EFFECTS OF ROAD TRANSPORT DEVELOPMENT ON URBAN GROWTH AND COMMERCIAL ACTIVITIES IN GOMBE METROPOLIS, GOMBE STATE NIGERIA

BY

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DEPARTMENT OF GEOGRAPHY
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DECLARATION

I hereby declare that the work in this thesis titled Effects of Road Transport Development on Urban Growth and Commercial Activities in Gombe Metropolis, Gombe State Nigeria, was conducted by me in the Department of Geography, Ahmadu Bello University Zaria. The information derived from different literatures has been duly acknowledged in the text, and a list of references provided. No part of this work has been presented for another degree or diploma at any institution.

…… **…….**

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CERTIFICATION

This dissertation titled Effects of Road Transport Development on Urban Growth and Commercial Activities in Gombe Metropolis, meets the regulations governing the award of the degree of M.Sc. Geography in the department of Geography of the Ahmadu Bello University Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This Dissertation work is dedicated to my late uncle Inusa Bala Saleh, who passed away on the 9th of March, 2015.

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ABSTRACT

Road transportation, urban growth and commercial activities, particularly in developing world continue to be among the crucial issues of global change in the 21st century affecting the physical dimension of cities. Thus, the study examined the effects of road transport development on urban growth and commercial activities in Gombe Metropolis using the following set objectives which are to: determine the changes in road network development over three periods (1996, 2005 and 2014); examine the pattern of urban growth between 1996 and 2014 in the study area; analyze the effects of road network development on urban growth over the period of time under study and to examine the effect of road transport development on commercial activities in the area. In order to achieve the objectives of this research, alpha, beta, gamma indices and GIS technique were used to measure the development in road network as well as determine the pattern of urban growth. Inferential statistical technique Paired T-test and questionnaire were also employed to test the research hypothesis and examine effects of road transport on commercial activities in study area. The results of the computation of beta index revealed that there is increase in connectivity in the area from 1.61 in 1996 to 1.70 in 2005 and 1.80 in 2014. Both gamma and alpha indices also indicated that there is a significant increase in road network in Gombe Metropolis during the period under study. Results obtained from the analysis of urban growth pattern showed that the total built up area has grown from 809.28 hectare (8.29km^2) in 1996 to 1,655.05 hectares (16.55km^2) in 2005 and to 3,689.01hectares (36.89km^2) in 2014. SPSS computations P-value (0.024) further revealed that urban growth always determine the development of road network in the study area. Survey results showed that 95% of the respondents revealed that improvement in road network affects commercial activities in many ways such as; provision of access to commercial outfits which bring about profit by locating along major roads, junctions and roundabouts which in turn result to increase in income, improvement in standard of living and reduction in poverty. It is therefore, concluded that road transport development dictate the pattern of urban growth and affects commercial activities positively. It is finally recommended that: more roads should be constructed, renovated and dualized in order to improve and diversify the commercial nature of Gombe Metropolis; rural roads should be improved to harness the economic potentials of the state at large and further research should explore the rest of the critical indicators of road transport development such as: accessibility, road density, traffic density, effects of transport cost, travel distance, travel time savings on commercial activities in the study area.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Transportation encompasses the movement of people, goods and services from one point of origin to destination (Filani, 1993). Transportation is indispensable to modern economic development especially in a developing country like Nigeria. It plays a vital role in shaping the economy of any nation (or region) because modern industries and commercial activities rely on proper, well developed and efficient transport system (Anyanwu, Oaikhena, Oyefusi and Dimowo, 1997). In support of this, Wane (2001), pointed out that transportation is a crucial vector for urban insertion since it gives access to economic activity; facilitate family life, and helps in spinning social networks.

Transport is a central dimension of the national and global production systems that are reshaping the world, making it a topic of universal interest and importance. People move from one place to the other, regularly or occasionally. Goods collected, extracted and manufactured, must be distributed from place to place prior to consumption. People who need services, which are generally provided at a limited number of places, must travel in order to access such services. Transport therefore fulfils a very important function in a society and is one of the most pervasive factors in any economy (Munby in Hoyle and Knowles, 2001).

