory, urban rent determination model, and theory of urban location are discussed in relation to this study.

3.2 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).

3.3 Accessibility and Complementarity Theory

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.

3.4 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 compelementarity, 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.

3.5 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 criterion 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:

$$\boldsymbol{\beta} = \frac{E}{V} \qquad \textbf{...Eqn.3.1}$$

where,

β = Beta Index;

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 (α) 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:

$$\text{Alpha Index } (\alpha) = \frac{(E - V + G)}{(2V - 5G)} \times 100$$ **…Eqn.3.3**

The Gamma Index (γ) 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.

$$\text{Gamma Index } (\gamma) = \frac{E}{3(V - 2G)} \times 100$$ **…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 nodality 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 vanEck, 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.

3.6 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 maneuverability, 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 maneuverability; 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 maneuver, traffic interruptions, and comfort and convenience."

Road hierarchy, as postulated by Onakerhoraye and Omuta (1994), 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. These range from inner-city grid to peripheral tributary types as indicated in APPENDIX I. 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.

3.7 Agglomeration Economies and Location Theory

The neo-classical or Weberian location theory evolved around cost minimization triangles. Optimum location revolves around the cost of materials and transportation costs: exogenous changes in costs can lead to alterations in the input mix of raw materials or to a new location. A serious limitation is that land/property rents are not included in the model, and so do not influence the location decision. The model was criticized for having an incomplete production function, which renders them devoid of any real world economic meaning despite their mathematical consistency. As a result, they are "meaningless as a basis for discussing why particular types of firm producing particular products exhibit particular types of locational behaviour" (McCann, 1995). Gordon and McCann (2000) reviewed models of industrial clustering, distinguishing between the classic agglomeration model, the industrial complex model where firms group as part of the production process and a network of firms, derived from sociological perspectives. The classical agglomeration model capitalizes the benefits in local rental value.

The intra-urban location theory originated with Alonso's land use model (Alonso, 1964). The theory implicitly assumes agglomeration economies in the city centre based on a city located on featureless plain where land use is allocated to the highest bidder in a competitive land market. In a uni-nodal city, the central business district (C.B.D.) is the point of maximum accessibility where business revenue is at maximum and costs (other than land costs) are minimized. Differences in the optimum locations of industrial and commercial land uses relate directly to the responsiveness of revenue and costs to distance from the centre presuming that revenues fall and costs rise with distance from the CBD. The Alonso (1964) and Di Pasquale and Wheaton (1996) models offer similar findings. The common finding is that of a declining rent gradient from the CBD but differ in their assumptions; while Di Pasquale and Wheaton (1996) presumed that revenue is spatially constant, Alonso has revenue decreasing with distance from the CBD leading to steeper distance decay gradient.

According to Lean and Goodall (1977), the explanation of actual location or patterns of land use are distinguished from an explanation of rational location or pattern of land use. Location theory seeks to answer the question of what is the most rational location or pattern of land use. The theory starts from assumptive base of fixed locations of markets and sources of factors of production and a given transport system, proceeding to build up the ideal or best location pattern. It relies on some criteria to judge what is the best pattern and earlier theorists define their criterion in terms of either costs or revenue and the most realistic one being profit-maximization. The same criteria are used for business uses in allocating urban sites amongst competing users.

Location theory is primarily concerned with the areal or regional pattern of distribution of productive activity, to the extent that a certain area is best suited for a particular activity but not suggesting that a given site is the best. Productive activities would derive advantages from being located within certain areas but within the areas, there may be many sites offering such advantages. According to the theory, locations of economic activities are influenced by economies derived from large-scale operation and from proximity to complementary firms and facilities, although each is affected by internal economies of scale with varying degrees. The benefits to activities grouped in a limited geographical area include greater volume of business. Commercial activities are highly dependent upon location and with a short distance one site needs differing and not as good as another. This determines the volume of sales and the number of sites that can be profitably occupied strictly limited, and such sites are preferably located along road transport that provide good accessibility.

3.8 Summary

The various theories and concepts were reviewed in order to set the foundation on which the aspects of the research were founded. A review of literature on earlier works was carried out with gaps in such studies identified. Some of the works and theories emphasized that the more accessible a location is the higher the value, and the better a location is connected in terms of network of access roads the higher the values of properties than a location that is in a disadvantaged location. Other works however found no direct impact of transport network on location of land use. In addition, different types of road network patterns were identified in the Chapter to assist in road network pattern analysis in this study. Literature on transportation and commercial property values on Nigeria are scanty, thus this study will fill the gap.

The theoretical frameworks that are relevant and adopted for this study are the concepts of property and property values, accessibility theory, pattern of road network and property values, model of road classification and hierarchy, and location theory. These theories and concepts are essential to guide the study towards attaining the stated aim and objectives and determine if the research findings confirm or contradict them.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This Chapter describes the methodological framework used in attaining the stated aim and objectives of the study. This Chapter showed how the research hypotheses postulated were empirically determined and examined relevant methodological approaches adopted in the study. The research design, type and sources of data were examined along with the procedure employed in testing the hypotheses and accomplishing the study objectives. In particular, focus was on the study populations/sample frame and its characteristics, sampling technique chosen, and a description of the choice of data collection instruments, questionnaire design, and methods of data measurement, analysis and presentation were contained in this Chapter.

4.2 Research Design

This section addressed the plan, structure, and strategy of investigation of issues related to the intra-urban road network and commercial property values in Ikeja metropolis of Lagos State. The plan outlined the research scheme by which the work was carried out, the structure indicated specific outline, while the strategy shows the means by which the research was executed and the methods adopted in data collection and analysis.

In this study, the cross-sectional survey type of design was used. This included descriptive, exploratory and explanatory designs to describe each of the many variables that are necessary for the study.

4.3 Types and Sources of Data

Required data were from primary and secondary sources. The primary data were obtained through questionnaires and were complemented with oral interviews of Estate Surveyors and Valuers, and occupiers of commercial properties involved in the study. Secondary data were obtained from property pages of newspapers in circulation in Ikeja; these newspapers include Castles, The Guardian, and The Punch. Telephone contacts were subsequently made with advertisers of such properties to obtain minimum values of the commercial properties on offer for letting along the arterial roads.

The secondary sources of data included Survey Directorate in the Lagos Ministry of Land and Physical Planning, Ministry of Transportation, Directorate of Land Information Systems in the Land Bureau, Ikeja, and West African Book Publishers Limited, Ilupeju, Lagos from where the Lagos Road and Street Maps were obtained. Details of road network were derived through the analysis of the satellites road maps while data on volume of traffic was obtained from Lagos State Traffic Management Authority (LASTMA). The data on volume of traffic along the arterial roads in the study area was obtained from LASTMA. The data was collected over a period of six months between October 2007 and April 2008. The period for traffic counts covered fourteen hours daily between 6a.m. and 8 p.m. at thirty minutes intervals. Average of the total counts for the seven months period was determined for each road.

4.4 Study Population

This research identified three study groups for investigation. These are the arterial roads in Ikeja, Nigeria, the firms of Estate Surveyors and Valuers, and commercial properties along the arterial roads.

Preliminary survey carried out on Lagos metropolis, using the Lagos Street Map (2008) as guide, revealed that there are 9,197 roads made up of dual carriageways, cul-de-sac, lanes, streets, avenues, ways, and crescents. The map is the current edition that covers the metropolis with new roads constructed after its publication located at the suburb of the study area. Out of the total 9,197 roads in Lagos metropolis, only 350 are arterial. When the three hundred and fifty (350) arterial routes were divided according to zones in Lagos metropolis, Lagos Island has 102 arterial routes (representing 29%); Mainland, 119 (34%); Apapa, 39 (11%) and Ikeja, 90 (26%). From the ninety roads that traverse Ikeja (the study area) thirty-seven (37) serve the mainly commercial and mixed commercial/industrial areas. From this, only twenty (20) mainly traverse the predominantly commercial axes while the remaining seventeen (17) serve institutional, industrial, and residential neighbourhoods. This study covered all major roads serving the commercial axis in Ikeja urban area to the exclusion of inter-city roads such as Lagos/Abeokuta Expressway, Oworonsoki/Apapa Expressway, Ikorodu Road, and Lagos/Ibadan Expressway that also form rings around the study area.

According to the register at the Lagos State Branch of the Nigerian Institution of Estate Surveyors and Valuers (NIESV), there are three hundred and twenty-five firms of Estate Surveyors and Valuers practicing in the Lagos metropolis as at March 2008. One hundred and ten (about 34%) operate in Ikeja, the study area. For commercial properties along the arterial roads in Ikeja, geographical information system was used to determine the population from where samples were made. In doing so, satellite image of the study area was derived using geographic information system and it was revealed that there were estimated two thousand and eight (2, 008) properties located along arterial roads.

4.5 Sample Frames

Sampling frame refers to complete list of all units in the population under study, and determines the structure of enquiries (Olaseni, 2004). A sampling frame has the property identifiable in every single element and includes the elements in a sample, and it is representative of the population. In choosing the sampling size and secure representative’s responses, the size of the sample was based on statistical estimation theory considering degree of confidence that is expected on the research of this nature.

The total number of arterial roads that traverse the Ikeja metropolis was determined from the network of roads using the Lagos Street Map (2008) and satellites maps obtained from the Directorate of Land Information Systems in the Lands Bureau, Governor’s Office, Ikeja. The Directory of Estate Surveyors and Valuers published by the N.I.E.S.V. (6th Edition) and the register available at the Lagos State Branch of the N.I.E.S.V. were used to determine the population of registered firms of Estate Surveyors and Valuers practicing in Lagos metropolis as at January 2008. Geographic information system (GIS) was used to determine the population of commercial properties captured in the study area.

4.6 Sample Size

A number of models have been developed to estimate sample size. Bartlett, et al (2001) developed a model for determining the minimum returned sample size for any given population size for continuous and categorical data. The model simplified lengthy calculation exemplified in Cochran's (1977) model and may be used if margin of error shown in the Table is appropriate for a research study and that sample size would need to be calculated if the error rates are not appropriate. Table 4.1 was developed by Bartlett et al (2001) based on margins of error of 0.03 for continuous and 0.05 for categorical data with consideration of appropriate study population, sample size, and alpha value.

Table 4.1: Minimum Returned Sample Size Table for Continuous and Categorical Data

S/N	Population Size	Sample Size					
		Continuous data (margin of error = 0.03)			Categorical data (margin of error = 0.05)		
		alpha=.10; t =1.65	alpha=.05; t =1.96	alpha=.01; t =2.58	p=.50; t =1.65	p = .50; t =1.96	p = .50; t =2.58
1	100	46	55	68	74	80	87
2	200	59	75	102	116	132	154
3	300	65	85	123	143	169	207
4	400	69	92	137	162	196	250
5	500	72	96	147	176	218	286
6	600	73	100	155	187	235	316
7	700	75	102	161	196	249	341
8	800	76	104	166	203	260	363
9	900	76	105	170	209	270	382
10	1,000	77	106	173	213	278	399
11	1,500	79	110	183	230	306	461
12	2,000	83	112	189	239	323	499
13	4,000	83	119	198	254	351	570
14	6,000	83	119	209	259	362	598
15	8,000	83	119	209	262	367	613
16	10,000	83	119	209	264	370	623

Source: Bartlett et al (2001)

In determining the sample size that is adequate for this study, the Bartlett *et al*'s (2001) model was used. The research sought to define sample of commercial properties to ensure at least 95% level of confidence and that probable error of using a sample rather than surveying the whole population did not exceed 0.03. The sample size was obtained from the number of commercial properties along the arterial roads in Ikeja, based on the total population of 2,008 commercial properties along the commercial axes.

In arriving at the sample size, two key factors were considered, these are the risk that the researcher was willing to accept, commonly called the margin of error, and consideration of the alpha level which is the level of acceptable risk in a way that true margin of error exceeds the acceptable margin. This means the probability that the differences revealed by statistical analyses really do not exist. Such errors occur when statistical procedures result in a judgment of no significant differences when these differences do indeed exist. These were addressed in this study to make the research finding reliable.

In most research studies, alpha level used in determining sample size is either 0.05 or 0.01 (Ary, Jacobs and Razavieh, 1996). The general rule of acceptable margin of error in general terms is 5% for categorical data and 3% for continuous data. A 3% margin of error to give a confidence that the true mean of a seven-point scale is within + 0.21, that is, 0.03 times seven points on the scale of the mean calculated from the sample size. For this study, categorical data were used at the alpha level of 0.05

According to the Bartlett et al (2001)'s model, the appropriate sample size for population of two thousand and eight (2,008) commercial properties along the arterial roads in the study area is four hundred and ninety-nine (499) which was rounded up to five hundred. Since the researcher's interest was also in the population of the occupiers of commercial properties, preliminary survey of the sampled five hundred properties was carried out. The outcome shows that about five thousand (5,000) occupiers representing an average of ten (10) in a property were estimated. Consequently, appropriate sample size of occupiers of the sampled commercial properties is six hundred (600) based on the Bartlett *et al*'s model. For Estate Surveyors and Valuers, hundred percent of the firms was used for the study.

4.7 Sampling Technique

The procedure for choosing the sample units from a population is known as sampling. While the population of study may be finite or infinite, the sample is necessarily finite and there are various techniques of selecting units that make up the sample, which have been categorized into probability and non-probability techniques. In respect of this study, simple random sampling probability technique was used.

Of the three study populations, sampling was clearly unnecessary for the arterial roads and Estate Surveyors/Valuers. This was because the analysis of arterial roads in a network would be incomplete if not all arterial roads were included. Similarly, all firms of Estate Surveyors and Valuers in the study area were used because the population was not too large. Consequently, hundred percent of arterial roads and firms of Estate Surveyors and Valuers in the study area was used. For arterial roads, what appeared necessary to secure required data was the existing road maps derived by Geographical Information System (GIS) obtained from the Lagos State Land Services and Information Bureau, Ikeja.

Commercial properties identified were numbered serially as they flank both sides of the arterial roads; each municipal numbering was then represented in a ballot box. The required number of properties in the sample size was subsequently selected from the box until appropriate sample size was obtained. In this regard, the sampled commercial properties were divided according to spread and locations along the arterial roads within the study area.

4.8 Analytical Techniques

Two sets of data were collected namely, data on road network pattern and data on commercial property values. In analyzing the data, a number of techniques were used, which are graph theoretic approach, regression analytical techniques which include analysis of variance (ANOVA), liner and multiple regression models, principal component analysis, stepwise regression and second order polynomial trend regression models. The techniques and application are explained in the next Sub-sections.

4.8.1 Graph Theoretic Approach

Some of the earlier researchers used graph theoretic technique to carry out road network analysis; the technique was adopted in this study to determine the degree of connectivity and accessibility of each of the nodes within the networks in the study area. In this case, the Shimbel index and connectivity matrix respectively revealed the levels of accessibility and connectivity of the nodal points in the network.

Using the technique, the road map of the study area, showing arterial routes, was converted into linear graph regardless of the width, quality, and standard of the roads. From this, a connectivity matrix emerged to reveal the degree of accessibility of each node within the network of roads. Each node was rated according to its level of accessibility using the Shimbel index and connectivity index matrices. The Shimbel index matrix summarizes the number of edges required to connect each node or vertex with other nodes in the network through the shortest path. The connectivity matrix indicates the node with the highest total number of connection or linkage with the other nodes.

In the connectivity matrix, points were allocated to each node and where two nodes were directly linked, a value of 1 point was given, and where there were no direct links a value of 0 point applied. The connectivity matrix shows the number of other nodal points to which a particular node is directly linked and the node with the highest number of points was considered to be most connected and the node or vertex with the least Shimbel index was regarded as the most accessible.

This technique is applicable to determine the relative accessibility and connectivity of each road in the network of arterial routes in the study area. It is useful as it enables qualitative data to be converted into quantitative one.

4.8.2 Regression Analysis

The evaluation of relationship between dependent and independent variables was carried out using the multiple regression models. The first step consisted of defining the variables of interest. In this study, the values of commercial properties located along the arterial routes in the study area were expressed along a set of road network characteristics (connectivity, length of road, road density, quality, traffic density and width of each road), accessibility, demand and supply of commercial properties, and location attribute (distance from the most central part of the study area). This was to determine the relationship between the combined explanatory variables and commercial property values. The value of commercial property in this case is the dependent variable (Y) and the road network characteristics are the independent variables, represented by x_1, x_2, x_3, x_4,..., x_n

In this case, commercial property value was regressed and correlated on the set of explanatory variable of road network. The coefficients of the variables measure directly or indirectly the marginal effects of the independent variables on commercial property values in the study area. The most general form for the model is:

$Y = f(X, d)$ **…Equation 4.1**

where,

Y: the dependent variable is a measure of commercial property value;

f : a function to be specified;

x: explanatory variables of road network pattern;

b: variables measuring the explanatory variables

In specific form, Equation 4.1 translates into Equation 4.2

$Y = a + b_1x_1 + b_2x_2 + b_3x_3 +\ldots, + b_nx_n + e$ **…Equation 4.2**

where,

y = dependent variable (value of commercial properties)

a = constant

$x_1, x_2, x_3, \ldots, \ldots, \ldots, \ldots, \ldots, x_n$ are independent variables (road network variables – traffic density, connectivity, road density, quality of road; accessibility; location; demand; and supply)

$b_1, b_2, b_3, \ldots, \ldots, \ldots, \ldots, \ldots, b_n$ are the regression coefficients which determines the contribution of the independent variables

e = residual or stochastic error (which reveals the strength of $b_1x_1 \ldots b_nx_n$; if e is low the amount of unexplained factors will be low and vice versa.

The multiple regression analysis is relevant to this study as it assists in predicting, making inferences, testing the set hypotheses, and modeling the relationships between the variables. The other variant of regression models were also used, the second order polynomial trend regression model for instance was used because it has better explanation capacity and the parameters estimated comply with the researcher's expectation better than the result of a linear regression model. In addition, Analysis of Variance (ANOVA) was used to establish the total variations of the within and between variables to determine the relationship between the variables. The principal component analysis was carried out to obtain small number of linear combinations of the variables, which account for most of the variability in the data.

4.9 Methods of Measuring and Analyzing Data

The attempt here is to provide an exposition on the methods used to measure and analyze data for each study objectives and hypotheses. A summary of the techniques and modes of measurement to attain the set objectives are summarized in Table 4.2

Table 4.2: Details of Measurement and Data Analysis

S/N	Objective	Hypothesis	Mode of Measurement	Method of Analysis
1	Analyze the pattern of arterial road network in the study area.	-	**(1)** To determine connectivity, the master plan of the study area was converted into linear graphs. (**2**) To determine the accessibility, all the nodal points were numbered and the number of nodes from one point to the other was counted.	A matrix was developed and nodes of all roads in the network cross-tabulated to derived the accessibility and connectivity indices for each arterial road using the Graph Theory.
2	Examine the spatial pattern of rental values, and trends of demand for and supply of commercial properties in the study area	-	**(1)** Data on rental values, requests and letting transactions in past – 5years in relation to arterial roads were obtained from Estate Surveyors and Valuers. (**2**) Average rental values for each arterial road in the study area were determined. Trends of the values, supply and demand were derived using polynomial regression model.	**(1)** Map of the study area was used to illustrate the spatial distribution of rental values. **(2)** The Microsoft Excel® software was used with polynomial order 2; R^2 and trend line options selected to derive predictive models.
3.	Derive models to determine variability in commercial property values along the arterial roads in the study area.	-	Polynomial regression model was used with options for trendline and R^2 selected to obtain a predictive model.	Polynomial model involving explanatory variables and rental values used with Order 2 option. Trend lines and predictive regression equations were derived. In addition, Statgraphic® and Microsoft Excel® software packages were used.
4.	Establish the relationship between the explanatory variables and commercial property values in the study area.	H_{01}: There is no statistically significant relationship between commercial property values and explanatory variables in the study area.	Two sets of variables were considered in this hypothesis. First, were the explanatory variables (road network: including traffic density, road density, quality of road, and connectivity), accessibility; demand and supply indices; and location attributes. Second, is the rental value (dependent variable).	1. The dependent and independent variables were analyzed using multiple regression model and Analysis of Variance to determine the P-value and R^2 .
5.	There are no differences in relative contributions of the explanatory variables to variability in commercial property values	H_{02}: There are no differences in relative contributions of the explanatory variables to variability in commercial property values in the study area.	Each variable was considered individually and regressed against commercial property values to determine R^2 adjusted for degree of freedom.	Polynomial regression model of order 2 option was used to determine contribution of each variable. A summary of the results analyzed to establish the individual contributions of each variable.

Accessibility and connectivity indices were derived using the graph theoretic analysis of the arterial roads. The process of determining the accessibility indices involved tracing out the arterial routes in the road network using transparent paper. The resulting graph then analyzed to obtain required quantitative data using the graph theoretic qualitative technique. In obtaining the levels of connectivity and accessibility of each nodal point, the road network was converted into linear graph with each route represented by single line regardless of its width, quality and standard but taking the shortest route possible.

The connectivity and accessibility matrixes were consequently prepared and the nodes within the graph numbered serially in the resulting road graph. Indexes for accessibility and connectivity were thereafter determined and shown in the Shimbel connectivity matrixes. The Shimbel matrix summarizes number of edges required to connect each node or vertex with other nodes in the network through the shortest path while the connectivity matrix indicates the node with the highest total number of connections or linkages with the other nodes. In the connectivity matrix, a score of 0 or 1 was given to each node, that is where two nodes are directly linked, a value of 1 point was given. Where two nodes have no direct link, a score of 0 point is assigned. The connectivity matrix therefore shows the number of other nodes that a particular node is directly linked with and the node with the highest total number of points is considered as most connected. Similarly, the node with the least Shimbel index is regarded as the most accessible.

In operationalizing the accessibility and connectivity indices for thirty-five nodal points in the road network, the thirty-five nodal points were weighted over identified twenty arterial roads to obtain degrees of accessibility and connectivity in the network using Eqn. 4.3 as formulated by Oni (2007b)

$$a, (c)_i = \frac{np_{1i} + np_{2i}}{\sum (rnp_1 + rnp_2)} \times \frac{rnp_1}{rnp_2} \qquad \textbf{...Eqn. 4.3}$$

where,

$a(c)_d =$ accessibility or connectivity index;

np_{1i} = accessibility or connectivity index of lower nodal point;

np_{2i} = accessibility or connectivity index of higher nodal point;

rnp_1= rank for lower nodal point;

rnp_2= rank for higher nodal point;

Road density was measured by calculating the unit length of road in the network over the total land area in the study area, expressed as length per square metre, while the land area was obtained from the Lagos Street Map (2008). Density of each road was determined using Eqn. 4.4 formulated by Oni (2007b).

$$r_d = \frac{\sum_{i=1}^{n} lr_i}{A} \qquad \textbf{...Eqn. 4.4}$$

where,

r_d = road density

$lr_{i...n}$ = length of individual road

A = entire land area covered by the study area

Volume of traffic along each road obtained from the Lagos State Traffic Management Authority (LASTMA) was expressed in relation to size of the entire land area to determine the traffic density. This determined the number of vehicles per square metre of land area and it is an indication of level of congestion in the study area. Further to details in Section 4.3, the traffic count covered all motorized vehicles including cars, trucks, buses, cycles, regardless of whether they were privately or publicly owned. The totals from all the traffic counts were collated and average traffic density for each road determined as shown in Table 5.14.

Quality of road, according to earlier literature (Onakerhoraye and Omuta, 1994; Lawal, 2000; Marshall, 2005; Mannering, et al 2004; Schliessler and Bull, 2004) is subjective. Respondents' perception was analyzed based on five attributes identified in the literature and points were assigned based on the attributes with 5 for the best and 1 the least. The attributes used were: (i) tarred, no potholes, motorable, and having dual carriage; (ii) tarred, with potholes, but motorable, and having dual carriage; (iii) tarred, no potholes, motorable, but with single carriageway; (iv) tarred, but with potholes, but motorable, and having single-carriage; (v) tarred, with potholes, unmotorable and having single-carriage. In respect of quality of roads, arterial road that is tarred, motorable, with dual carriage and without potholes that could impede movements was assigned 5; 4 for those that are tarred, motorable, having dual carriage but with potholes; 3 to road that is tarred, single carriage, with potholes but motorable. The road that is tarred, with single carriage way, motorable and having potholes is assigned 2; while the road that is tarred, single carriage, having potholes and are not motorable was assigned 1.

4.10 Data Collection Instruments

A combination of self-administered questionnaires and in-depth personal interviews were considered most appropriate as data collection instrument for this study due to the advantages derivable from both approaches. The questionnaires ensured that questions posed to the respondents were uniformly phrased, thus permitting objective comparison of results while interviews gave the respondents opportunity to express views more expansively than would be possible with a closed-ended questionnaire. Moreover, the interviews permitted explanation of issues in the questionnaire by the researcher in areas where some respondents may not be fully knowledgeable. The intention was to frame questions in the form of a questionnaire combined with personal interviews to clarify information where required by the respondents.

Two sets of questionnaires were prepared. One type was for Estate Surveyors and Valuers (Appendix I), while the other was administered on occupiers of commercial properties (Appendix II). Out of 325 firms of Estate Surveyors and Valuers in Lagos metropolis 110 firms (representing about 31%) are located in Ikeja and one hundred and ten (110) questionnaires were therefore administered.

The questionnaires contained combination of closed and open-ended questions. The open-ended questions permitted respondents to give detailed answers in cases where their experiences could not be articulated into few options. The questionnaires addressed to occupiers of commercial properties consisted of questions that covered the location and background of respondents, length of time in occupation of the commercial property, what dictated the choice of present premises, questions relating to rental value of the premises. Other questions cover factors that influenced their choice of locations, and effects of locations along arterial roads on commercial property values.

For Estate Surveyors and Valuers, the questionnaire covered address of property, size, services, rent paid, size of land, while the respondents rated the determinant factors in addition to questions on rental values of commercial properties along the arterial routes in past five years. Other questions include estimate of the number of requests for commercial properties, factors that influence commercial property values, and of their perception of the quality and rating of arterial roads in the study area.

4.11 Validity and Reliability Tests

There are many kinds of validity, but they all refer to whether or not the data being measured truly reflect the what it ought to be. Reliability refers to consistency and ability to obtain the same answer each time a measure is used. There are three types of reliability test: inter-rater, internal consistency, and test-retest. Validity test determines if a measurement truly reflects the concept being studied. There are three common types of validity: internal, external, and construct. Reliability test determines the consistency that researchers should be able to obtain the same answer each time a measure is used. It is concerned with how consistent the result obtained with the instruments are and that the instrument gives similar, close or the same result if the study is replicated under the same assumptions and conditions (Asika, 1991).

In this study, various dimensions of the concepts of intra-urban road network and commercial property values and design instruments to generate data on each dimension were determined and tested for correlation among them. Two identical instruments measuring the same variables were administered within a short time interval. The decision rule was that different measures of the same construct should be fairly highly correlated - a high association among the forms indicates high reliability of the instrument and low association among them will show low reliability.

In addition, a pilot test was used to determine the reliability and validity of the questionnaire. For face and content validity of the instrument (content-related evidence), senior academics, specialists and experts on the topic were consulted to determine the appropriateness of the items of the instrument. This was to find out if the instrument covered the breadth of the content area and ascertain if the format used in designing it is appropriate for obtaining the required information.

Pilot studies were carried out on Covenant University community and larger Ikeja urban area applying the graph theoretic approach. During the pilot study, some specialized aspects and items that were discovered to be unnecessary and wrongly worded questions were consequently re-worded, reconstructed, or removed. The pilot test actually revealed possible difficulty that the researcher would have encountered during actual data and information collection exercise so precautionary measures were put in place. The pilot study also gave insight into the applicability of the graph theory in studies on both small and large communities.

CHAPTER FIVE

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

5.1 Introduction

This Chapter presents an analysis of the data collected from questionnaires administered to Estate Surveyors and Occupiers of commercial properties in Ikeja. For this purpose, the Chapter is structured into seven sections, namely, preliminary survey details; analysis of arterial road network including graph theoretic analysis, characteristics of the arterial road network, and analysis of accessibility and connectivity degrees in the road network. This is in addition to the analysis of commercial property values and spatial pattern of the properties.

The Chapter also deals with presentation of results, which begins with description of the participants' bio-data. The hypotheses formulated for this study guided the arrangement of the tables. Each hypothesis focuses on the variables identified (patterns of arterial roads as independent variables and commercial property as dependent or criterion variable). A summary of the main findings follows each hypothesis and in addition and where relevant, selected findings from the personal data collected are used to inform and contrast the findings.

5.2 Preliminary Survey Details

Data was collected between the months of January and July 2008. The administration of questionnaires on Estate Surveyors and Valuers was carried out personally, while four field assistants were involved in collecting data from occupiers of commercial properties. The various responses were analyzed between August and December 2008 with the aid of Statgraphic® statistical software and Microsoft Excel Spreadsheet®.

Two types of questionnaires (Questionnaires I and II) were administered. Questionnaire I was addressed to Estate Surveyors and Valuers, while Questionnaire II was administered to Occupiers of commercial properties. Considering the response rates in relation to sample size of the study groups, the response rate from Estate Surveyors and Valuers was 90% while 57% of the occupiers of commercial properties responded to the survey as detailed in Table 5.1

Table 5.1: Questionnaires Administered on Respondents

S/N	Type	Respondents	Number administered	Number of questionnaires returned	Response rate
1.	Questionnaire I	Estate Surveyors	110	99	90%
2.	Questionnaire II	Occupiers of commercial properties	1,000	570	57%

Source: Field Survey, 2008

For each group of respondents, sufficient number of questionnaires was administered to cater for incomplete and non-responses to the survey and ensure that sufficient number was returned. In this respect, one hundred and ten (110) questionnaires were administered to Estate Surveyors and Valuers whereas ninety (90) was the appropriate sample size. Similarly, one thousand (1,000) questionnaires were administered to occupiers of commercial properties, this was sufficient to cover the appropriate minimum sample size of six hundred (600). Out of combined total number of one thousand, one hundred and ten (1,110) questionnaires thus administered, 669 (representing 60.27%) were returned duly completed by combined respondents.

From Table 5.1, it can be deduced that the response rate of the respondent-Estate Surveyors was highly encouraging with ninety percentage success achieved. This was made possible by personal contact and assistance of the Lagos State Branch Chairman of the Nigerian Institution of Estate Surveyors and Valuers. Lower response rate (57%) was however attained with occupiers of commercial properties. This was probably due to the fact that many of the sampled respondents were careful in volunteering information which they thought may be used against them; they therefore did not return the questionnaire. In administering the questionnaires to occupiers of commercial properties, 1000 questionnaires were administered in relation to the ratio of commercial properties along each road to the total of all arterial roads. This is shown in Table 5.2

Table 5.2: Distribution of Questionnaires to Occupiers

S/N	Arterial Road	No. of commercial properties			Total number administered	Total number returned	Response rate	Rank
		Left side	Right side	Total				
1	Oba Akran Road	75	62	137	68	35	51.47	11
2	Kodesho Street	51	43	94	47	32	68.09	4
3	Obafemi Awolowo	82	79	161	80	50	62.50	7
4	Adeniyi Jones	34	27	61	31	14	45.16	17
5	Aromire Avenue	29	27	56	28	15	53.57	10
6	Allen Avenue	57	61	118	59	27	45.76	15
7	Opebi Road	55	68	123	61	30	49.18	14
8	Opebi/ Bank-	5	3	8	4	2	50.00	13
9	Bank-Anthony Way	76	81	157	78	43	55.13	9
10	Lateef Jakande Road	84	74	158	78	50	64.10	6
11	ACME Road	61	59	120	60	18	30.00	20
12	WEMPCO Road	39	49	88	44	20	45.46	16
13	Ogba Road	47	62	109	54	45	83.33	2
14	Isheri-Agege Road	63	65	128	64	48	75.00	3
15	Oregun Road	56	61	117	58	38	65.52	5
16	Ikosi Road	38	34	72	36	12	33.33	19
17	Olowu Street	35	41	76	38	32	84.21	1
18	Simbiat Abiola Road	29	39	68	34	15	44.12	18
19	Toyin Street	64	73	137	68	35	51.47	11
20	Opebi Link Road	11	9	20	10	6	60.00	8
	TOTAL	**991**	**1,017**	**2,008**	**1,000**	**570**		

Source: Field Survey, 2008

Table 5.2 shows the distribution of questionnaire and response rates along the individual arterial roads in the study area. The number of questionnaires administered on occupiers was related to the number of commercial properties along each arterial road. The response rate along Olowu Street was the highest (84.21%) followed by Ogba Road (83%) and Isheri-Agege (75%) while responses were low along Ikosi Road (33%) and ACME Road (30%). This indicates that the response rate was higher in the core area (Olowu Street, Opebi Link-road, Allen Avenue, Aromire Avenue, Opebi Road, Obafemi Awolowo Way, Oba Akran Avenue, Toyin Street, Kodesho Street, Lateef Jakande Road and Adeniyi Jones Avenue) than other areas. The reason for this could probably be that the elite, professionals and enlightened respondents were concentrated in the core area and because of their literacy level they understand the importance of interview and administration of questionnaires and responded promptly.

Further details about the respondents in terms of sex are given in Tables 5.3

Table 5.3: Sex of the Respondents

Sex	Respondents		Combined Total	Overall Response Rate
	Estate Surveyors	Occupiers		
Male	60 (61%)	239 (41.90%)	299 (44.69%)	42%
Female	39 (39%)	331(58.10%)	370 (55.31%)	58%
Total	**99 (100%)**	**570 (100%)**	**669 (100%)**	**100%**

Source: Field Survey, 2008

From Table 5.3, the combined respondent Estate Surveyors/Valuers and Occupiers returned total of six hundred and sixty-nine questionnaires. Out of which about 45% were male and 55% female. With respect to respondents that were Estate Surveyors, 61% of them were male and 39% female, while about 42% male and 58% female occupiers returned the questionnaires. Reason for differences in response rates by sex of the respondents could probably be due to the population sizes of the respondents.

In respect of the respondents' occupation, details of questionnaires that were distributed are shown in Table 5.4

Table 5.4: Occupation of the Respondents-occupiers

S/N	Occupation	Frequency	Percentage
1	Professionals (practicing firms of professionals)	195	34.20
2	Retail Businesses	345	60.53
3	Banking	5	0.88
4	Others: car-sales, business, photocopy and repair	25	4.39
	Total	**570**	**100**

Source: Field Survey, 2008

Table 5.4 shows that many of the respondents were into retail business activities such as sales outlets of consumer goods while few of them were into banking services.

With respect to professional qualifications of respondents (Estate Surveyors and Valuers) about 71% were Associate members of the Nigerian Institution of Estate Surveyors and Valuers (NIESV), about 8% are Fellows while 21% are Probationers as shown in Table 5.5

Table 5.5: Respondents' Professional Qualifications

S/N	Professional Qualification	Frequency	Percentage
1	Associate Nigerian Institution of Estate Surveyors and Valuers (ANIVS)	70	70.70
2	Fellow Nigerian Institution of Estate Surveyors and Valuers (FNIVS)	8	8.10
3	Probationer	21	21.20
Total		**99**	**100.00**

Source: Field Survey, 2008

The details in Table 5.5 indicate that many of the Estate Surveyors and Valuers were registered professionals and their opinions were most likely to lead to reliable findings. The reason adduced for wide differences in the number of respondents that were Fellows, Associates or Probationers of the NIESV could probably be a consequence of distributions of the various cadres on the NIESV register. Majority of registered Estate Surveyors and Valuers are of the Associate cadre and it was not surprising that this was reflected in the number captured in the administration of the questionnaires.

In terms of academic qualifications, none of the Estate Surveyors and Valuers had a Doctor of Philosophy (Ph.D.) degree; 10% have Master of Science degree; about 41.4% have Bachelor's of Science degree; 42.4% are Higher National Diploma holders; while 6% holds Ordinary National Diploma as shown in Table 5.6

Table 5.6: Respondents' Academic Qualifications

S/N	Academic Qualification	Frequency	
		Number	Percentage
1	Ph. D.	0	0.00
2	M.Sc.	10	10.10
3	B.Sc.	41	41.40
4	HND	42	42.40
5	OND, SC,	6	6.10
Total		**99**	**100.00**

Source: Field Survey, 2008

Table 5.6 shows that about eighty-four percent of the Estate Surveyors and Valuers had either HND or B.Sc. with about ten percent possessing higher degrees. The reason for this could probably be because real estate practice is financially rewarding and only few practitioners often consider going for higher degrees. However, the overall implication is that many of the respondents are literate and are professionally qualified and the reliability of their opinions was therefore not in doubt.

5.3 Analysis of Road Network in Ikeja

The attempt in this section is to address the first objective of the study, that is, to analyze the road network. This is accomplished by examining existing patterns of road networks identified in earlier works and by analyzing road network in the study area using the graph theoretic approach. The road network of the study area was analyzed in terms of its explanatory variables. The satellite map of roads in the study area (Fig. 5.1) was used to analyze the arterial road network.

Examining the different types of road network pattern shown in Figs. 3.1a, 3.1b, and 3.1c in APPENDIX I for comparison with the pattern in study area, the type of road network pattern that showed some semblance is Traditional type of road network pattern. The type of road network consists of similar-sized roads and width that crisscross each other to create several links and nodal points. As earlier stated, the traditional type of road network encourages concentration of vehicular and pedestrian movements at nodal points. It also encourages concentration of goods and services giving rise to increase in demand for space by commercial users who take advantage of greater accessibility offered. This possibly accounted for locations of commercial properties along the arterial roads in the study area.

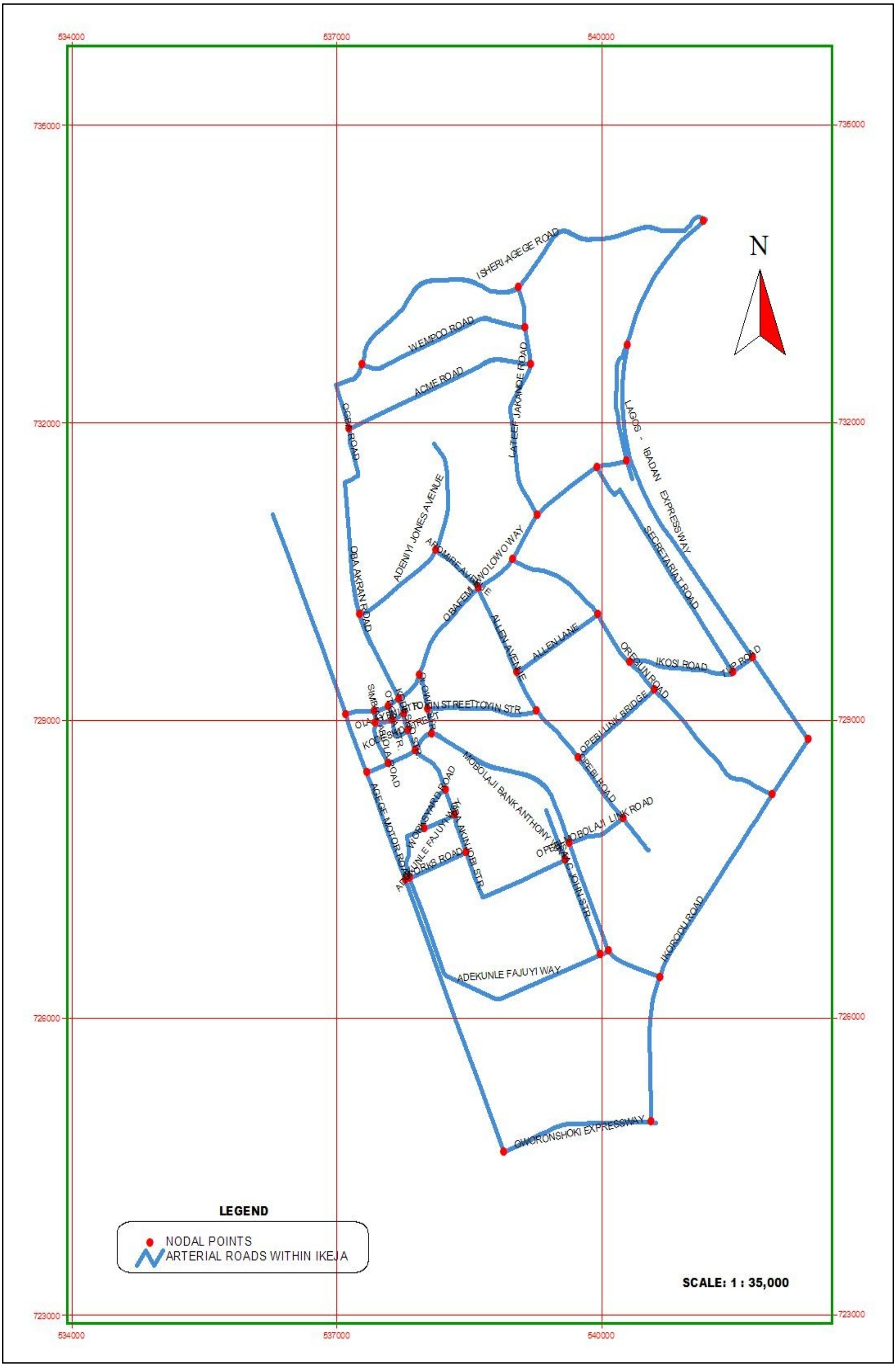

Fig. 5.1: Satellite Map of the Arterial Roads in the Study Area
Source: Lagos State Planning Information Centre, Ikeja

Furthermore, Fig. 5.1 was converted into linear graph by tracing the individual roads using transparent drawing sheet; the linear graph is shown in Fig. 5.2

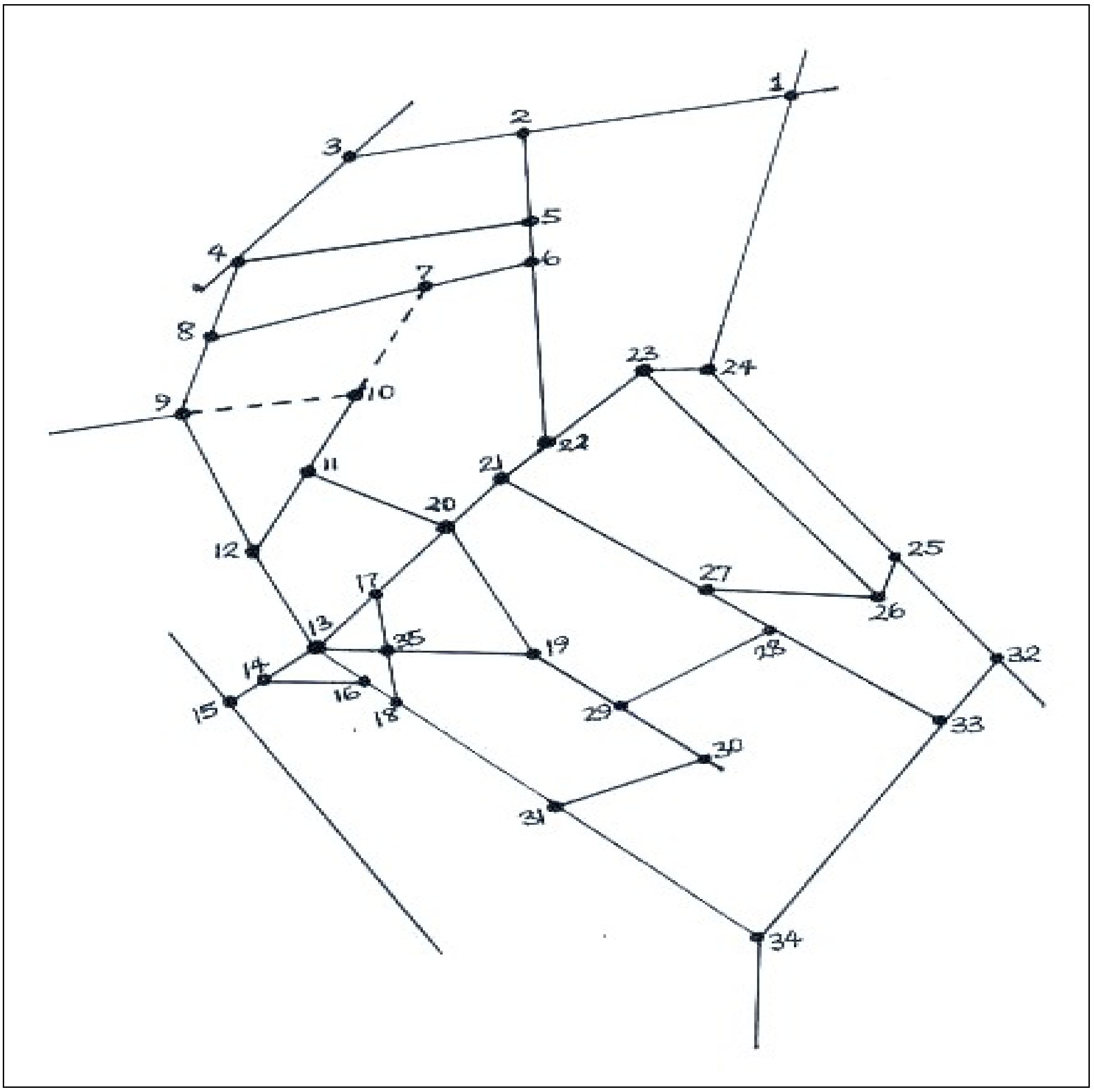

Fig.5.2: Graph of Arterial Road Network in Ikeja Metropolis

Fig. 5.2: Graph of Arterial Road Network in Ikeja
Source: Author's Analysis, 2008

This revealed that there are thirty-five (35) nodal points within the network of twenty-one (21) arterial roads in the study area. Twenty of the roads traverse the commercial axes of the study area while one serves government establishments. When Fig. 5.2 is compared with illustrations of the various types of road network patterns in

APPENDIX I, the closest to the pattern of arterial road network in the study area is Traditional Type having features earlier described in Section 3.6 (at Page 52).