Transport plays a crucial role in urban growth by linking and providing access for people to essential services such as education, markets, employment, recreation, health care and other key services that induce growth of towns, cities and metropolis. Enhanced mobility for the poor and vulnerable groupsespecially in cities of the developing world, is

one of the most important preconditions for achieving Millennium Development Goals. Those cities with transport modes in an integrated system are more likely to evolve and prosper as centers for trade, commerce, industry, education, tourism and services (Buis, 2009). The rate of growth of urban centers has called for the need for movement of people, goods, services and information. In order to sustain the growth of urban centers, efficient transportation system is required (Button, 1991). However, the rate of growth of urban centers is related to the rate of movement of people, goods and services, using different means of transportation (Hoyle and Knowles, 1998).

Transport developments may lead to changes in the pattern of land use in an urban center around the transport corridors, with more transport intensive uses; including consumer activities locating closer to transport interchanges. Commercial, retail and residential development may be affected. These impacts can be important at a local level but basically affect the geographical pattern of activity rather than the overall level of activity. The effects are therefore, local rather than national or even regional (Planning, Economic and Development Consultants, 2004).

There are different conventional transport modes: roads, rail, air, water and pipelines. These modes of transport are all important in one way or the other. For instance, rail is prominent in the transportation of goods, but its relative advantage is limited to long distance bulk movement. Air transport is more efficient in the movement of passengers and high valued goods over long distance. In the case of water transport, its advantage lies in the capacity to carry bulk cargo over long distances at cheaper rates than other forms of transport modes.

Roads transport on the other hand, serves other modes of transport as it provides door-to-door services. Schneider (1994) described roads as an integrated system that is made up of nodes and routes.The nodes are towns which associated themselves to the roads, while the routes are the different types of roads. Howe (1984) defined roads as an economic penetrating route which is required to open ways for investment in new activities such as agriculture and commerce. Musa (2003) defined roads as those which are clearly necessary ingredients of nearly every aspect of economic and social development. It links the most remote locations and has been found to be more useful in gathering goods to collection points for distribution and marketing in rural and urban centers. Ajiboye and Afolayan (2009), noted that road transport is the most common and complex network. It covers a wide range, physically convenient, highly flexible and usually the most operationally suitable and readily available means of movement of goods and passenger traffic over short, medium and long distances. This is why attention is often placed on road transport development.

Road networks are observed in terms of its components of accessibility, connectivity, traffic density, level of service, compactness and density of particular roads. Access to major roads provides relative advantages consequent upon which commercial users locate to enjoy the advantages. Good road projects clearly contribute to poverty reduction by improving the living conditions of people and by augmenting the opportunities available for trade and employment (Onakomaiya, 2012).

The economic development of Nigeria has reflected the development of her transport systems. This is particularly true of the road transport system, which is by far the most widely used mode of transport in the country. Filani (2003), noted that the vast

majority of transportation in Nigeria is by road. Today, road transport accounts for more than 90% of the country's goods and passengers movements. This was further reaffirmed by Onakomaiya (2012), that of all commodity movements to and from the sea-ports, at least two-thirds are now handled by road transport, while up to 90% of all other internal movements of goods and persons take place by roads. The potential significance of road development for investment, trade, growth and poverty alleviation has long been recognized. Not only does road transport infrastructure facilitate the direct provision of services to consumers, it also provides intermediate inputs that enter into the production of other sectors and raise factor productivity (Anyanwu, *et al*., 1997). As such, its role toward enhancing economic growth and diversification cannot be underestimated. Thus, the role played by roads in economic development has motivated government to spend a lot on transport development with huge amount of money budgeted to roads in the transport sector (National Development plan, 1975-1980).

Gombe is a typical example of the rapid growth and development of cities in Nigeria. The city became capital of Gombe State in 1996. Since then road networks have been improved for the 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 urban growth and its concomitant effects on commercial activities along the old and newly constructed road networks in the metropolis. It is also evident that Gombe State government has spent a considerable amount of financial resources constructing, expanding and modernizing roads in the state, particularly in the state capital (Gombe),

where many other such projects are still ongoing. The state government has since the creation of Gombe state in 1996 embarked upon the development of more roads to increase connectivity and accessibility, within and around the state.