5.3.1 Analysis of Accessibility in the Road Network of Ikeja, Nigeria

In an attempt to determine the relative accessibility index of each arterial road in the study area, the map of arterial roads was converted into linear graph regardless of the width, quality, and standard of the roads. From this, a connectivity matrix emerged to reveal the degree of accessibility of each node within the network of roads. Each node was rated according to level of accessibility using the Shimbel index and connectivity index matrices. The Shimbel index matrix summarizes the number of edges required to connect each node or vertex with other nodes in the network through the shortest path. Connectivity matrix indicates the node with the highest total number of connection or linkage with the other nodes. The accessibility index matrix is shown in Table 5.7

As shown in Table 5.7, thirty-five nodal points are within the network or arterial roads in the study area. The nodal points are contained within twenty roads thus making for further analysis. Nodal point 21 with the least accessibility index of 106 (Obafemi Awolowo Way/Oregun Road) is the most accessible followed by node 20 (Obafemi Awolowo Way/Allen Avenue) with index 107, and node 22 (Obafemi Awolowo Way/Lateef Jakande Road) with 114. The least accessible nodal point is 15 (end of Obafemi Awolowo Way with Lagos/Abeokuta Expressway) with accessibility index of 178, followed by Iseri/Agege Road by Berger Area (nodal point 3 with index of 167). This implies that all the important nodal points lie along Obafemi Awolowo Way, thereby showing that the arterial road is the most important delivering much of the accessibility in the road network of the study area.

Table 5.7 Accessibility Indices **HERE**

The model in Eqn. 4.3 was used to determine the relative accessibility indices of the twenty arterial roads in relation to thirty-five nodal points in the study area. This resulted in the relative weighted accessibility indices as shown in Table 5.8

Table 5.8: Weighted Accessibility Indices of Arterial Roads in Ikeja

S/N	Arterial Road	Weighted Index	Rank
1	Obafemi Awolowo Way	0.10	1
2	Toyin Street	0.55	2
3	Bank Anthony Way	0.57	3
4	Lateef Jakande Road	0.58	4
5	Isheri-Agege Road	0.64	5
6	Ogba Road	0.64	5
7	Oregun Road	0.65	7
8	Opebi Linkroad	0.69	8
9	Simbiat Abiola Way	0.72	9
10	Aromire Avenue	0.73	10
11	Ikosi Road	0.73	10
12	Olowu Street	0.73	10
13	WEMPCO Road	0.73	10
14	Adeniyi Jones Avenue	0.74	14
15	Allen Avenue	0.74	14
16	Kodesho Street	0.74	14
17	Oba Akran Avenue	0.74	14
18	Opebi Road	0.74	14
19	Opebi/Bank-Anthony Way	0.74	14
20	ACME Road	0.75	20

Source: Field Survey, 2008

Table 5.8 considers the level of accessibility of all the major arterial roads in the study area using the weighted relative accessibility indices. The analysis has shown the importance of different roads in terms of relative accessibility of the arterial roads in the network. As explained in Chapter Four, the road with the lowest accessibility index is the most accessible. From the Table, Obafemi Awolowo Way was further confirmed as the most accessible, followed by Toyin Street, and Bank-Anthony Way while the least accessible is ACME Road. Also, Isheri-Agege and Ogba Roads; Aromire Avenue, Ikosi Road, Olowu Street, and WEMPCO Road; Adeniyi Jones Avenue, Allen Avenue, Kodesho Street, Oba Akran Avenue, Opebi Road, and Opebi/Bank-Anthony Way have equal degrees of accessibility in the arterial road network in the study area.

This finding fits into the actual situation in the study area and probably explains reasons for high concentration of vehicular/pedestrian movements and business activities along such roads with high concentration of converted and purpose-built commercial properties to take advantage of the levels of accessibility. Furthermore, the importance of this finding is that the ordering of the arterial roads might be a guide to property developers who consider accessibility as major factor of physical criteria in determining the feasibility and viability of a development project to make choice out of the alternative arterial roads in the study area.

5.3.2 Analysis of Connectivity in Road Network of Ikeja

The attempt here was to address the levels of connectivity in the road network. A connectivity matrix was developed from the graph of the study area (Fig. 5.2). In the matrix, values were allotted to each node; where two nodes are linked, 1 point was given and where there was no direct link, 0 point applied. The connectivity matrix shows the number of other nodal points to which a particular node had direct link and the node with the highest number of points was the most connected. The node with the least Shimbel index was regarded as the most accessible in the network. The connectivity indices for the arterial roads are contained in Table 5.9

Table 5.9 Connectivity Matrix **HERE**

From Table 5.9, the best-connected nodal points are those denoted as 13 (Obafemi Awolowo Way Roundabout) and 20 (Obafemi Awolowo Way/Allen Avenue Roundabout), each having index of 4. This means that each of the nodes has direct links with four other nodal points, while the least connected is nodal point 15 (end of Obafemi Awolowo Way with Lagos/Abeokuta Expressway) having index of 1. The thirty-five nodal points are encompassed within twenty roads, the weighted connectivity indices were determined by applying model in Eqn. 4.3. The resulting individual connectivity indices are contained in Table 5.10

Table 5.10: Weighted Connectivity Indices of Arterial Roads in Ikeja

S/N	Arterial Road	Weighted Index	Rank
1	Opebi Link-road	0.02	1
2	Kodesho Street	0.08	2
3	Simbiat Abiola Way	0.10	3
4	Oregun Road	0.14	4
5	Toyin Street	0.15	5
6	Oba Akran Avenue	0.18	6
7	Bank Anthony Way	0.18	6
8	Awolowo Way	0.23	8
9	Aromire Avenue	0.23	8
10	Allen Avenue	0.23	8
11	Opebi Road	0.24	11
12	Lateef Jakande Road	0.25	12
13	Opebi/Bank-Anthony Way	0.26	13
14	Adeniyi Jones Avenue	0.27	14
15	WEMPCO Road	0.27	14
16	Ikosi Road	0.29	16
17	ACME Road	0.33	17
18	Isheri-Agege Road	0.33	17
19	Olowu Street	0.34	19
20	Ogba Road	0.35	20

Source: Field Survey, 2008

From Table 5.10, the best-connected road in the study area is Opebi-Link Road, followed by Kodesho Street, and Simbiat Abiola Way, while the road with the least connectivity is Ogba Road. It was found that Oba Akran Avenue and Bank-Anthony, have same index of 6; Awolowo Way, Aromire Avenue, Allen Avenue, each has index of 8; while Adeniyi Jones Avenue, WEMPCO Road, ACME and Isheri-Agege Roads have equal degrees of connectivity (index of 14).

This analysis has shown the relative connectivity and importance of each arterial road in the study area. The importance of this is that physical criteria in determining best locations for ordering of arterial roads in the study area is made possible especially in feasibility and viability appraisal of alternative sites along the roads for development of commercial properties.

5.3.3 Estate Surveyors' Ranking of the Arterial Roads in Ikeja

The respondents (Estate Surveyors) were given opportunity to rank the arterial roads in the study area in terms of their relative accessibility to Allen Avenue/Obafemi Awolowo Way nodal points which has the highest connectivity index of 4 (Table 5.9, Page 81). Relative importance index (RII) analysis was carried out by reducing the data to index numbers. Index number in this regard means division by a general measure of variate level. Details of their opinions in respect of ranking of the roads are shown in Table 5.11

Table 5.11: Estate Surveyors' Ranking of Arterial Roads in Ikeja Metropolis

S/N	Road	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	R.I.I	Rank
1	Toyin Street	0	27	0	45	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0.82	1st
2	Obafemi Awolowo Way	54	0	0	27	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0.79	2nd
3	Opebi Road	27	27	27	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0.78	3rd
4	Adeniyi Jones	0	0	0	0	27	0	72	0	0	0	0	0	0	0	0	0	0	0	0	0.68	4th
5	Aromire Avenue	0	18	54	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0.67	5th
6	Olowu Street	0	0	0	0	54	0	0	0	0	27	18	0	0	0	0	0	0	0	0	0.62	6th
7	Simbiat Abiola Way	18	27	0	0	0	0	0	0	0	0	27	0	0	0	27	0	0	0	0	0.60	7th
8	Oregun Road	0	0	0	27	0	0	0	0	27	18	0	27	0	0	0	0	0	0	0	0.55	8th
9	Lateef Jakande Road	0	0	18	0	0	0	27	0	0	0	27	0	27	0	0	0	0	0	0	0.53	9th
10	Opebi Link Road	0	0	0	0	0	27	0	27	0	0	27	18	0	0	0	0	0	0	0	0.53	9th
11	Kodesho Street	0	0	0	0	0	0	0	27	27	27	0	0	18	0	0	0	0	0	0	0.49	11th
12	Oba Akran Avenue	0	0	0	0	0	27	0	0	0	27	0	0	27	0	18	0	0	0	0	0.43	12th
13	Ikosi Road	0	0	0	0	0	18	0	0	0	0	0	54	0	0	27	0	0	0	0	0.37	13th
14	Opebi/Bank-Anthony Link road	0	0	0	0	0	18	0	0	0	0	0	54	0	0	27	0	0	0	0	0.37	13th
15	Isheri-Agege Road	0	0	0	0	0	0	0	45	0	0	0	0	0	27	0	0	27	0	0	0.35	15th
16	Bank-Anthony Way	0	0	0	0	0	0	0	0	27	0	0	0	27	45	0	0	0	0	0	0.33	16th
17	Ogba Road	0	0	0	0	18	0	0	0	0	0	0	0	0	0	27	54	0	0	0	0.25	17th
18	WEMPCO Road	0	0	0	0	0	0	0	0	18	0	0	0	0	27	0	27	27	0	0	0.21	18th
19	ACME Road	0	0	0	0	0	0	0	0	18	0	0	0	0	27	0	0	0	0	0	0.21	18th

Key: RII – relative importance index
Source: Field Survey, 2008

In Table 5.11, the first row indicates numbering from 1 to 19 so as to guide respondents in carrying out the ranking, 1 represented the best, 2 second best and so on to 19 which represents the least in the ranking. The numbers in each cell below the first row are the number of respondents that ranked each road according to their opinions of level of accessibility of each road. From the Table, respondents' opinions were interpreted using relative importance index analysis. The analysis shows that respondents rated Toyin Street as best of all the arterial roads within the study area in term of accessibility to Allen Avenue. Obafemi Awolowo Way, Opebi Road, Adeniyi Jones Avenue, and Aromire Avenue in succession while the least accessible roads to Allen Avenue are Ogba Road, WEMPCO Road and ACME Road. Also from the Estate Surveyors' opinion, WEMPCO and ACME Roads, Ikosi Road and Opebi/Bank-Anthony Way, Lateef Jakande and Opebi Link Roads have equal levels of accessibility. This appears to be in consonance with the earlier findings in Sections 5.3.1 and 5.3.2.

In establishing the respondents' opinions concerning the volume of traffic, which is a factor in traffic congestion along each arterial road, the researcher assigned 5, 4, 3, 2 and 1 to "Very High", "High", "Undecided", "Low" and "Very Low" respectively to guide the respondents. Table 5.12 shows the details of respondents' opinions on volume of vehicular traffic on arterial roads in the study area.

Table 5.12: Respondents' Opinions on Traffic Volumes in Ikeja

Road	**Very High** (5)	**High** (4)	**Undecided** (3)	**Low** (2)	**Very Low** (1)	**Weighted Mean**
Obafemi Awolowo Way	45	45	9	0	0	4.36
Bank-Anthony Way	36	36	0	27	0	3.82
Oba Akran Avenue	18	54	0	18	9	3.55
Toyin Street	0	54	9	36	0	3.18
Oregun Road	9	63	0	27	0	3.55
Allen Avenue	63	36	0	0	0	4.64
Opebi Road	45	45	0	9	0	4.27
Adeniyi Jones Avenue	18	45	0	36	0	3.45
Lateef Jakande Road	36	54	0	9	0	4.18
Wempco Road	0	63	0	27	9	3.18
Isheri-Agege Road	18	45	36	9	0	4.00
Kodesho Street	9	72	9	9	0	3.82
Simbiat Abiola Way	0	72	18	0	9	3.55
Aromire Avenue	9	81	0	9	0	3.91
Olowu Street	9	45	9	27	9	3.09
Opebi Link Road	0	54	9	27	9	3.09
Ikosi Road	0	63	0	27	9	3.18
Ogba Road	9	36	0	36	27	2.91

Source: Field Survey, 2008

Table 5.12 indicates Estate Surveyors' perception of volume of traffic along arterial roads in the study area. They rated Allen Avenue as having highest mean volume of traffic (4.64) followed by Obafemi Awolowo Way (4.36), Opebi Road (4.27), and Lateef Jakande Road (4.18). This finding is in line with expectations given the concentration of commercial activities such as banks, retail business outlets and offices in the neighbourhood, especially along the aforementioned roads.

5.3.4 Estate Surveyors' Opinions on Techniques for Analyzing Road Network

In this Section, the Estate Surveyors and Valuers were given opportunity to express opinion in respect of techniques for determining relative accessibility of different locations in the study area. Their responses to the question on awareness of such techniques indicated that no respondents were aware of any technique. It was discovered that the respondents take decisions concerning relative accessibility of locations in the study area by intuition. Details of their responses are contained in Table 5.13

Table 5.13 Estate Surveyors' Use of Techniques in Measuring Accessibility

S/N	Response	Frequency	Percentage
1	I am aware of scientific technique for measuring accessibility	-	0.00
2	I am not aware of any technique to measure accessibility, so I decide relative accessibility of locations by intuition	99	100.00
Total		**99**	**100.00**

Source: Field Survey, 2008

5.3.5 Analyzing Other Explanatory Variables of Road Network in Ikeja, Nigeria

The attempt in this section is to analyze other explanatory variables in addition to accessibility and connectivity in the study area. This consists of traffic, road and traffic densities, quality of the road, accessibility, and connectivity of the arterial roads.

The analysis of length density in the study area showed six categories with density ratio ranging between 0.01 and 0.07. Isheri-Agege Road has the highest length density with index of 0.07 followed by Obafemi Awolowo Way, 0.06; and Oregun Road, 0.05. In addition, each of Oba Akran Avenue, Adeniyi Jones Avenue, Opebi Road, Lateef Jakande Road, ACME Road, and WEMPCO Road has 0.03. Each of Allen Avenue, Ogba Road, Ikosi Road, Opebi Link Road, Ogba Road, and Opebi Link Road has index of 0.02; while each of Kodesho Street, Aromire Avenue, Opebi/Bank-Anthony Way, Olowu Street, Simbiat Abiola Way and Toyin Street has the least index of 0.01. The implication of this is that Isheri Road is the longest arterial road, followed by Obafemi Awolowo Way and Oregun Road respectively. This analysis enables comparison of arterial roads for overall correlation with commercial property values. It is a subset of road network and indicates the ratio of each arterial road to total length of roads in the study area.

Vehicular traffic density was obtained from the number of vehicles per metre length, and it shows the level of traffic congestion in the study area. It was derived from the ratio of traffic volume and length of each road. As shown in Table 5.14, Simbiat Abiola Way has the highest vehicular movement per metre length, followed by Kodesho Street, and Aromire Avenue. Isheri-Agege Road and Bank-Anthony Way have the least number of vehicles per metre length of road in the study area. High density is an indication that such roads will experience frequent traffic congestion while those with few vehicles per metre length shows few traffic congestion. The intention is to consider traffic volume and congestion in the road network and find out the relationship with commercial property values.

As stated earlier, quality of road was determined based on perception of the respondents and the researcher's direct observation. In the study area, five categories of quality of roads were identified: (i) tarred, no potholes, motorable, and with dual carriage; (ii) tarred, with potholes, but motorable, and having dual carriage; (iii) tarred, no potholes, motorable, but with single carriageway; (iv) tarred, but with potholes, but motorable, and having single-carriage; (v) tarred, with potholes, un-motorable and having single-carriage. The first category was rated highest followed by the second and in sequence, while the fifth category was the least in terms of quality. Quality of road is a subset of road network that may be a pull or push factor and so encourages or discourages demand for a particular location with consequence reflected in property values. Quality of road in the study area was analyzed to facilitate use of the relative importance of each road for determining the relationship between its accessibility and commercial property values.

In measuring location, the most accessible nodal point in the network of arterial roads was used as the reference point to which other locations were related. In doing so, the number of links from the farthest point on each road in the network (Fig. 5.2) was counted to the most accessible location in the network, taking the shortest routes possible; the location indices for the roads are shown in Table 5.14

Table 5.14: Location indices of Arterial Roads in Ikeja

S/N	Road	Location
1	Oba Akran Avenue	4
2	Kodesho Street	6
3	Obafemi Awolowo Way	5
4	Adeniyi Jones Avenue	3
5	Aromire Avenue	2
6	Allen Avenue	2
7	Opebi Road	4
8	Opebi Rd/Bank-Anthony	5
9	Bank-Anthony Way	6
10	Lateef Jakande Road	4
11	ACME Road	4
12	WEMPCO Road	4
13	Ogba Road	6
14	Isheri-Agege Road	5
15	Oregun Road	3
16	Ikosi Road	3
17	Olowu Street	3
18	Simbiat Abiola Way	4
19	Toyin Street	3
20	Opebi Link Road	2

Source: Author's Analysis, 2008

The Table shows that Allen Avenue, Aromire Avenue, and Toyin Street, and Adeniyi Jones Avenue have the best location attribute derived from nearness to the most accessible nodal point in the study area. This probably accounted for similar range of mean rental values in the locations as shown in Table 5.17

Demand for commercial properties was determined by analyzing the number of requests for the properties on yearly basis using the data obtained from the Estate Surveyors and Valuers over a five-year period, and average of their figures indicated for each arterial road. Similarly, the supply of commercial properties was derived from the analysis of data on number of letting transactions effectively completed by Estate Surveyors and Valuers within the same period, and average number of the transactions determined.

The summary results of the analysis of the explanatory variables discussed in this sub-section is shown in Table 5.15

S/N	Road	Traffic volume	Road Length (in metres)	Traffic Density	Road Density	Connectivity	Road Quality	Accessibility	ttings)**Supply** (average	ests)**Demand** (average	nt**Location** (number of links to the most accessible locations
1	Oba Akran	16,651	2,307.18	7.22	0.06	0.18	4	0.74	14	18	4
2	Kodesho Street	16,240	559.465	29.03	0.01	0.08	4	0.74	6	9	6
3	Obafemi Awolowo Way	19,042	4,292.12	4.44	0.11	0.23	5	0.10	15	35	5
4	Adeniyi Jones	12,211	2,233.46	5.47	0.06	0.27	4	0.74	15	21	3
5	Aromire Avenue	17,414	616.81	28.23	0.02	0.23	4	0.73	7	9	2
6	Allen Avenue	18,038	1,411.30	12.78	0.04	0.23	5	0.74	22	29	2
7	Opebi Road	16,510	1,886.00	8.75	0.05	0.24	4	0.74	16	21	4
8	Opebi Rd/Bank-Anthony Way	18,392	674.13	27.28	0.02	0.26	5	0.74	4	7	5
9	Bank-Anthony Way	17,186	4,718.66	3.64	0.12	0.18	5	0.57	13	17	6
10	Lateef Jakande Road	17,173	2,443.60	7.03	0.06	0.25	4	0.58	8	11	4
11	ACME Road	18,433	2,200.49	8.38	0.06	0.33	4	0.75	6	6	4
12	WEMPCO Road	14,898	1,963.85	7.59	0.05	0.27	4	0.73	5	5	4
13	Ogba Road	15,539	1,121.50	13.86	0.03	0.35	4	0.64	4	5	6
14	Isheri-Agege	12,816	5,080.41	2.52	0.13	0.33	5	0.64	5	5	5
15	Oregun Road	18,276	3,888.18	4.70	0.10	0.14	5	0.65	9	10	3
16	Ikosi Road	14,900	1,207.08	12.34	0.03	0.27	3	0.73	2	3	3
17	Olowu Street	14,626	623.96	23.44	0.02	0.34	3	0.73	7	9	3
18	Simbiat Abiola	17,517	571.44	30.65	0.02	0.10	4	0.72	6	8	4
19	Toyin Street	13,608	875.48	15.54	0.02	0.15	5	0.55	23	27	3
20	Opebi Link Road	18,796	1,106.57	16.99	0.02	0.02	5	0.69	4	5	2
Total		**328,266**	**39,781.68**								

Table 5.15: Details of the Explanatory Independent Variables
Source: Field Survey, 2008

5.4 Analysis of Spatial Pattern of Commercial Properties and Rental Values in Ikeja, Nigeria

In this Section, attempt was made to determine the second objective of the study which is to analyze the spatial pattern and values of commercial properties in the study area. To achieve the objective, the spatial distribution and arrangement of commercial properties and their values along the arterial roads were analyzed. The trends of commercial property values was also analyzed and models for predicting rental values in the study area derived.

5.4.1 Spatial Pattern of Commercial Properties and Rental Values in Ikeja

Commercial properties in the study area are arranged along both sides of the arterial roads. In all, there are twenty (20) arterial roads with two thousand and eight (2008) commercial properties located on both sides as detailed in Table 5.16

Table 5.16: Number of Commercial Properties along Arterial Roads in Ikeja

S/N	Arterial Road	Number of commercial			
		Left	**Right**	**Total**	
1	Oba Akran Avenue	75	62	137	6.80
2	Kodesho Street	51	43	94	4.68
3	Obafemi Awolowo Way	82	79	161	8.02
4	Adeniyi Jones Avenue	34	27	61	3.04
5	Aromire Avenue	29	27	56	2.79
6	Allen Avenue	57	61	118	5.88
7	Opebi Road	55	68	123	6.13
8	Opebi/ Bank-Anthony Way	5	3	8	0.40
9	Bank-Anthony Way	76	81	157	7.82
10	Lateef Jakande Road	84	74	158	7.87
11	ACME Road	61	59	120	5.98
12	WEMPCO Road	39	49	88	4.38
13	Ogba Road	47	62	109	5.43
14	Isheri-Agege Road	63	65	128	6.38
15	Oregun Road	56	61	117	5.83
16	Ikosi Road	38	34	72	3.59
17	Olowu Street	35	41	76	3.79
18	Simbiat Abiola Road	29	39	68	3.39
19	Toyin Street	64	73	137	6.80
20	Opebi Link Road	11	9	20	1.00
	TOTAL	**991**	**1,017**	**2,008**	**100.00**

Source: Field Survey, 2008

Table 5.16 demonstrates proportional distribution of commercial properties along twenty arterial roads in the study area. As stated earlier, there are 2,008 commercial properties along the arterial roads. Obafemi Awolowo Way accommodates the highest number of properties (8.02%) of total followed by Lateef Jakande Road (7.9%) and Bank-Anthony Way (7.8%). Along these roads, properties are developed on large plot sizes with few high-rise buildings than as found along other streets. This probably was because of availability of adequate plots of land that enables extensive use through horizontal developments.

In addition, the nature of commercial properties in terms of number of floors along the arterial roads showed a form of relationship with the length of each road. Allen Avenue and Toyin Street have shorter road lengths than Obafemi Awolowo Way, Lateef Jakande Road and Bank-Anthony Way, this probably accounted for many high-rise commercial structures along Allen Avenue and Toyin Street as against closely arranged commercial developments particularly along Adeniyi Jones Avenue and Aromire Avenue on fewer number of floors. The smaller plot sizes along these roads probably accounted for developers maximizing the land by vertical development through increase in the number of floors in order to maximize return from the development.

As a follow up on the second objective of study, Estate Surveyors and Valuers in addition to occupiers of commercial properties in the study area were asked varieties of questions, one of which covered the rental values of commercial properties. This was with a view to establishing opinions on rental values in the past five years. The figures provided were analyzed and mean rental values along each arterial road determined as shown in Table 5.17 below:

Table 5.17: Mean Rental Values of Commercial Properties along Arterial Roads in Ikeja

S/N	Road	**Rent** (Naira per square metre) per annum					Mean Rent for 5years	Category
		2003	2004	2005	2006	2007		
1	Allen Avenue	4,500	5,000	6,400	8,000	10,50	6,880	A
2	Adeniyi Jones Avenue	4,500	5,500	6,500	8,500	9,000	6,800	
3	Opebi Road	4,500	4,500	6,000	8,000	10,00	6,600	
4	Bank-Anthony Way	3,500	5,000	6,000	7,800	9,500	6,360	
5	Oba Akran Avenue	3,600	5,000	6,000	8,000	9,100	6,340	
6	Bank-Anthony/Opebi Way	3,500	5,000	6,000	7,500	9,000	6,200	
7	Toyin Street	3,600	4,500	5,800	8,000	8,700	6,120	
8	Aromire Avenue	4,000	4,500	5,600	7,800	8,500	6,080	
9	Kodesho Street	3,000	4,200	5,000	6,500	8,000	5,340	B
10	Ogba Road	3,600	4,500	5,000	6,000	7,000	5,220	
11	Obafemi Awolowo Way	3,500	3,500	5,000	6,000	8,000	5,200	
12	Simbiat Abiola Road	3,000	3,500	4,800	6,000	8,000	5,060	
13	ACME Road	3,500	4,000	5,000	6,000	6,500	5,000	C
14	Lateef Jakande Road	3,000	4,000	4,500	6,500	7,000	5,000	
15	Olowu Street	3,500	3,500	5,000	6,000	6,500	4,900	
16	Opebi Link-Road	3,500	3,600	4,500	5,000	7,000	4,720	
17	Oregun Road	3,000	3,500	4,500	6,000	6,500	4,700	
18	WEMPCO Road	3,000	3,500	4,000	5,000	6,000	4,300	
18	Ikosi Road	3,000	3,000	4,000	4,500	5,700	4,040	

20	Isheri/Agege Road	3,000	3,200	3,500	4,000	5,500	3,840	**D**
Mean Rental Value (annual basis)		**3,515**	**4,150**	**5,155**	**6,555**	**7,800**		

Source: Field Survey, 2008

The percentage distribution of the commercial property values (in Naira per square metre per annum) indicates that 5% of mean rental values fall within the range of N3,001 and N4,000/m^2. 35% are within the range of N4,001 and N5,000; 20% are in the range of N5,001 and N6,000; and 40% are found within the range of N6,001 to N7,000. The highest rental values were found along Allen Avenue followed by Adeniyi Jones Avenue, Aromire Avenue, Opebi Road and Bank-Anthony Way, while lowest rental value was obtained along Isheri/Agege Road. Details of values of commercial properties along the arterial roads in the study area are shown in Table 5.18

Table 5.18: Pattern of Commercial Property Values along Arterial Roads in Ikeja

S/N	Category	Arterial Roads	Range of Mean Rental Value	Number of roads	Percentage
1	A	Allen Avenue, Adeniyi Jones Avenue, Opebi Road, Bank-Anthony Way, Oba Akran Avenue, Bank-Anthony Way/Opebi Road, Toyin Street, and Aromire Avenue.	N6,001/m^2 - N7,000/m^2	8	40
2	B	Kodesho Street, Ogba Road, Obafemi Awolowo Way, and Simbiat Abiola Way.	N5,001/m^2 - N6,000/m^2	4	20
3	C	ACME Road, Lateef Jakande Road, Olowu Street, Opebi Link-Road, Oregun Road, WEMPCO Road, and Ikosi Road.	N4,001/m^2 - N5,000/m^2	7	35
4	D	Isheri/Agege Road	N3,001/m^2 - N4,000/m^2	1	5
Total				**20**	**100**

Source: Field Survey, 2008

From Table 5.18, four categories of commercial properties were identified based on range of mean rental values in relation to arterial road network. The categories were determined based on the range of mean rental values in the study area. The finding is not unexpected as spaces along the arterial roads in Category A have, over the years, the most sought after by commercial users like banks, wholesale/retail outlets, and multi-storey office complexes.

In determining the movements (increase or decrease) in commercial property values in the study area, a polynomial trend analysis was carried out and model for predicting the trends derived. The resulting model and coefficient of determination are indicated in Fig. 5.3

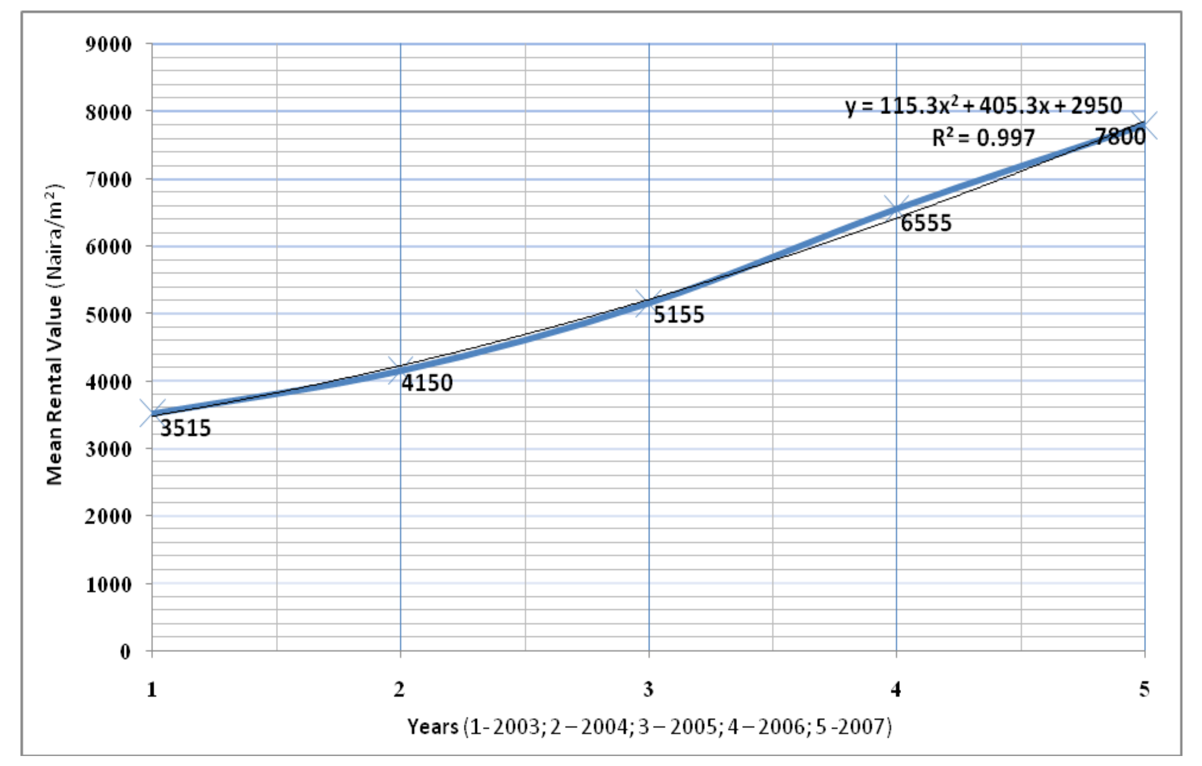

Fig. 5.3: Trend in Average Mean Rental Values of Commercial Property in Ikeja (2003 – 2007)
Source: Author's Analysis, 2008

From Fig 5.3, the trend lines show continous rise in minimum and maximum rental values of commercial property values along the arterial roads in the study area from year to year. This is an indication that there will be increases in commercial property values and that the increases will continue into the future. The model is fitted for predicting future maximum commercial property values with coefficient of determination equals 0.997, implying that *ceteris paribus* there is high probability that the forecast will be realized.

A regression of the average of mean commercial property values (y) against number of years (x) resulted in Eqn. 5.1

$$y = (115.3)\,x^2 + (405.3)\,x + 2950 \qquad \textbf{...Eqn.5.1}$$

where, y is in Naira per square metre

The model is expected to be true for the number of years beginning from 2003 (taken as 1) and subsequent consecutive years taken as 2, 3, 4, and 5 as the case may be. Eqn. 5.1 thus represents a predictive model useful at any time to forecast the likely average of mean rental values of commercial properties along arterial roads in the study area.

Furthermore, the minimum and maximum rental values for each of the five-year study period were extracted from Table 5.18 to predict the trends and range of commercial property values along the arterial roads in the study area in the near future. In this respect, the minimum rent for each of the study year was denoted as Set A while maximum rent was in Set B, the mean rental values represent the average of the minimum and maximum rents for each year as shown in Table 5.19

Table 5.19 Mean Rental Values Relative to Year

S/N	**Year**	**Rent** (in Naira/m^2)		
		Minimum (Set A)	**Maximum** (Set B)	**Mean**
1	2003	3,000	4,500	3,750
2	2004	3,000	5,500	4,250
3	2005	3,500	6,500	5,000
4	2006	4,000	8,500	6,250
5	2007	5,500	10,500	8,000

Source: Field Survey, 2008

In determining the trends of minimum and maximum rental values of commercial properties along the arterial roads in the study area, the rental values stated in Set A and Set B and the mean rental values were regressed. This resulted in Fig. 5.4. The Figure shows the trend lines of continous rise indicating that there will be increases in the minimum, maximum and mean rental values of commercial properties and such increases will continue into the foreseeable future.

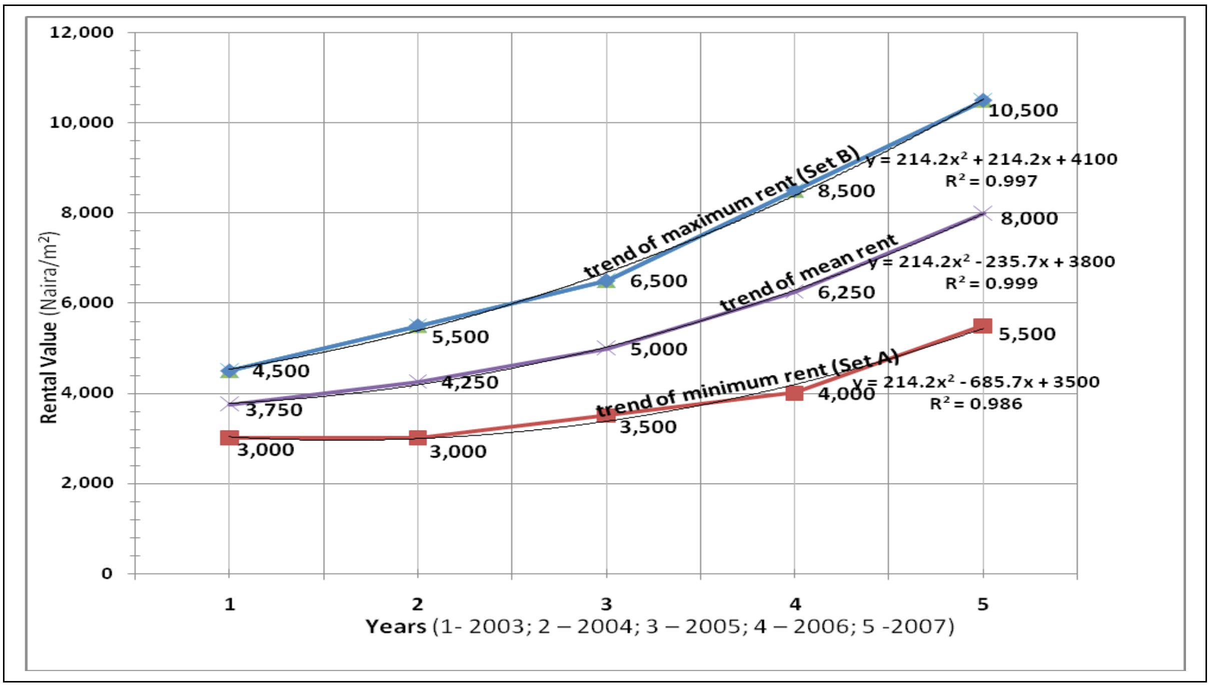

Fig. 5.4: Graphical Illustration of the Trends in Commercial Property Values in Ikeja
Source: Author's Analysis, 2008

As shown in Fig. 5.4, individual models were derived from the regression of the minimum, maximum and mean rental values in the study area. The analysis resulted in Eqns. 5.2, 5.3, and 5.4 for minimum, maximum, and mean rental values respectively.

$y_{mini} = (214.2)\, x_{mini}^{\ 2} - (685.7)\, x_{mini} + 3500$ **…Eqn. 5.2**

y_{mini} = the minimum rental value expressed in Naira per square metre (N/m^2);

x_{mini} = number of years considered in determining the trend in minimum rent

Eqn. 5.2 represents a model for predicting the minimum rental value of commercial property values along the arterial roads in the study area. In the model, y_{mini} is the minimum rental value expressed in Naira per square metre (N/m^2), while x_{mini} represents number of years. The model is fitted for predicting future minimum commercial property values with coefficient of determination equals 0.986. This implies that *ceteris paribus* there is very high probability that the forecast will be realized.

The model for predicting maximum rental value of commercial property values along the arterial roads is shown in Eqn. 5.3

$y_{maxi} = (214.2)\, x_{maxi}^{\ 2} + (214.2)\, x_{maxi} + 4100$ **…Eqn. 5.3**

where,

y_{maxi} = the maximum rental value expressed in Naira per square metre (N/m^2);
y_{maxi} = number of years considered in determining the trend in maximum rent

The model in Eqn. 5.3 is fitted for predicting future maximum commercial property values with coefficient of determination being 0.997, implying that *ceteris paribus* there is very high probability that the such prediction will be realized.

Model for predicting average rental values of commercial properties along arterial roads in the study area was equally derived from Fig. 5.4 and represented by Eqn. 5.4

$y_{mean} = (214.2)\, x_{mean}^{2} - (235.7)\, x_{mean} + 3800$ **…Eqn. 5.4**

where,

y_{mean} = the average of the maximum and minimum rental value (in Naira per square metre)

x = number of years considered in predicting future average rental values.

The model is fitted for predicting future average commercial property values with coefficient of determination being 0.999, implying that *ceteris paribus* there is very high probability that the such prediction will be realized.

From these analyses, a model for predicting the range of mean rental values of commercial properties was derived and shown as Eqn. 5.5:

$y_{mini} < y_{mean} < y_{maxi}$ **…Eqn. 5.5**

Furthermore, the model for predicting specific mean rental values is as follows:

$\delta y = y_{mini} + \gamma$ **…Eqn. 5.6**

where,

δy = expected mean rental values;

y_{mini} = prevailing minimum rental values;

γ = difference between maximum and minimum ÷ 2

In addition to the model for predicting commercial property values along the combined arterial roads in the study area, a number of models were derived for predicting average rental values of commercial properties along each arterial road as shown in Table 5.20

Table 5.20: Predictive Models of Commercial Property Values along Arterial Roads in Ikeja, Nigeria

S/N	Road	Predictive Model	R^2 value
1	Allen Avenue	y = 1500x + 2380	0.945
2	Adeniyi Jones Avenue	y = 1200x + 3200	0.973
3	Opebi Road	y = 1450x + 2250	0.926
4	Bank-Anthony Way	y = 1480x + 1920	0.991
5	Oba Akran Avenue	y = 1400x + 2140	0.990
6	Bank-Anthony/Opebi Way	y = 1350x + 2150	0.995
7	Toyin Street	y = 1370x + 2010	0.974
8	Aromire Avenue	y = 1230x + 2390	0.953
9	Kodesho Street	y = 1230x + 1650	0.988
10	Ogba Road	y = 830x + 2730	0.988
11	Obafemi Awolowo Way	y = 1150x + 1750	0.924
12	Simbiat Abiola Road	y = 1250x + 1310	0.960
13	ACME Road	y = 800x + 2600	0.984
14	Lateef Jakande Road	y = 1050x + 1850	0.958
15	Olowu Street	y = 850x + 2350	0.938
16	Opebi Link-road	y = 840x + 2200	0.874
17	Oregun Road	y = 950x + 1850	0.970
18	WEMPCO Road	y = 750x + 2050	0.969
19	Ikosi Road	y = 690x + 1970	0.927
20	Isheri/Agege Road	y = 580x + 2100	0.838

Source: Field Survey, 2008

Table 5.20 shows different predictive models applicable to each of the arterial roads in the study area. The R^2 values indicate that, all things being equal, the predicted values of commercial properties using these models have almost one hundred percent probability of being realized.

5.4.2 Analysis of Commercial Property Values along Arterial Roads in Ikeja

As earlier discussed under Tables 5.18 and 5.19, the range of mean rental values that falls in Category A is between ₦6,0001/m^2 and ₦ 7,000/m^2 are found along 40% of the arterial roads in Ikeja. These are found along Allen Avenue, Adeniyi Jones Avenue, Opebi Road, Bank-Anthony Way, Oba Akran Avenue, Bank-Anthony Way/Opebi Road, Toyin Street, and Aromire Avenue.

Category B consists of 20% of the arterial roads along which mean rental values range between ₦5,001/m^2 to ₦6,000/m^2 are found. These roads include Kodesho Street, Ogba Road, Obafemi Awolowo Way, and Simbiat Abiola Way. Category C has 35% of the arterial roads with rental values of commercial properties ranging between ₦4,001/m^2 and ₦5,000/$m^{2.}$ The roads are ACME Road, Lateef Jakande Road, Olowu Street, Opebi Link-road, Oregun Road, WEMPCO Road, and Ikosi Road. Category D has 5% of the arterial roads falling within a range of mean rental values of ₦3,000/m^2 to ₦4,000/m^2.

Consequently, in describing the pattern of commercial property values in the study area, attempt was made to depict the spatial distribution of mean rental values on a Value Map to give a pictorial illustration of the pattern of the values along the arterial roads. The spatial distribution of the mean rental values as analyzed is depicted pictorially on the Value Map in Fig. 5.5

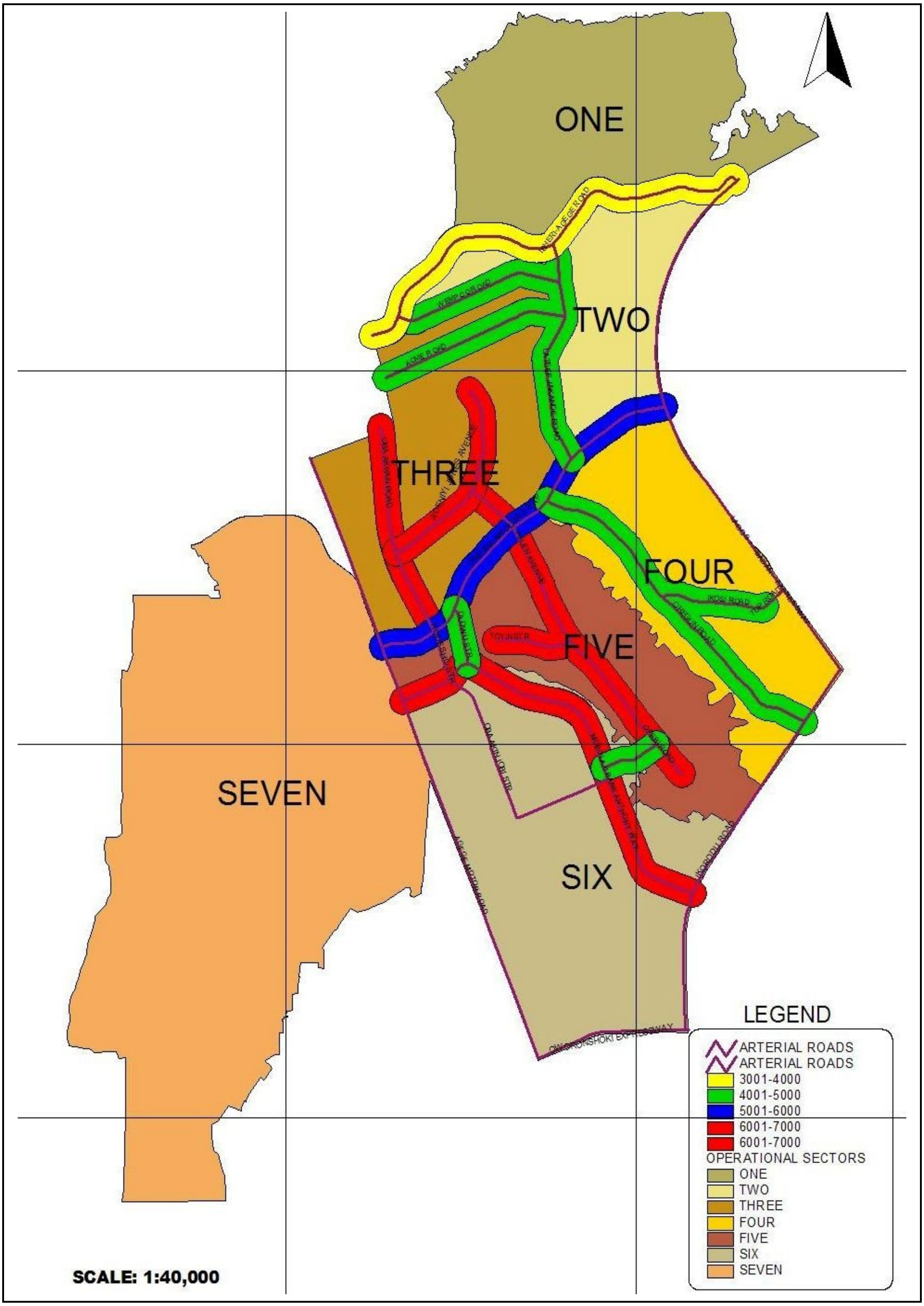

Fig. 5.5: Value Map Showing Spatial Pattern of Commercial Property Values in Ikeja
Source: Field Survey, 2008

In Fig. 5.5, the highest mean rental values (in Category A) are concentrated around the central portion of the study area. Category B follows a little distance away from the central area, and Category C is found farther away while Category D are found at the remote and outlying precincts of the study area. This finding is consistent with earlier theory that rental values decreases as distance from the central business district increases.

Furthermore, the study found relationship between high mean rental values and high accessibility and connectivity indexes. For instance, for Category A, the average accessibility index is 0.74 and connectivity index is 0.30, both representing the highest in the study area. This further confirms that the higher the level of accessibility, the higher the land values. This deduction is corroborated by presence of banks and high net-worth commercial entities along the roads in Category A. There has been high competition among such banks and between banks and other wholesale and retail shopping complexes with ease of movement and high accessibility that have accounted for high rental values along the arterial roads in the sector.

5.5 Analysis of Demand for Commercial Properties in Ikeja

The attempt in this Section was to determine the demand for commercial properties in the study area. In doing so, the number of requests for commercial properties by prospective tenants was obtained from the records of Estate Surveyors and Valuers. The total number of requests for properties along each arterial road was divided by number of respondents to obtain average demand for commercial properties as shown in Table 5.21

Table 5.21: Demand for Commercial Properties along Arterial Roads in Ikeja

S/N	Road	Years/Average Number of Requests					Total	Percentage
		2003	2004	2005	2006	2007		
1	Obafemi Awolowo Way	18	23	31	54	49	175	13.57
2	Bank-Anthony Way	10	12	15	20	28	85	6.59
3	Oba Akran Avenue	11	14	20	22	21	88	6.80
4	Toyin Street	9	29	20	34	41	133	10.30
5	Oregun Road	6	9	11	12	13	51	3.95
6	Allen Avenue	23	21	29	33	38	144	11.00
7	Opebi Road	12	16	18	25	33	104	8.06
8	Adeniyi Jones Avenue	16	19	20	22	25	103	7.98
9	Lateef Jakande Road	6	11	11	12	12	53	4.10
10	WEMPCO Road	3	4	5	6	9	27	2.09
11	Isheri Road	5	4	5	5	8	27	2.09
12	Kodesho Street	5	7	8	11	14	46	3.57
13	Simbiat Abiola Way	6	8	8	9	11	42	3.26
14	Aromire Avenue	7	7	7	11	10	43	3.30
15	Olowu Street	6	7	9	9	14	46	3.57
16	Opebi Link-Road	3	3	4	6	6	23	1.78
17	Ikosi Road	2	3	2	3	4	14	1.09
18	Ogba Road	3	4	6	5	7	25	1.90
19	Bank-Anthony/Opebi	6	5	7	7	9	34	2.60
20	ACME	6	6	6	7	7	31	2.40
Total		**163**	**212**	**243**	**315**	**357**	**1290**	**100.00**

Source: Field Survey, 2008

As shown in Table 5.21, the highest number of requests for commercial properties was recorded for Obafemi Awolowo Way (13.57%), followed by Allen Avenue (11%), and Toyin Street (10.3%). Least number of requests was recorded along Ikosi Road, Opebi Link-Road, and Ogba Road. This implies that the highest number of requests for commercial properties was found along the arterial roads within central part of the study area, where high rental values are prevalent.

Furthermore, a polynomial trend analysis of demand for commercial properties in the study area showed that there has been steady rise in the number of requests for commercial properties in the past five years and that, all things being equal, the increase would continue into the near future as shown in Fig. 5.6

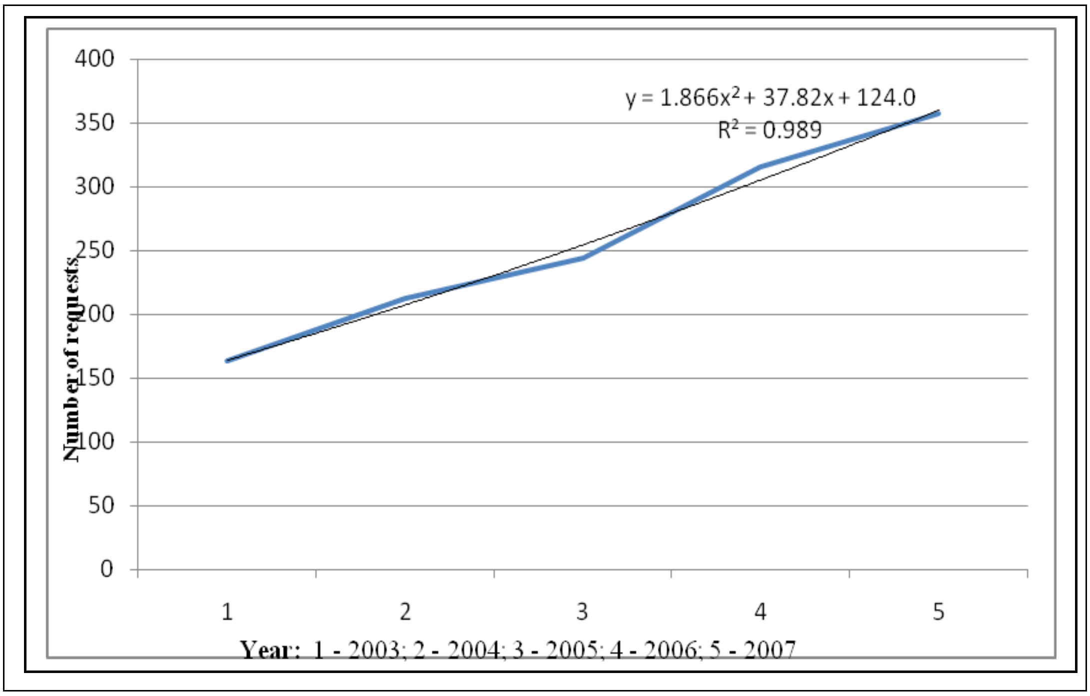

Fig. 5.6: Graphical Illustration of the Trend in Demand for Commercial Properties in Ikeja
Source: Field Survey, 2008

Fig. 5.6 shows that a model derived for predicting demand for commercial properties (y^d) in certain number of years (x) in the study area is:

$y^d = 1.87x^2 + 37.82x + 124$ **…Eqn. 5.7**

The analysis indicates that R^2 statistic in the model is 0.989. This implies that, all things being equal, there is very high probability that the prediction of demand for commercial property values in the study area using the model is attainable.

5.6 Analysis of Supply of Commercial Properties in Ikeja

In this Section, the supply of commercial properties was considered in terms of letting transactions completed within the past five years. Details of the average letting transactions in the study area are shown in Table 5.22

Table 5.22: Supply of Commercial Properties along Arterial Roads in Ikeja

S/N	Road	Year/Average Number of Letting Transactions					Total	Percentage
		2003	2004	2005	2006	2007		
1	Obafemi Awolowo Way	16	18	14	11	16	75	7.9
2	Bank-Anthony Way	9	7	8	20	19	63	6.7
3	Oba Akran Avenue	7	8	12	22	19	68	7.2
4	Toyin Street	8	21	19	34	33	115	12.16
5	Oregun Road	6	7	10	12	9	44	4.65
6	Allen Avenue	14	11	18	33	34	110	11.63
7	Opebi Road	6	13	11	25	23	78	8.25
8	Adeniyi Jones Avenue	7	14	10	22	22	75	7.93
9	Lateef Jakande Road	5	8	6	12	7	38	4.02
10	WEMPCO Road	3	3	4	6	8	24	2.54
11	Isheri Road	5	4	3	5	7	25	2.64
12	Kodesho Street	3	3	4	11	8	29	3.1
13	Simbiat Abiola Way	4	4	6	9	7	30	3.2
14	Aromire Avenue	5	4	6	11	8	34	3.6
15	Olowu Street	5	6	5	9	8	33	3.5
16	Opebi Link-Road	3	2	2	6	5	18	2
17	Ikosi Road	2	2	1	3	3	11	1.2
18	Ogba Road	3	4	4	5	6	22	2.33
19	Bank-Anthony/Opebi Road	5	4	3	7	6	25	2.6
20	ACME	6	5	4	7	5	27	2.85
Total		**122**	**148**	**150**	**272**	**253**	**946**	**100.00**

Source: Author's Analysis, 2008

Table 5.22 shows that 115 (12.16%) commercial properties were let along Toyin Street, followed by Allen Avenue (11.63%), and Obafemi Awolowo Way (7.90%) and Opebi Road (8.25%). This implies that many of the letting transactions occurred within the central part of the study area. This probably reinforced the attempt of Estate Surveyors and Valuers to meet high demand for commercial properties in the area. The least in terms of letting transactions of commercial properties are found along Ikosi Road confirming that, all things being equal, attempts would be made by Estate Surveyors and Valuers to meet high demand for commercial properties through increased number of letting transactions. The supply of commercial properties follows the direction of demand and spatial pattern of commercial property values. High supply of commercial properties is associated with central locations within the study area to benefit from high demand and property values.

Furthermore, a second order polynomial trend analysis of the average number of letting transactions involving commercial properties in the study area showed that, all things being equal, there would be increases in number of commercial properties available for letting from year to year and into the near future as shown in Fig. 5.7

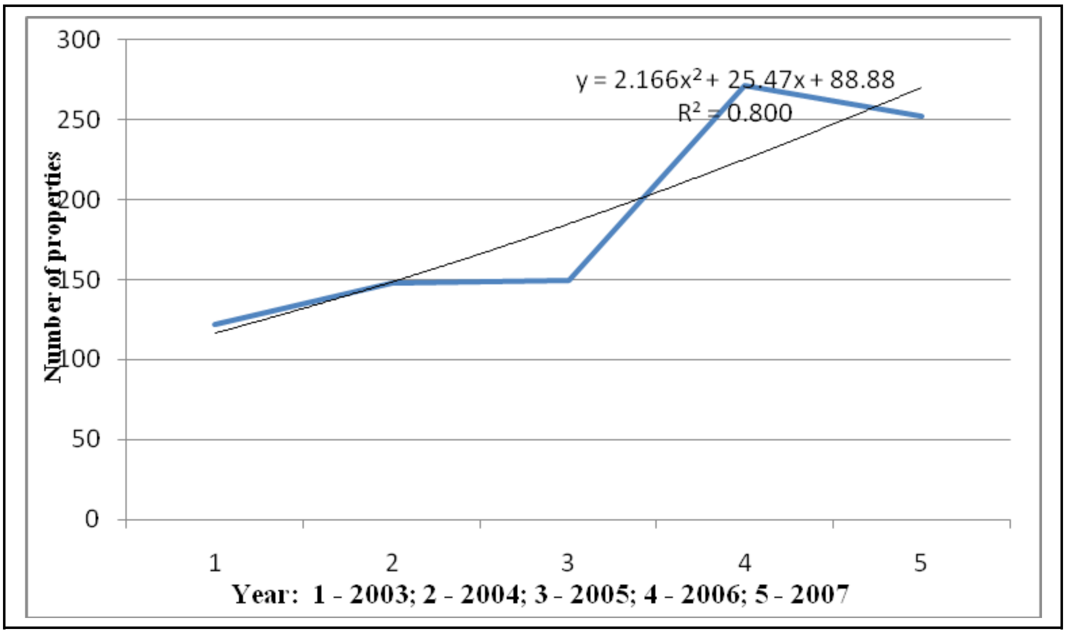

Fig. 5.7: Graphical Illustration of the Trend in Supply of Commercial Properties in Ikeja
Source: Field Survey, 2008

Fig. 5.7 shows the trend line of supply of commercial properties in the study area rising from year to year. A model for predicting the number of letting transactions (y^s) to meet requests for commercial properties over certain number of years, is:

$y^s = 2.17x^2 + 25.47x + 88.9$ **…Eqn. 5.8**

This model has the capacity to predict the average number of properties to be let and it is possible to determine the relationship between demand and supply. In addition, it makes possible the interplay of the two variables in predicting commercial property values in the study area. This interaction of demand and supply of commercial properties is illustrated by Fig. 5.8

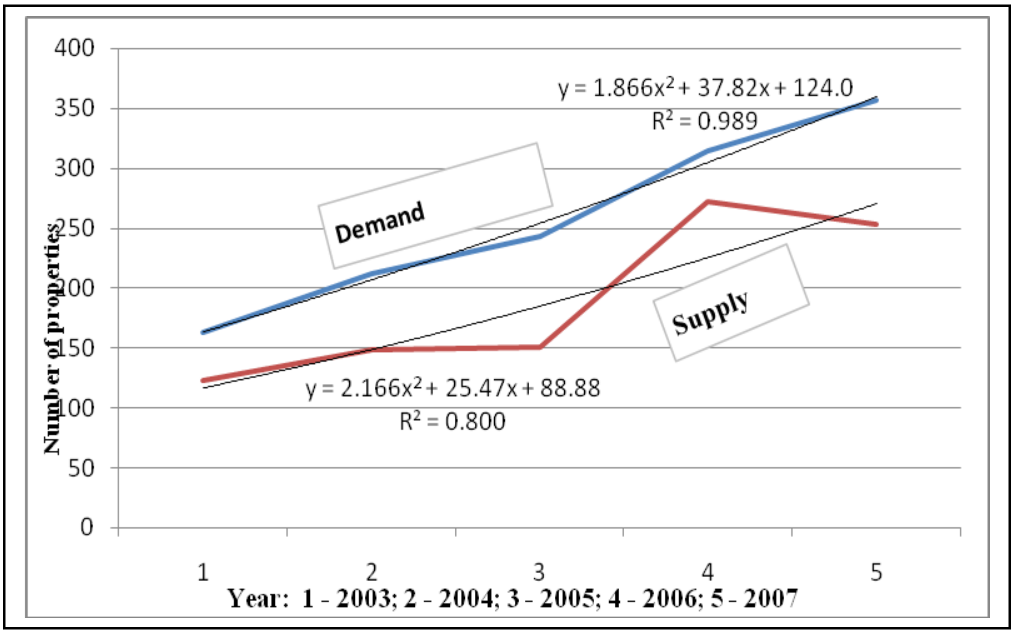

Fig. 5.8: Graphical Illustration of the Interplay of Supply and Demand for Commercial Properties in Ikeja
Source: Author's Analysis, 2008

Fig. 5.8 indicates that demand would, all things being equal, be above supply of commercial properties in the study area, and that the trends would continue to be on the increase from year to year and into the near future. The import of this finding is that since demand would increase above supply on from year to year into the near future, there is high probability that commercial property values in the study area would continue to increase.

5.7 Determination of Relationship between Explanatory Variables and Commercial Property Values in Ikeja

In this Section, attempt was made to determine the relationship that exists between the several explanatory variables (arterial road network, accessibility, location, demand and supply) and commercial property values in the study area. This was carried out to ensure logically consistent findings in consonance with the aim and objectives of the study. In this respect, two hypotheses earlier formulated are re-stated in the null form as follows:

H_{o1}: "There is no statistically significant relationship between the explanatory variables and commercial property values in the study area"

H_{o2}: "There are no differences in the contributions of the individual explanatory variables to variability in commercial property values in the study area"

Each hypothesis was tested and results presented in the next Sub-Sections. In doing so, attempt was made to determine if there are statistically significant relationships between the variables using the multiple regression models, and Analysis of Variance.

5.7.1 Relationship between Explanatory Variables and Commercial Property Values in Ikeja

The attempt was to test the first hypothesis that "there is no statistically significant relationship between the explanatory variables and commercial property values in the study area". In doing so, the multiple regression models was used, commercial property values was the dependent variable while the explanatory variables of location, demand, supply, accessibility, and road network (decomposed into road density, traffic density, road quality, and connectivity) made up the independent variables. The variables were represented by in the models as follows: commercial property value = y, traffic density = traden, road density = rodens, connectivity = connt, quality of road = qulrd, accessibility = acces, demand = demnd, supply = suply, and location = loctn.

The result of multiple linear regression models used in analyzing the relationship between the variables is summarized in Table 5.23

Table 5.23: Summary Statistic of the Explanatory Variables

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	-2044.95	2487.33	-0.822148	0.4285
Accessibility	7702.66	2167.5	3.55371	**0.0045**
Connectivity	633.735	2072.23	0.305823	0.7654
Demand	300.486	75.6406	3.97255	0.0022
Location	217.517	139.035	1.56448	0.1460
Road density	7305.53	9049.88	0.807251	0.4366
Road quality	1.53242	337.26	0.00454373	0.9965
Supply	-315.814	104.256	-3.02921	0.0115
Traffic density	8.48526	32.6862	0.259598	0.8000

Source: Author's Analysis, 2008

The output in Table 5.23 shows the results of fitting a multiple linear regression model to describe the relationship between commercial property values and the independent variables. The model to express the result of the fitting is shown in Eqn. 5.7

$$y = -2044.95 + 7702.66acces + 633.74connt + 300.49demnd + 217.52loctn + 7305.53rodens + 1.53qulrd - 315.81suply + 8.49traden \quad \textbf{...Eqn. 5. 7}$$

From Eqn. 5.7, it can be deduced that there is positive relationships between all the explanatory variables (except supply, which indicates negative relationship) and commercial property values. It implies that as accessibility and connectivity in the road network improves, together with increases in demand for commercial properties; with improvements in location attributes, road density, quality of roads and traffic density, commercial property values would increase. In addition, as supply decreases, commercial property values would increase, all things being equal.

For instance, as quality of roads improves, accessibility in terms of ease of getting to the locations of commercial activities would increase. The effects would be evident in the number of pedestrian and commercial activities taking advantage of ease of movements in the study area. The consequence would also be noticeable in demand for service products and commercial activities along the arterial roads with concomitant increase in commercial property values. This finding is valid and the equation would be useful as a predictive model.

Also from Table 5.23, the P-values for accessibility, demand, and supply, are less than 0.05, indicating that there are statistically significant relationships between commercial property values and the three variables at 95% confidence level.

Furthermore, the Analysis of Variance (Table 5.24) shows that the F-ratio is 3.11 with a P-value of 0.0423. In addition, details of the R^2, R^2 (adjusted for degree of freedom), and Durbin-Watson statistics are shown in the Table.

Table 5.24: ANOVA of the Relationship between Commercial Property Values and Independent Variables

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	1.12374E7	8	1.40467E6	3.11	**0.0423**
Residual	4.96171E6	11	451064.		
Total (Corr.)	1.61991E7	19			

R-squared = **69.3705** percent
R-squared (adjusted for d. f.) = **47.0945** percent
Standard Error of Est. = **671.613**
Mean absolute error = **354.052**
Durbin-Watson statistic = 1.59854 (P = **0.0705**)
Lag 1 residual autocorrelation = 0.127051
Source: Field Survey, 2008

From Table 5.24, the R-squared statistic indicates that the model as fitted explains 69.37% of variability in commercial property values. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 47.0945%. The Durbin-Watson (DW) statistic tests the residuals and determines if there is any significant correlation based on the order in which the data occur. From the ANOVA Table, the P-value of DW statistic (0.0705) is greater than 0.05 meaning that there is no indication of serial autocorrelation in the residuals at the 95.0% confidence level. In addition, the analysis of variance of the relationship between explanatory variables and commercial property values shows that the F-ratio is 3.11 and a P-value of 0.0423, which is less than 0.05. This implies that the null hypothesis is rejected meaning that there is statistically significant relationship between commercial property values and the variables.

The analysis shows that the explanatory variables of road network, in the presence of location, supply, and demand jointly explain 47.10% variability in commercial property values in the study area. By implication, other determinants of commercial property values probably account for the remaining 52.90%.

Furthermore, in determining the relationship between commercial property values (dependent variable) and arterial road network (independent variable), the latter was decomposed into its explanatory variables of road density, traffic density, road quality and connectivity. Multiple regression models was used for the analysis, the result of which is shown in Tables 5.25

Table 5.25: Summary Statistic of the Relationship between Commercial Property Values and Road Network Explanatory Variables

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	4755.56	2394.61	1.98595	0.0656
Traffic density	21.6365	43.0481	0.502612	0.6225
Connectivity	1101.74	3100.93	0.355293	0.7273
Road quality	-56.5059	460.833	-0.122617	0.9040
Road density	7481.84	11846.1	0.631589	0.5372

Source: Field Survey, 2008

The output shows results of fitting a multiple linear regression model to describe the relationship between commercial property value and four independent explanatory variables of road network. The equation of the fitted model is:

$$y = 4755.56 + 21.64traden + 1101.74conn - 56.51qulrd + 7481.84roden \qquad \textbf{...Eqn. 5. 8}$$

Furthermore, the F-ratio is 0.16 and P-value of 0.9549 as shown in Table 5.26

Table 5.26: ANOVA of Relationship between Commercial Property Values and Road Network Explanatory Variables

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	665968.	4	166492.	0.16	**0.9549**
Residual	1.55331E7	15	1.03554E6		
Total (Corr.)	1.61991E7	19			

R-squared = **4.11114** percent
R-squared (adjusted for d.f.) = **0.0** percent
Standard Error of Est. = **1017.62**
Mean absolute error = **798.433**
Source: Field Survey, 2008

In addition Table 5.26 shows that the R^2 = 4.11% and since the P-value is greater than 0.05, there is no statistically significant relationship between commercial property values and road network at 95.0% or higher confidence level. The R-Squared statistic indicates that the model as fitted explains 4.11% of the variability in commercial property value. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.0%.

This implies that road network alone, in the absence of other variables, has no statistically significant relationship with commercial property values in the study area. The R-squared (adjusted for degree of freedom) indicates that there is no model as the road network explains no variability in commercial property values, in the absence of other variables. However, when accessibility, demand, location, and supply are considered as independent variables and road network is removed from the model, a regression of commercial property value (y) and the variables results in Tables 5.27 and 5.28

Table 5.27: Summary Statistics of Regression of Commercial Property Values and Explanatory Variables

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	-990.488	1461.43	-0.67775	0.5083
Accessibility	6802.83	1695.7	4.01181	**0.0011**
Demand	285.359	63.4553	4.49701	0.0004
Location	266.984	119.619	2.23196	0.0413
Supply	-296.575	83.1178	-3.56813	0.0028

Source: Author's Analysis, 2008

The output in Table 5.27 shows the results of fitting a multiple linear regression model to describe the relationship between commercial property values and the four independent variables. The equation of the fitted model derived from the output is:

y = -990.49 + 6802.83acces + 285.36demnd + 266.98loctn - 296.58suply **…Eqn. 5.9**

The R^2 statistic, P-value, and F-ratio are shown in Table 5.28. The P-value is 0.0021, which is less than 0.05 confidence level.

Table 5.28: ANOVA of Relationship between Four Independent Variables and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	1.05701E7	4	2.64253E6	7.04	**0.0021**
Residual	5.62899E6	15	375266.		
Total (Corr.)	1.61991E7	19			

R-squared = **65.2512** percent
R-squared (adjusted for d. f.) = **55.9849** percent
Standard Error of Est. = **612.589**
Mean absolute error = **395.632**
Durbin-Watson statistic = 1.23421 (P=**0.0208**)
Lag 1 residual autocorrelation = 0.292141
Source: Author's Analysis, 2008

Since the P-value (0.0021) in the ANOVA table (Table 5.28) is less than 0.05, there is a statistically significant relationship between the variables at 95.0% confidence level. The R-Squared statistic indicates that the model as fitted explains 65.2512% of the variability in commercial property values. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 55.9849%. All the independent variables in Table 5.27 returned P-values that are less than 0.05 implying that each of the variables has significant relationships with commercial property values.

5.7.2 Determination of the Contributions of Individual Explanatory Variables to Variability in Commercial Property Values in Ikeja, Nigeria

An attempt was made to test the second hypothesis that **"**there are no differences in individual contributions of the explanatory variables to variability in commercial property values in the study area". This was to determine the contributions of the independent variables to variability in commercial property value on individual basis. As stated earlier, the explanatory independent variables are road network (traffic density, road density, quality of road, and connectivity), accessibility, location attribute, demand, and supply while commercial property value is the dependent variable. Each of the independent variables was regressed against commercial property values using the polynomial regression model of order 2.

5.7.2.1: Relative Contribution of Accessibility to Variability in Commercial Property Values

In determining the contribution of accessibility (independent variable) to variability in commercial property value (dependent variable), the polynomial regression model of order 2 was used and the output of the regression shown in Tables 5.29

Table 5.29: Summary Statistics of Regression of Commercial Property Values and Accessibility

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	8045.18	1194.45	6.73549	0.0000
Accessibility	-15795.5	5684.45	-2.77872	0.0129
Accessibility^2	17093.8	6174.89	2.76827	**0.0132**

Source: Author's Analysis, 2008

The output in Table 5.29 shows the results of fitting a second order polynomial model to describe the relationship between Commercial Property Value and accessibility. The equation of the fitted model is:

$$y = 8045.18 - 15795.5acces + 17093.8acces^2 \qquad \textbf{...Eqn. 5.10}$$

The Analysis of Variance of the relationship between the variables indicates the F-ratio, R^2 and P-value. The P-value is 0.0405 as shown in Table 5.30

Table 5.30: ANOVA of Relationship between Accessibility and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	5.09101E6	2	2.5455E6	3.90	**0.0405**
Residual	1.11081E7	17	653417.		
Total (Corr.)	1.61991E7	19			

R-squared = **31.4277** percent
R-squared (adjusted for d.f.) = **23.3604** percent
Standard Error of Est. = **808.342**
Mean absolute error = **630.884**
Durbin-Watson statistic = 0.543018 (P=**0.0000**)
Lag 1 residual autocorrelation = 0.573676
Source: Author's Analysis, 2008

Since the P-value in the ANOVA table (Table 5.30) is less than 0.05, there is a statistically significant relationship between commercial property value and accessibility at the 95% confidence level. The R-Squared statistic indicates that the model as fitted explains 31.4277% of the variability in commercial property value. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 23.3604%. In determining whether the order of the polynomial was appropriate, it suffices to note that the P-value on the highest order term of the polynomial equals 0.0131543, which is less than 5%. Since the P-value is less than 0.05, the highest order term of accessibility is statistically significant at the 95% confidence level.

5.7.2.2: Relative Contribution of Connectivity to Variability in Commercial Property Values

In respect of the contribution of connectivity to commercial property values in the study area, the second order polynomial regression of the variables resulted in Tables 5.31

Table 5.31: Summary Statistic of the Relationship between Commercial Property Values and Connectivity

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	3630.16	832.8	4.35898	0.0004
Connectivity	20913.0	8678.97	2.40962	0.0276
Connectivity^2	-49765.1	21229.4	-2.34416	**0.0315**

Source: Author's Analysis, 2008

Table 5.31 shows the result of fitting a second order polynomial model to describe the relationship between commercial property value and connectivity. The equation of the fitted model is:

$y = 3630.16 + 20913.0connt - 49765.1connt^2$ **…Eqn. 5.11**

Also from Table 5.31, each level of the polynomial regression shows that all the P-values are less than 0.05 confidence level. However, Analysis of Variance of the variables indicates the F-ratio = 2.90 and P-value of 0.0822 as shown in Table 5.32

Table 5.32: ANOVA of Relationship between Connectivity and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	4.12488E6	2	2.06244E6	2.90	**0.0822**
Residual	1.20742E7	17	710248.		
Total (Corr.)	1.61991E7	19			

R-squared = **25.4636** percent
R-squared (adjusted for d.f.) = **16.6946** percent
Standard Error of Est. = **842.762**
Mean absolute error = **628.989**
Source: Author's Analysis, 2008

Since the P-value in the ANOVA Table is greater or equal to 0.05, there is no statistically significant relationship between commercial property value and connectivity at 95% or higher confidence level. The R-Squared statistic indicates that the model as fitted explains 25.46% of the variability in commercial property value. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 16.70%. In determining whether the order of the polynomial is appropriate, it necessary to observe that the P-value on the highest order term of the polynomial equals 0.0314774, which is less than 5%. Since the P-value is less than 0.05, the highest order term is statistically significant at the 95% confidence level.

5.7.2.3: Relative Contribution of Demand to Variability in Commercial Property Values

In respect of the contribution of demand to variability in commercial property values in the study area, the second order polynomial regression of the variables resulted in Tables 5.33

Table 5.33: Summary Statistics of Regression of Commercial Property Values and Demand

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	4471.5	632.902	7.06507	0.0000
Demand	114.354	93.6273	1.22138	0.2386
Demand^2	-2.08742	2.6005	-0.8027	**0.4332**

Source: Author's Analysis, 2008

The output shows the results of fitting a second order polynomial model to describe the relationship between commercial property values and demand. The equation of the fitted model is shown in Eqn. 5.12

$y = 4471.5 + 114.354demnd - 2.08742demnd^2$ **…Eqn. 5.12**

The Analysis of Variance revealed that the F-ratio is 2.14, P-value = 0.1477, and R-squared of 20.1487% as shown in Table 5.34

Table 5.34: ANOVA of Relationship between Demand and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	3.26392E6	2	1.63196E6	2.14	**0.1477**
Residual	1.29352E7	17	760893.		
Total (Corr.)	1.61991E7	19			

R-squared = **20.1487** percent
R-squared (adjusted for d.f.) = **10.7545** percent
Standard Error of Est. = **872.292**
Mean absolute error = **604.394**
Source: Author's Analysis, 2008

The P-value of 0.1477 in the ANOVA table is greater than 0.05, implying that there is no statistically significant relationship between commercial property value and demand in the absence of other variables at 95% or higher confidence level. The R-Squared statistic indicates that the model as fitted explains 20.15% of the variability in commercial property value. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 10.76%.

5.7.2.4: Relative Contribution of Supply to Variability in Commercial Property Values

In this Section, attempt was made to determine the contribution of supply to variability in commercial property values. The analysis of the variables using polynomial regression model of order 2 option resulted in Tables 5.35 and 5.36

Table 5.35: Summary Statistics of Regression of Commercial Property Values and Supply

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	3768.58	680.215	5.54028	0.0000
Supply	333.226	137.575	2.42214	0.0269
Supply^2	-11.9502	5.49174	-2.17604	**0.0439**

Source: Author's Analysis, 2008

The output in Table 5.35 shows the result of fitting a second order polynomial model to describe the relationship between supply and values of commercial properties. The equation of the fitted model is:

$y = 3768.58 + 333.23suply - 11.9502\ suply^2$ **…Eqn. 5.13**

In addition to the predictive model derived, the Analysis of Variance of the relationship between commercial property values and supply was carried to determine the P-value, F-ration, and R-square statistics shown in Table 5.36.

Table 5.36: ANOVA of Relationship between Supply and Commercial Property Values

Source	**Sum of Squares**	**Degree of freedom**	**Mean Square**	**F-Ratio**	**P-Value**
Model	4.49386E6	2	2.24693E6	3.26	**0.0632**
Residual	1.17052E7	17	688544.		
Total (Corr.)	1.61991E7	19			

R-squared = **27.7414** percent
R-squared (adjusted for d.f.) = **19.2404** percent
Standard Error of Est. = **829.785**
Mean absolute error = **643.449**
Source: Author's Analysis, 2008

The P-value in Table 5.36 is 0.0632 which is greater than 0.05, and since the P-value is greater it implies that there is no statistically significant relationship between commercial property values and supply at 95% or higher confidence level, in the absence of other variables. The R-Squared statistic indicates that the model as fitted explains 27.74% of the variability in commercial property values. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 19.2404%. In determining whether the order of the polynomial is appropriate, it suffices to note that the P-value on the highest order term of the polynomial equals 0.0439443, which is less than 0.05, indicates that the highest order term is statistically significant at 95% confidence level.

5.7.2.5: Relative Contribution of Road Quality to Variability in Commercial Property Values

In this case, the contribution of quality of the arterial roads to commercial property values in the absence of other variables was determined. Commercial property value as the dependent and quality of roads as the independent variables were regressed using the second order polynomial regression model. The resulting statistics are shown in Tables 5.37 and 5.38, which respectively are the summary statistics and Analysis of Variance.

Table 5.37: Summary Statistics of Regression of Commercial Property Values and Road Quality

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	-7320.0	7967.57	-0.918724	0.3711
Road quality	6254.0	3858.29	1.62093	0.1234
Road quality^2	-748.0	459.635	-1.62738	**0.1220**

Source: Author’s Analysis, 2008

The output in Table 5.37 shows the result of fitting a second order polynomial model to describe the relationship between commercial property value and road quality. The equation of the fitted model is:

$y = -7320.0 + 6254.0qulrd - 748.0qulrd^2$ **…Eqn. 5.14**

Table 5.38 is the ANOVA of the relationship between commercial property values and quality of roads in the absence of other variables. The Table shows the F-ratio, P-value and R-squared statistics.

Table 5.38: ANOVA of the Relationship between Road Quality and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	2.18354E6	2	1.09177E6	1.32	**0.2921**
Residual	1.40156E7	17	824445.		
Total (Corr.)	1.61991E7	19			

R-squared = **13.4794** percent
R-squared (adjusted for d.f.) = **3.3005** percent
Standard Error of Est. = **907.989**
Mean absolute error = **709.0**
Source: Author’s Analysis, 2008

From Table 5.38, the P-value is 0.2921 which is greater than 0.05. Since the P-value is greater than 0.05, it implies that there is no statistically significant relationship between commercial property value and road quality, in the absence of other variables, at 95% or higher confidence level. The R-Squared statistic indicates that the model as fitted explains 13.48% of the variability in commercial property values. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 3.3005%.

5.7.2.6: Relative Contribution of Traffic Density to Variability in Commercial Property Values

In determining the individual contribution of traffic density to variability in values of commercial properties in the study area in the absence of other variables, the second order polynomial regression model was used and giving the details in Tables 5.39

Table 5.39: Summary Statistics of Regression of Commercial Property Values and Traffic Density

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	6302.7	706.293	8.92364	0.0000
Traffic density	-151.419	111.381	-1.35947	0.1918
Traffic density^2	4.42948	3.27717	1.35162	**0.1942**

Source: Author's Analysis, 2008

The output in Table 5.39 shows the result of fitting a second order polynomial model to describe the relationship between commercial property value and traffic density. The equation of the fitted model is:

$$y = 6302.7 - 151.419 \text{ traden} + 4.42948 \text{ traden}^2 \quad \textbf{…Eqn. 5.15}$$

The F-ratio, P-value and R-squared statistics of the variables are shown in Table 5.40. The Table shows that P-value is 0.4140, F-ratio = 0.93, and R^2 = 9.85478%.

Table 5.40: ANOVA of the Relationship between Traffic Density and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	1.59639E6	2	798193.	0.93	**0.4140**
Residual	1.46027E7	17	858983.		
Total (Corr.)	1.61991E7	19			

R-squared = **9.85478** percent
R-squared (adjusted for d.f.) = **0.0** percent
Standard Error of Est. = **926.813**
Mean absolute error = **754.059**
Source: Author's Analysis, 2008

Since the P-value in the ANOVA table is greater than 0.05, there is no statistically significant relationship between commercial property value and traffic density in the absence of other variables at 95% or higher confidence level. The R-Squared statistic indicates that the model as fitted explains 9.85478% of the variability in commercial property value.

5.7.2.7: Relative Contribution of Road Density to Commercial Property Values

In determining the individual contribution of road density to variability in commercial property value in the absence of other variables, the second order polynomial regression model was used and the output shown in Table 5.41 and 5.42

Table 5.41: Summary Statistics on Regression of Commercial Property Values and Road Density

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	4770.54	677.738	7.03891	0.0000
road density	25441.4	25870.7	0.983406	0.3392
road density^2	-164110.	185466.	-0.884852	**0.3886**

Source: Author's Analysis, 2008

The output in Table 5.41 shows the result of fitting a second order polynomial model to describe the relationship between commercial property value and road density. The equation of the fitted model is:

$$y = 4{,}770.54 + 25{,}441.4\ \text{rodens} - 164{,}110.\ \text{rodens}^2$$ **…Eqn. 5.16**

Table 5.42: ANOVA of the Relationship between Road Density and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	957406.	2	478703.	0.53	**0.5958**
Residual	1.52417E7	17	896570.		
Total (Corr.)	1.61991E7	19			

R-squared = **5.91024** percent
R-squared (adjusted for d.f.) = **0.0** percent
Standard Error of Est. = **946.874**
Mean absolute error = **779.023**
Source: Author's Analysis, 2008

The P-value in Analysis of Variance Table 5.42 is 0.5958 which is greater than 0.05. Since the P-value is greater than 0.05, it implies that there no statistically significant relationship between commercial property value and road density at the 95% or higher confidence level, in the absence of other variables. The R-Squared statistic indicates that the model as fitted explains 5.91024% of the variability in commercial property value. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.0%.

5.7.2.8: Contribution of Location to Variability in Commercial Property Values in Ikeja, Nigeria

In determining the individual contribution of location attribute to variability in commercial property value, the polynomial regression model of order 2 was used and the output shown in Table 5.43 and 5.44

Table 5.43: Summary Statistics of Regression of Commercial Property Values and Location

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	5429.12	2014.28	2.69532	0.0153
location	-191.044	1059.53	-0.18031	0.8590
location^2	44.6996	130.159	0.343422	**0.7355**

Source: Author's Analysis

The output in Table 5.43 shows the result of fitting a second order polynomial model to describe the relationship between commercial property value and location. The equation of the fitted model is:

$$y = 5429.12 - 191.044\ loctn + 44.6996\ loctn^2$$ **…Eqn. 5.17**

Table 5.44: ANOVA of the Relationship between Location and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	1.00549E6	2	502743.	0.56	**0.5800**
Residual	1.51936E7	17	893742.		
Total (Corr.)	1.61991E7	19			

R-squared = **6.20704** percent
R-squared (adjusted for d.f.) = **0.0** percent
Standard Error of Est. = **945.379**
Mean absolute error = **783.497**
Durbin-Watson statistic = 0.170306 (P=**0.0000**)
Lag 1 residual autocorrelation = 0.777615
Source: Author's Analysis

The ANOVA Table (Table 5.44) indicates that P-value is 0.5800, which is greater than 0.05 and since the P-value in the ANOVA table is greater than 0.05, there is no statistically significant relationship between commercial property value and location in the absence of other variables at 95% or higher confidence level. The R-Squared statistic indicates that the model as fitted explains 6.20704% of the variability in commercial property values. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.0%.

5.7.2.9: Summary of the Results of Regression Analysis of Individual Variables

In this Sub-section, a summary of the results of the analysis using second order polynomial regression of commercial property values and individual explanatory variables are shown in Table 5.45. The R^2 column in the Table indicates the percentage variability in dependent variables brought about by the independent variable while the column for P-value explains significance or otherwise of the relationship between the variables. P-Values that is greater than 0.05 indicate that there is no significant relationship between the variable and commercial property value, vice versa.

Table 5.45: Summary Statistics of Eight Individual Variables

S/N	Variable	Results of Regression with Polynomial Order 2			Predictive model
		R^2 (%)	R^2 (adj. for d.f.) %	P-value	
1	Accessibility	31.43	23.36	0.0405	$y = 8045.18 - 5795.5acc + 17093.8acc^2$
2	Connectivity	25.46	16.70	0.0822	No predictive model since there is no statistically significant relationship between commercial property value and the variable.
3	Demand	20.15	10.76	0.1477	-ditto-
4	Supply	27.74	19.24	0.0632	-ditto-
5	Road Quality	13.48	3.30	0.2921	-ditto-
6	Traffic Density	9.86	0.00	0.4140	-ditto-
7	Road Density	5.91	0.00	0.5958	-ditto-
8	Location	6.21	0.00	0.5800	-ditto-

Source: Author's Analysis, 2008

From Table 5.45, accessibility explains 31.43% variability in the values of commercial properties in the study area and has statistically significant relationship with commercial property values. All other predictors have P-values above 0.05 implying that the predictor-variables could be removed without hurting the model significantly. This established the importance of accessibility amongst all the variables. The implication of this finding is that Estate Surveyors and Valuers cannot ignore accessibility in accurately expressing opinions on commercial property values in the study area. Such opinion on comparable properties would be reliable only when individual accessibility of the arterial roads are considered.

The only individual variable in respect of which a model could be derived is accessibility. When demand, supply, connectivity, road and traffic densities, road quality, and location were considered on their individual basis, there was no statistically significant relationship with commercial property value. The R^2 (adjusted for degree of freedom) (Table 5.45) shows that there are significant differences in contributions of the individual variables to variability in commercial property values in the study area.

It must however be reiterated that although some variables may have no statistically significant relationship with commercial property values when considered on their individual basis, removing them entirely from the regression model may not be very correct. It is therefore important to carry out a stepwise regression analysis to determine the truly insignificant variables; this is carried out in the next Sub-section.

5.7.2.10: Determining the Statistically Significant Variables

As earlier stated, it would be wrong to assume that all predictor variables with P-values above 0.05 could be removed from the predictive models. In fact, the P-values may change dramatically if one of them is removed. A useful method for simplifying this is to perform a stepwise regression. The stepwise regression analysis involves the addition or removal of the variables in turns. The approach is to obtain a model that contains only significant predictors while not excluding any useful variables.

Two stepwise options were considered which are the Forward Selection and Backward Selection. Forward selection started with the model containing only the constant and bringing variables in one at a time if they improve the fit significantly, while Backward Selection started with a model containing all of the variables and removed them one at a time until all remaining variables are statistically significant. In both methods, the removed variable is re-entered at a later step when they appeared to be useful predictors, or variables entered early later removed if they were no longer significant. In this study, the Backward selection stepwise regression model is used. It involves the systematic removal of each variable as shown below.

Stepwise regression
Method: backward selection
F-to-enter: 4.0
F-to-remove: 4.0

Step 0:
8 variables in the model. 11 d.f. for error.
R-squared = 69.37% Adjusted R-squared = 47.09% MSE = 451064.

Step 1:
Removing variable road quality with F-to-remove =0.0000206455
7 variables in the model. 12 d.f. for error.
R-squared = 69.37% Adjusted R-squared = 51.50% MSE = 413476.
Step 2:

Removing variable traffic density with F-to-remove =0.0786251
6 variables in the model. 13 d.f. for error.
R-squared = 69.17%   Adjusted R-squared = 54.94%   MSE = 384171.

Step 3:
Removing variable connectivity with F-to-remove =0.079177
5 variables in the model. 14 d.f. for error.
R-squared = 68.98%   Adjusted R-squared = 57.90%   MSE = 358903.

Step 4:
Removing variable road density with F-to-remove =1.68386
4 variables in the model. 15 d.f. for error.
R-squared = 65.25%   Adjusted R-squared = 55.98%   MSE = 375266.

The stepwise regression analysis revealed four variables that entered into the models, these variables are accessibility, demand, location and supply which on their individual bases did not show statistically significant relationship with commercial property values.

Furthermore, the resulting R^2, R^2 adjusted for degree of freedom, and mean standard error were derived from the analysis of the four explanatory variables that entered into the models. The R^2 indicates the contribution of the variables to variability in commercial property values; d.f. is the degree of freedom, while the mean standard error accounted for errors in the percentage of variability which may be negative or positive of the stated R^2 as shown in Tables 5.46 and 5.47

Table 5.46: Summary Statistics of the Stepwise Regression of Explanatory Variables and Commercial Property Values

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	-990.488	1461.43	-0.67775	0.5083
Accessibility	6802.83	1695.7	4.01181	0.0011
Demand	285.359	63.4553	4.49701	0.0004
Location	266.984	119.619	2.23196	0.0413
Supply	-296.575	83.1178	-3.56813	0.0028

Source: Author's Analysis, 2008

The output (Table 5.46) shows the results of fitting a multiple linear regression model to describe the relationship between commercial property values and eight independent variables. The equation of the fitted model of the variables is therefore:

$$y = -990.488 + 6802.83acces + 285.36demnd + 266.98loctn - 296.58suply$$ **…Eqn. 5.18**

The analysis of variance of the variables shows that the F-ratio is 7.04 and a P-value of 0.0021, which is less than 0.05

Table 5.47: ANOVA of the Relationship between Independent Variables and Commercial Property Values

Source	Sum of Squares	Degree of freedom	Mean Square	F-Ratio	P-Value
Model	1.05701E7	4	2.64253E6	7.04	**0.0021**
Residual	5.62899E6	15	375266.		
Total (Corr.)	1.61991E7	19			

R-squared = **65.2512** percent
R-squared (adjusted for d.f.) = **55.9849** percent
Standard Error of Est. = **612.589**
Mean absolute error = **395.632**
Durbin-Watson statistic = 1.23421 (P=**0.0208**)
Lag 1 residual autocorrelation = 0.292141
Source: Field Survey, 2008

Since the P-value in the ANOVA table (Table 5.47) is less than 0.05, there is statistically significant relationship between the variables at 95.0% confidence level. The R-Squared statistic indicates that the model as fitted explains 65.25% of the variability in commercial property values. The adjusted R-squared statistic is 56%, which is more suitable for comparing models with different numbers of independent variables. In determining whether the model can be simplified, it suffices to note that the highest P-value on the independent variables is 0.0413, belonging to location. Since the P-value is less than 0.05, location is statistically significant at 95.0% confidence level.

5.7.2.11: Determination of the Relative Contributions of Principal Components

The attempt here was to obtain small numbers of linear combinations of the eight variables that account for most of the variability in the data. The variable components, namely, accessibility, location, demand, supply, road quality, traffic density, connectivity, and road density are numbered 1 to 8 respectively with the corresponding Eigen-values and cumulative percentages shown in Table 5.48

Table 5.48: Principal Components Analysis of the Independent Variables

S/N	Component	Eigen-value	Percent of Variance	Cumulative Percentage
1	Accessibility	3.12481	39.060	39.060
2	Location	1.82867	22.858	61.918
3	Demand	1.19184	14.898	76.816
4	Supply	0.824682	10.309	87.125
5	Road Quality	0.492654	6.158	93.283
6	Traffic Density	0.384739	4.809	98.092
7	Connectivity	0.127795	1.597	99.690
8	Road Density	0.0248127	0.310	100.000

Source: Author's Analysis, 2008

From Table 5.48, three components with Eigen-values greater than or equal to 1.0 were extracted using the stepwise regression analysis. The components are accessibility, location, and demand, and they jointly account for 76.82% variability in commercial property values in the study area.

5.8 Resolution of Conceptual and Theoretical Postulations

In this Section, attempt was to resolve some theoretical issues on relationships between transportation and property values as deduced in the literature. In doing this, a number of theories and concepts identified in reviewed literature were examined by seeking opinions of practicing Estate Surveyors and Valuers who rated them according to set options. The options were Strongly Agreed, Agree, Undecided, Disagree, and Strongly Disagree, which were rated 5, 4, 3, 2 and 1 respectively with the relative importance index used. The resulting figures are shown in Table 5.49, which contains the frequency of each option.

From Table 5.49, about 73% of the Estate Surveyors and Valuers strongly agreed that improvement in road transportation facilities, especially roads, brings about improved accessibility, and that there is strong relationship between accessibility and commercial property values in the study area. Similarly, majority of the respondents also strongly agreed that commercial property users seek locations that maximize their pecuniary profits, once sites are developed. There will be strong influence on the use to which other surrounding sites could be put and that locations along arterial roads have positive effects on commercial property values; while direct accessibility to road positively affect values as commercial properties along arterial roads possess relative advantages over those located off the roads. About 60% agreed that property values decrease with increasing distance from Allen Avenue/Awolowo Way roundabout. They also agreed that road junctions are major causes of traffic congestion and that road nodal points have greater positive effects on commercial property value, while 60% disagreed that the lower the transport costs the higher the commercial property values in the study area.

Table 5.49: Resolution of Theories and Postulations

Questions	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree(1)	Mean
Lower transport costs result in high commercial property value	18	9	27	36	9	2.30
Improvement in road transportation facilities, especially roads, brings about improved	72	27	0	0	0	4.73
from Allen Avenue/Awolowo Way Roundabout	36	45	0	18	0	4.00
in Ikeja metropolis	45	27	0	27	0	3.91
Locations at points where two or more roads meet have greater positive effect on commercial property values than locations farther from such locations	36	54	0	9	0	4.18
The better a transport network the less the friction and the higher the value of commercial property	45	45	0	9	0	4.27
Direct accessibility to road positively affects commercial property value	63	36	0	0	0	4.64
Physical attributes of commercial properties (land size, age, condition, parking etc) affect their values	36	63	0	0	0	4.36
Commercial properties along main roads have relative advantages over those located off the roads	54	45	0	0	0	4.55
Greater relative advantages belong to commercial properties at the focus of road transport	18	63	18	0	0	4.00
Neighbourhood characteristics (population, types of properties etc) affect commercial property values	36	63	0	0	0	4.36
Competition amongst land uses affects values of commercial properties in Ikeja	36	45	18	0	0	4.18
There is strong relationship between accessibility and commercial property values in Ikeja	36	63	0	0	0	4.36
Locations prone to attacks by criminals reduce commercial property values.	27	54	0	18	0	3.91
Commercial property values increase at locations near institutional or corporate buildings	18	81	0	0	0	4.18
There is no relationship between connectivity in road network and value of commercial properties	0	0	18	81	0	2.18
Predominant land uses in a neighborhood will determine commercial property values	0	54	45	0	0	3.55
and commercial property values in Ikeja Metropolis	72	27	0	0	0	4.73
Commercial property users seek locations that maximize their pecuniary profits	81	9	0	9	0	4.64
Once sites are developed there will be strong influence on use to which other sites could be put	54	36	9	0	0	4.46
on commercial property values in Ikeja	45	54	0	0	0	4.46

Source: Field Survey, 2008

5.9 Summary

This Chapter has validated and in some cases invalidated a number of theories and postulations in orderly process of thought. This study investigated the relationship between transportation, commercial property value, drawing heavily from earlier works, in the hope of providing a synthesis, which overcomes the weaknesses of each contribution and maximizes the strengths inherent in them.

In addition, it was established that there was significant relationship between explanatory variables and commercial property values. The result for relative contributions of the explanatory variables revealed that there was no significant relationship between road network and commercial property values, in the absence of other variables. Also, it was established that there were continuous increases in demand for and supply of commercial properties, and commercial property values; and that the increases will continue from year to year while models for predicting the increases were derived. Inferences from the analysis in this Chapter will be the subject of further discussion in the Chapter 6.

CHAPTER SIX

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

The attempt in this Chapter is to draw inferences from the data analysis and elucidate the findings using a format that is constructive and beneficial for policy implementations. This is followed by recommendations and concluding comments, while attempt is also made towards identifying opportunities for future research.

6.2 Research Findings

A number of deductions were made from the data analysis, these are highlighted as follows:

1. The study found that most Estate Surveyors and Valuers rely on intuition in deciding the relative accessibility of arterial roads. Estate Surveyors and Valuers cannot afford to continue providing inadequate professional advice that is based on mere intuition. This is because investors in commercial properties require professional opinions on locations that will make such investment viable. The analysis showed individual levels of accessibility of the arterial roads in the study area, thereby giving developers and investors the choice of alternative sites along the roads.

2. The Estate Surveyors and Valuers rated Toyin Street as the best in terms of accessibility in the study area based on intuition whereas the use of analytical technique found that Obafemi Awolowo Way is the most accessible. However, the Estate Surveyors' ranking of levels of accessibility by intuition and the result of the analytical technique jointly ranked ACME Road as the least accessible. Relating this to rental values of commercial properties, the locations fall into different categories of mean rental values. Obafemi Awolowo Way falls within the category with rental values ranging between N5, 001 and N6, 000 per square metre per annum while rental values of commercial properties along ACME Road

are between N4, 001 and N5, 000 per square metre per annum. The implication is that the level of accessibility has direct influence on rent passing on commercial property values in the study area.

3. The analysis showed that the highest number of commercial properties along the arterial roads in the study area has mean rental values ranging between N6, 000 and N7, 000 per square metre per annum. This is the commonest in the study area with indication that high mean rental values are associated with arterial road with high accessibility and connectivity index. This finding is corroborated by concentration of banks and high net-worth commercial entities that have been competing for space within the highly accessible and connected locations along Obafemi Awolowo Way, Allen Avenue, Aromire Avenue, Adeniyi Jones, Oba Akran Avenue in the study area. This has partly accounted for high rental incomes in such locations.

4. The study found that highest demand for commercial property values was found along the arterial roads within the central part of the study area, where there is high rental value. This implies that high rental value shows direct relationship with demand for commercial properties in the study area. This was not unexpected as the central part of urban areas offer advantages of agglomeration of commercial activities. The findings also supports earlier works of Alonso (1964), Lean and Goodall (1977), and Di Pasquale and Wheaton (1996).

5. Trend analysis of demand for and supply of commercial properties indicated continuous rise in demand from year to year into the near future. A model for predicting future demand was derived, which is $y^d = 1.87x^2 + 37.82x + 124$. Similarly, a predictive model of trend in supply was derived, $y^s = 2.17x^2 + 25.47x + 88.9$. The predictive models are useful to forecast the likely demand and supply of commercial properties along the arterial roads in the study area. If knowledge is derived of probable average demand and supply of commercial properties within the study area, say, in the next twenty (20) years (i.e. year 2022), demand is $y^d = 1.87(20)^2 + 37.82(20) + 124$. Therefore, predicted average demand for commercial properties for year 2022 would be about 1,628. Similarly, the predictive model of supply would be $y^s = 2.17(20)^2 + 25.47(20) + 88.9$, which is 1,066. The implication is that, all things being equal demand would be greater than supply of

commercial property values in the study area. This further confirms that commercial property values would increase in the near future.

6. The study showed that the minimum rental value of commercial properties along arterial roads in the study area could be determined using the model: $y_{mini} = (214.2)\, x_{mini}^2 - (685.7)\, x_{mini}$. For instance, in 20 years' time (by year 2022 i.e. 20 years from 2003), the minimum rental values of the properties can be expected to be: $y_{mini} = (214.2)(20)^2 - (685.7)(20) + 3500$ $y_{mini} = (214.2)(400) – (685.7)(20) + 3500$ y_{mini} = 85, 680 – 13, 714 + 3,500

   y_{mini} = N 75, 466/m^2 p.a.

   In addition, it was found that the maximum rental value of commercial properties along arterial roads in the study area could be determined using the model: $y_{maxi} = (214.2)\, x_{maxi}^2 + (214.2)\, x_{maxi} + 4100$.

   Thus, in year 2022, the maximum rent expected to prevail in the study area is:

   $y_{maxi} = (214.2)(20)^2 + (214.2)(20) + 4100$.

   $y_{maxi} = (214.2)(400) + (214.2)(20) + 4100$

   $y_{maxi} = 85680 + 4284 + 4100$

   y_{maxi} = N94, 064/m^2 p.a.

   From the illustrations, the range of commercial property values along arterial roads in the study area revealed is $y_{mini} < y_{mean} < y_{maxi}$. Substituting for y_{mini}, y_{mean}, and y_{maxi} in Eqn. 5.16, the range of mean values of commercial properties expected to prevail by year 2022 would be N75, 466/m^2 p.a. < N84, 765 < N94, 064/m^2. This shows that commercial property values in 2022 will most likely range between N75, 000 and N95, 000/m^2 p.a.

   Adopting the model in Eqn. 5.17, i.e. $\delta = y_{mini} + \gamma$, the expected average of the mean rental value of commercial properties along the arterial roads by year 2022 will, *ceteris paribus*, be:

   $$\delta = N75,000 + \frac{(N95,000 – N75,000)}{2}$$

   Therefore, the expected average of the mean rental value of commercial properties along the arterial roads in year 2022 will be N85, 000/m^2 p.a. However, when considered on annual basis, the polynomial trend analysis (Figs. 5.3 and 5.4) still showed continuous rising trend from year to year. The resulting model for predicting commercial property values in relation to road network pattern is $y = (115.3)\ x^2 + (405.3)\ x + 2950$.

This implies that for every year ($x = 1$) the mean commercial property value (y) in the study area will increase by N3, 470.60/m^2 p.a. at $R^2 = 0.96$. The R^2 of 0.96 indicates very high probability of attaining the prediction. This model will be useful for Development Appraisers, Estate Surveyors and Valuers, and Financiers in expressing opinions about the average annual increase in commercial property values and assists them in forecasting the feasibility and viability appraisals of investments in commercial property values in the study area.

In addition, the model for predicting the minimum rental value of commercial properties along the arterial roads in the study area is $y_{mini} = (214.2)\ x_{mini}^{2} - (685.7)\ x_{mini} + 3500$. This means that for every year (μ_{mini}=1) the minimum rental value will be N3, 028.50/m^2. The model for predicting the maximum rental value was also developed, which is: $y_{maxi} = (214.2)\ x_{maxi}^{2} + (214.2)\ x_{maxi} + 4100$. This indicates that for every year the expected maximum rental value is N4, 528.40/m^2 p.a.

7. In testing the first null hypothesis that "there is no significant relationship between the explanatory variables and commercial property values in the study area", the multiple linear regression model revealed that the P-values for accessibility is 0.0045; demand, 0.0022; supply, 0.0115; connectivity, 0.7654; location, 0.1460; road density, 0.4366; road quality, 0.9965; and traffic density, 0.8000. This showed that except for density, connectivity, location, road density, quality of road, and traffic density, all other independent variables have statistically significant relationship with commercial property values in the study area. The ANOVA of the relationship between commercial property values and explanatory variables showed that the P-value is 0.0423, which is less than 0.05. This implies that there is statistically significant relationship between commercial property values and the independent variables. The R^2 = 69.4% (R^2 adj. d.f. = 47%) implies that the variables explain 47.10% variability in commercial property values. It therefore suffices to state that Estate Surveyors and Valuers must consider the variables as major issues in valuation of commercial properties in the study area for their opinion of value to be reliable.

8. Regression of the explanatory variables of road network (traffic density, connectivity, road quality, and road density) and commercial property values in the absence of other variables showed that the P-value is 0.9549 and a R^2 of 4.11114%. This implies that there is no statistically significant relationship between commercial property values and road network, in the absence of other variables.

Various results obtained in the regression of each explanatory variable individually and commercial property values showed that accessibility returned a P-value of 0.0405 (which is less than 0.05) and $R^2 = 31.43\%\%$. This indicates that there is statistically significant relationship between accessibility and commercial property values in the study area, and that the variable contributes 31.43% of variability in commercial property values.

A predictive model of commercial property value in terms of accessibility is $y = 8045.18 – 15795acces + 17093.8acces^2$. The model is useful as a predictive tool for determining the impact of accessibility on commercial property values in the study area. For instance, assuming the variable remains constant, say at unity, commercial property values would be $y = 8,045.18 – 15795(1) + 17093.8(1)^2 =$ ₦9,343.98. Assuming that accessibility is improved probably through removal of hindrances to vehicular and pedestrian movements, doubling the existing levels of accessibility the model will become $y = 8045.18 – 15795(2) + 17093.8(2)^2 =$ ₦ 44,830.38. Comparing the two results, there is an increase of about 380% in values of commercial properties.

This implies that, all things being equal, improvement in levels of accessibility in the study area will have positive impact on commercial property values. This probably could be that improvements in accessibility would encourage more commercial property occupiers seek locations along the arterial roads in the study area, and increasing demand will bring competition amongst the occupiers thereby values to increase. This is in line with findings in earlier studies of Haig (1926), Wachs and Kumagi (1973), Lean and Goodall (1977), Leake and Huzayyin (1979), Kivel (1993), and Neiemer (1997).

In addition, improvements in accessibility in the form of road construction will lead to greater accessibility and bring about higher rents. This finding therefore supports earlier theory that the higher the degree of accessibility and complementarities, the larger the urban area and the higher the land values in the centre are likely to be (Lean and Goodall, 1977); and the closer the destination, the higher the accessibility (Song, 1996).

9. A regression of connectivity, road quality, traffic density and road density with commercial property value showed P-values greater than 0.05, implying that there are no statistically significant relationships between the variables and commercial property values in the study area, in the absence of other variables. This simply means that there is no model to explain or predict the relationship between commercial property values and each of the variables on their individual basis.

10. The study found that although when demand, supply and location variables are considered on their individual bases they returned no statistically significant relationships with commercial property values in the study area. A stepwise regression analysis however showed that accessibility, demand, location, and supply would effectively enter into the model for predicting commercial property values in the study area. A predictive model consisting of the variables was derived: y = -990.488 + 6802.83acces + 285.36demnd + 266.98loctn – 296.58suply. This means that as accessibility, demand and location attributes improves when supply decreases, commercial property values would increase, all things being equal. This implies that the interplay of the four variables has great impact on commercial property values in the study area.

6.3 Recommendations

The following recommendations are made based on the researcher’s findings, to point the way forward on the part of the Estate Surveyors and Valuers, the Nigerian Institution of Estate Surveyors and Valuers (NIESV), investors, and the Government.

1. An analytical mind will be required in an emerging competitive 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 judgment based on intuitive decisions is very high and the best way to reduce such misjudgment is to adopt scientific techniques. This study has tested and adopted the graph theoretic technique and found it a useful tool in analyzing

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 development 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 seminar, workshops and conferences, while current curriculum in Polytechnics and Universities offering Estate Management should be broadened to include road network analysis.

This is achievable through funding of research in this regard. In U.K., the Royal Institution of Chartered Surveyors (RICS) over the years have been funding research towards determining the impacts of rails, roads, and air transportation on property values. The Nigerian Institution of Estate Surveyors and Valuers (NIESV) is advised to fund research into the impacts of various modes of transportation on property values. Discussion of the results of such research works should be communicated to Estate Surveyors and Valuers through regular Mandatory Continuous Professional Development (MCPD) Programmes, and national conferences of the NIESV.

2. 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 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, which actually delivers greater accessibility, as major issue in valuation of commercial 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 the highest return that is adequate and sufficient to compensate investors in such projects.

3. 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 judgments that would stand the test of time.

4. The estate surveying and valuation profession in Nigeria 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 realize 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.

5. The Lagos State Government has enacted the Land Use Charge 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 Charge Law of 2001 is a function of property value, the Lagos State Government should increase its funding of road improvements including the construction, maintenance, and rehabilitation of the arterial road network. Arterial road network actually delivers location attributes, accessibility, and enhances demand, supply,

quality of roads, and connectivity elements. 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 charges.

6.4 Opportunities for Further Research

This study is probably a pioneering research into the impact of arterial road networks on commercial property values in Ikeja, Nigeria. Further research efforts need to be carried out in other cities of Nigeria, 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 Nigerian 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 analyze 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 Nigeria. This will become handy in feasibility and viability appraisal and site selection process for development projects.

6.5 Conclusion

The arterial road network and values of commercial properties in Ikeja 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 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 values. The study has thrown up challenges, especially in linking transport with estate management, valuation, and project development appraisal.

The researcher is also hopeful that the findings in 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 Nigeria 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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APPENDIX I

ROAD NETWORK PATTERNS

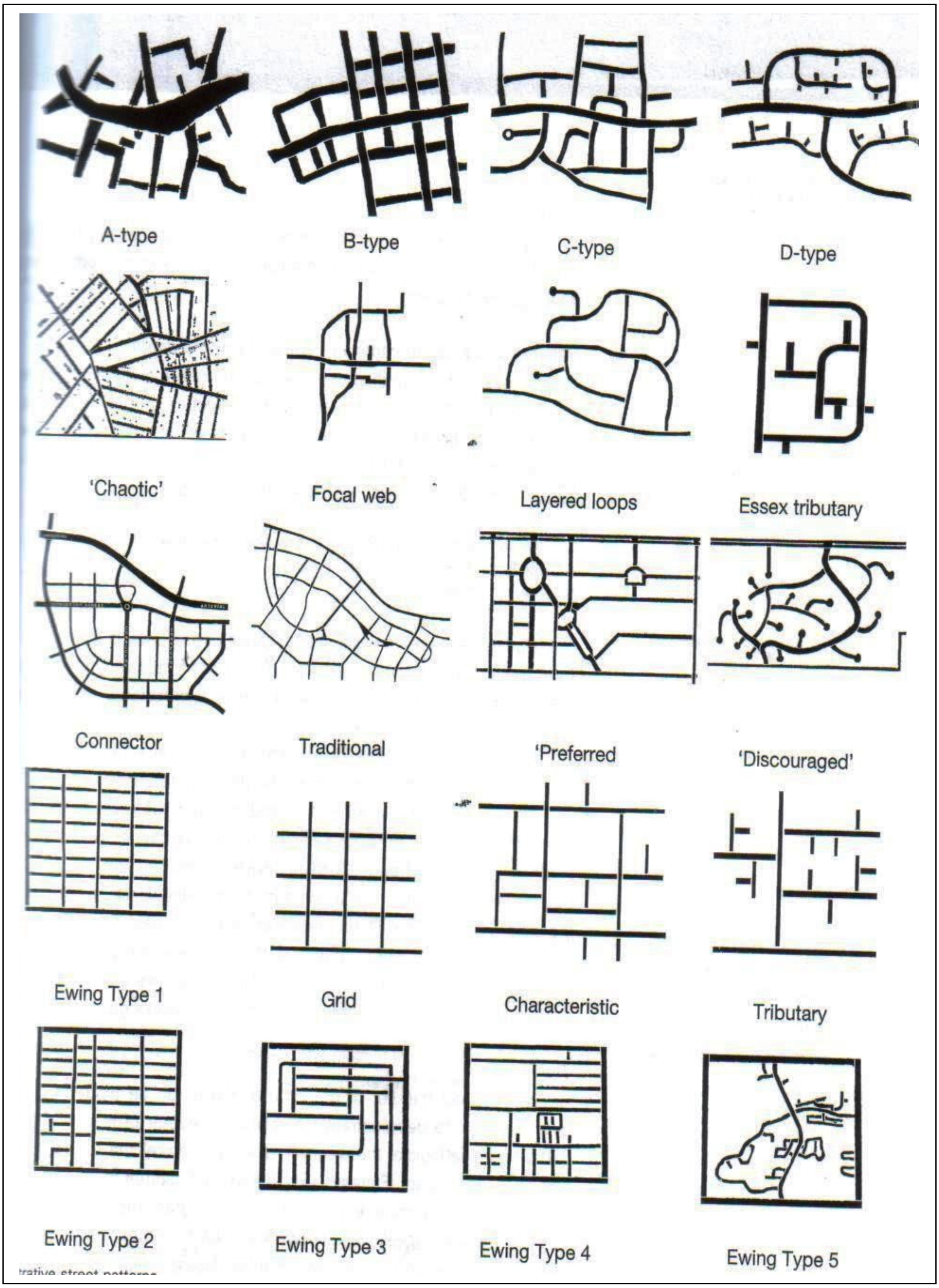

Fig. 3.1a: Sampled Road Network Patterns
Source: Marshall (2005)

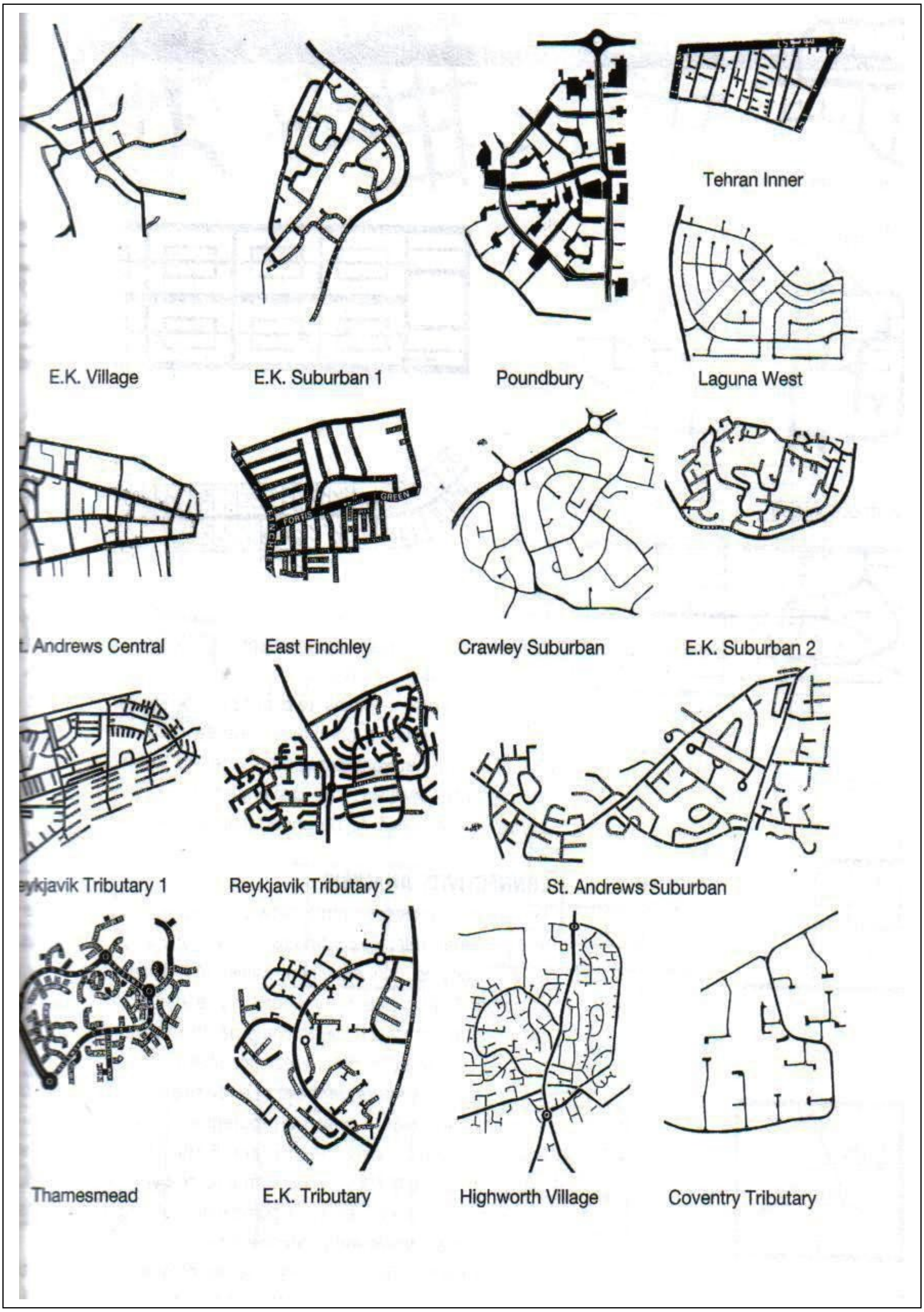

Fig. 3.1b: Sampled Road Network Patterns
Source: Marshall (2005)

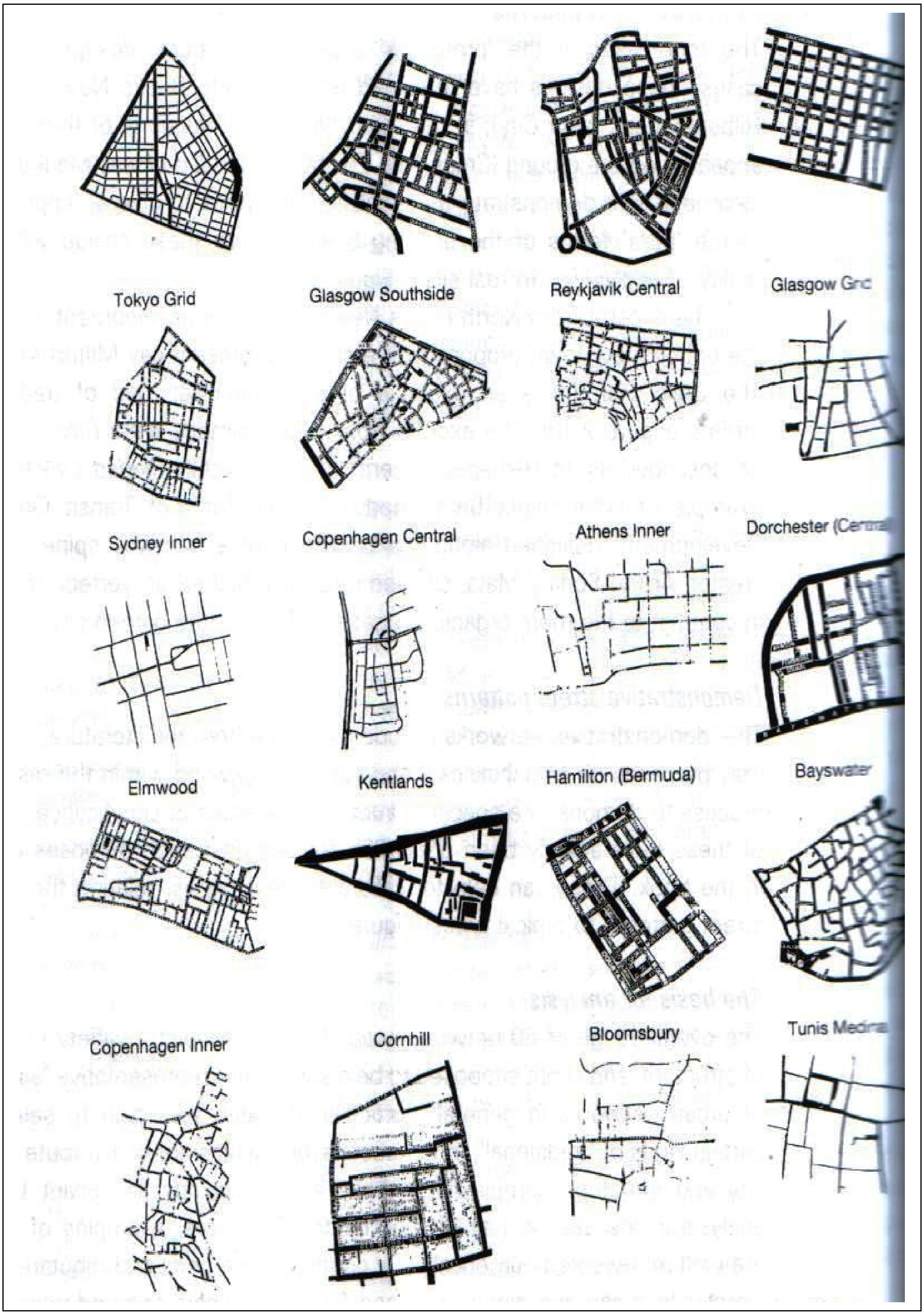

Fig. 3.1c: Sampled Road Network Patterns
Source: Marshall (2005)

APPENDIX II

QUESTIONNAIRE 1

(For Estate Surveyors and Valuers)

Dear Noble Colleague,

This questionnaire is designed to obtain information on the topic – **Arterial Road Network and Commercial Property Values in Ikeja**, **Nigeria**, a research project in Department of Estate Management, Covenant University, Ota, Ogun State, Nigeria.

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

Kindly complete the blank spaces and put marks in the appropriate boxes as applicable.

Thank you.
Olawande Oni
February, 2008

SECTION A

1. Location of Office: ______________________________

2. Gender:

(a) Male [ ]

(b) Female [ ]

3. Qualifications:

(a) Professional Qualification:

(i) ANIVS [ ]
(ii) FNIVS [ ]
(iii) Probationer [ ]
(iv) Others, please state: ___________

(b) Highest Academic Qualification:

(i) B.Sc. [ ]
(ii) M.Sc. [ ]
(iii) Ph.D. [ ]
(iv) HND [ ]
(v) OND [ ]
(vi) Others, please state: ___________

(c) Others, pls. state____

4. Post Qualification Work Experience as Estate Surveyor

(a) Less than 5 years [ ]
(b) 5 – 10 years experience [ ]
(c) 11 – 15 years [ ]
(d) Above 15 years [ ]

SECTION B

5. Kindly rate the following streets in relation to their levels of accessibility relative to Allen/Obafemi Awolowo Way Roundabout

Location/Street Name:	**Rating** (Pls. tick ONE point for each street)1=Best, 2 = next etc																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.Obafemi Awolowo																			
2. Bank-Anthony Way																			
3. Oba Akran Avenue																			
4. Toyin Street																			
5. Oregun Road																			
6. Opebi Road																			
7. Adeniyi Jones																			
8. Lateef Jakande Road																			
9. Wempco Road																			
10. Isheri Road																			
11. Kodesho Street																			
12. Simbiat Abiola Way																			
13. Aromire Avenue																			
14. Olowu Street																			
15. Opebi Link Road																			
16. Ikosi Road																			
17.Ogba Road																			
18. Bank-Anthony Way																			
19. ACME Road																			

6. Please rate the following roads in terms of your perception of the levels of traffic congestion

Road	**Rating of Traffic Situation in Ikeja**				
	Very high	**High**	**Undecide**	**Low**	**Very Low**
1. Obafemi Awolowo Way					
2. Bank-Anthony Way					
3. Oba Akran Avenue					
4. Toyin Street					
5. Oregun Road					
6. Allen Avenue					
7. Opebi Road					
8. Adeniyi Jones Avenue					
9. Lateef Jakande Road					
10. Wempco Road					
11. Isheri Road					
12. Kodesho Street					
13. Simbiat Abiola Road					

14. Aromire Avenue					
15. Olowu Street					
16. Opebi Link Road					
17. Ikosi Road					
18. Ogba Road					
19. Bank-Anthony Way					
20. WEMPCO Road					

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

(a) Yes [ ]

(b) No [ ]

8. You must have rated certain locations in Ikeja 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 [ ]

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

(a) ____

(b) ____

10. If No, Why did you not use any technique?

(a) I am not aware of the techniques to measure accessibility [ ]

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

11. 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: __________________

12. What is the average rent per square metre for commercial properties along each of the following roads in Ikeja metropolis for the past five years?

Location/Street Name:	**Average Rent per square metre p.a.**				
	2003	**2004**	**2005**	**2006**	**2007**
1. Obafemi Awolowo Way					
2. Bank-Anthony Way					
3. Oba Akran Avenue					
4. Toyin Street					
5. Oregun Road					
6. Allen Avenue					
7. Opebi Road					
8. Adeniyi Jones Avenue					
9. Lateef Jakande Road					
10. Wempco Road					
11. Isheri Road					
12. Kodesho Street					
13. Simbiat Abiola Way					
14. Aromire Avenue					
15. Olowu Street					
16. Opebi Link Road					
17. Ikosi Road					
18. Ogba Road					
19. Bank-Anthony Way					
20 ACME Road					

13. How important are the under listed factors affecting commercial property values in Ikeja metropolis?

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 the commercial property itself					
8	Road network					
9	Neighbourhood					
10	Transport costs					
11	Traffic congestion					
12	Location					
13	Demand					
14	Accessibility					
15	Intensity of Land Use					

14. What will be the impact of each of these factors on commercial property value? Please **tick one** impact **for each factor**

S/N	Factor	Impact		
		Positive	**Negative**	**No impact**
1	Competition amongst			
2	Neighbourhood			
3	Transport costs			
4	Traffic congestion			
5	Location			
6	Demand			
7	Accessibility			
8	Intensity of Land Use			
9.	Other factor, please			

15. Kindly estimate the average number of requests for commercial properties that your firm received in the past FIVE years with respect to listed locations

Location/Street Name:	Average Number of Requests in past 5 years				
	2003	**2004**	**2005**	**2006**	**2007**
1. Obafemi Awolowo Way					
2. Bank-Anthony Way					
3. Oba Akran Avenue					
4. Toyin Street					
5. Oregun Road					
6. Allen Avenue					
7. Opebi Road					
8. Adeniyi Jones Avenue					
9. Lateef Jakande Road					
10. Wempco Road					
11. Isheri Road					
12. Kodesho Street					
13. Simbiat Abiola Way					
14. Aromire Avenue					
15. Olowu Street					
16. Opebi Link Road					
17. Ikosi Road					
18. Ogba Road					
19. Bank-Anthony/Opebi Road					
20. ACME Road					

16. Kindly estimate the average number of letting transactions of commercial properties effectively carried out by your firm in the past FIVE years with respect to listed locations

Location/Street Name:	**Average Number of Requests in past 5 years**				
	2003	**2004**	**2005**	**2006**	**2007**
1. Obafemi Awolowo Way					
2. Bank-Anthony Way					
3. Oba Akran Avenue					
4. Toyin Street					
5. Oregun Road					
6. Allen Avenue					
7. Opebi Road					
8. Adeniyi Jones Avenue					
9. Lateef Jakande Road					
10. Wempco Road					
11. Isheri Road					
12. Kodesho Street					
13. Simbiat Abiola Way					
14. Aromire Avenue					
15. Olowu Street					
16. Opebi Link Road					
17. Ikosi Road					
18.Ogba Road					
19. Bank-Anthony/Opebi Road					
20. ACME Road					

17. Please rate the factors influencing rental value in order of importance. 1 being the highest, 2 next, etc

S/N	**Factor**	**Rating (Please Tick ONE point for each street)**												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**1**	**12**	**13**
1.	Location (relative to arterial road)													
2.	Road accessibility (nearness to road)													
3.	Road network pattern (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, environmental quality of the area, etc)													
8.	Traffic (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/upgrade existing property to modern standard)													
11.	Demand for commercial space													

12.	Economic attributes (local/national economic condition, and ability of tenants to pay)													
13.	Others, pls state:													

18. Do your clients make demand for commercial properties located near junctions of two or more roads?

(a) Yes [ ]

(b) No [ ]

19. Kindly express your opinion by responding to the questions in the Table below.

S/N	**Question**	**Response** (Please tick ONE for each Question)				
		Strongly Agree	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**
1	Lower transport costs often result in higher commercial property values					
2	Improvement in transportation facilities, especially roads, brings about improved accessibility.					
3	Commercial property values decreases outwards with increasing distance from Allen Avenue by Obafemi Awolowo Way Roundabout					
4	Road junctions are major causes of traffic congestion in Ikeja metropolis					
5.	Locations at points where two or more roads meet have greater positive effects 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 values					
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 roads have relative advantages over those located off the roads					
10.	Greater relative advantages belong to commercial properties at the focus of road transport					

11.	Characteristics of a neighbourhood (population density, general types and standard of properties, etc) affect commercial property values					
12.	Competition amongst land uses affects value of commercial properties in Ikeja					
13.	There is strong relationship between accessibility and commercial property values in Ikeja					
14.	Location that is prone to attacks by criminals will reduce commercial property values					
15.	Location near institutional or corporate buildings will increase commercial property values					
16.	There is no relationship between connectivity (where two or more roads meet) in road network and value of commercial properties in Ikeja					
17.	Predominant land uses in a neighbourhood will determine commercial property values					
18.	There is strong relationship between accessibility and commercial property values in Ikeja 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 influence on the use to which remaining sites would be put					
21	Locations along arterial roads positively affect commercial property values in Ikeja metropolis					

Thank you.

APPENDIX III

QUESTIONNAIRE 2

(For Occupiers of Commercial Properties)

Dear Sir/Madam,

This questionnaire is designed to obtain information on the topic **– Arterial Road Network and Commercial Property Values in Ikeja**, **Nigeria**, a research project in Department of Estate Management, Covenant University, Ota, Ogun State, Nigeria.

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

Kindly complete the blank spaces and put marks in the appropriate boxes as applicable.

Thank you.

Olawande Oni
February, 2008

SECTION A

1. Location of Office: ________________________________

2. Gender:

(a) Male [ ]

(b) Female [ ]

3. Occupation:

(a) Professional [ ]

(b) Commerce [ ]
(c) Others, please specify____

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

5. What is the net floor area that you are occupying? __________________ square metres

6. How much are you paying as rent? N______________ per annum

SECTION B

7. 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 [ ]

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

(a) Very Good [ ]
(b) Good [ ]
(c) Undecided [ ]
(d) Poor [ ]
(e) Very Poor [ ]

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

(a) Yes [ ]
(b) No [ ]

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

(a) Purpose-built [ ]
(b) Converted [ ]

11. What factors influenced your choice of the present premises? Please select as **MANY** options as possible.

S/N	**Factor**	**Please select HERE**
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:	

12. Have locations along arterial roads affected commercial property values in Ikeja metropolis?

(a) Yes [ ]

(b) No [ ]

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

(a) Yes [ ]

(b) No [ ]

14. 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, environmental quality of													
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:_________________													

15. Kindly express your opinion by responding to the questions in 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	Improvement in transportation facilities, especially roads, brings about improved accessibility.					
3	Commercial property values decreases outwards with increasing distance from Allen Avenue/Awolowo Way Junction					
4	Road junctions is a major cause of traffic congestion in Ikeja 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 Ikeja					
13.	There is strong relationship between accessibility and commercial property values in Ikeja					
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 Ikeja 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 Ikeja 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 sites would be put					
21	Locations along arterial roads positively affect commercial property values in Ikeja metropolis					

16. 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 the commercial property itself					
8	Road network					
9	Neighbourhood					
10	Transport costs					
11	Traffic congestion					
12	Location					
13	Demand					
14	Accessibility					
15	Intensity of Land Use					

Thank you.