Table 1.1 below shows that the Gombe State Government had spent a total of 116.7 billion nairain the state to construct, rehabilitate and renovate road networks in the state from 1996 – 2014.

Table 1.1 Roads Network Developed in Gombe State

Duration	Km of Roads	% of roads	Cost of Roads (N billion)	Percentage of cost
1996 – 2005	411.36 km	39.8	43.5	37.7
2006 – 2014	621.40 km	60.2	73.2	62.3
Total	1,032.76 km	100	116.7	100

Source: Gombe State Ministry for Works and Transport, 2014

The Table 1.2below also shows that Gombe State Government had spent a total of 54.3 billion naira to develop road networks of about 108.28km in the state capital.

Table 1.2: Roads Network Developed in Gombe Metropolis

Duration	Km of roads	Percentage of roads	Cost of roads (#billion)	Percentage of cost
1996 – 2005	32.16 km	29.7%	16.9	37.3%
2006 - 2014	76.12km	70.3%	37.4	68.9%
Total	108.28km	100%	54.3	100%

Source: Gombe State Ministry for Works and Transport, 2014

1.2 Statement of the Research Problem

Urban areas all overthe world offer a number of advantages in terms of concentration of people followed by demand for transportation and residential accommodation. In Nigeria, Gombe is a good example of an urban center that has developed rapidly since 1996, when it became the capital of Gombe State. Construction of roads increased substantially with the opening up of residential areas that also benefitted from increasing demand for lettable spaces in commercial properties. A good number of private companies, retail stores, commercial banks and so on 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 relationship between road transport and development has been the focus of many studies. For example, Aderamo (1990) examined road development and urban expansion of Illorin, Nigeria. The author observed that the choice of Illorin as the state capital resulted in its rapid population increase and area expansion. It revealed that the city has four major residential districts which are clearly identifiable on the urban landscape. Today, Illorin has witnessed more physical expansion and opening-up of new road network resulting in the city enveloping many of the smaller settlement around it which makes it more accessible within and outside the city.

Dakyes and Ogbuli (2012) investigated the impact of road transport development on socio-economic development in Gwagwalada Area Council, Abuja, Nigeria. The study concluded that improvement in transportation, especially road development, would no

doubt enhance the socio-economic activities of the study area, thereby improving the well-being of the people in the area.

Furthermore, Precious (2011) analyzed the effects of road transport development on spatial integration in Kaduna State. The study used different policy regimes between 1960 and 2009 to show road development over four time periods in the state and how it reflected on the movement of the people in the state. The study has also revealed that the huge investment on road development has actually translated into improved accessibility and connectivity, decrease in travel time and travel cost below inflation rates. Ajiboye and Afolayan (2009)examined the impact of transport development on agricultural production in a developing country which focuses on kolanut production in Nigeria. The study revealed that improved transportation would have positive impact on farmers' productivity, income, employment and reduce poverty level in the rural areas.

Umar (2011) examined the effects of road transport development on food-grain marketing and distribution in Katsina State. The study highlighted the important role that road development plays in integrating, developing and sustaining any economy. The study specifically focused on the relationship between transport planning and the agricultural sector of the economy as essential to any development strategy. Muktar (2011) in a similar study on the impact of transportation on economic growth, reiterated that road transport is an important determinant of the success of a nation's effort in diversifying its production base, expanding trade and linking together resources and markets into an integrated economy. It is also necessary for connecting villages with towns and market centers and in bringing together remote and developed regions closer to one another.

Many of the aforementioned studies emphasized the effects of road development on spatial integration, economic growth and effects of road development on agricultural production and marketing, while little attention was given to road transport development and its effects on urban growth and commercial activities. Furthermore, none of these researches was conducted in Gombe metropolis, Gombe State. It is also interested to note that the present research intend to use GIS and Remote Sensing technique (satellite imageries) for a better and accurate estimation of urban growth pattern in the study area. None of the above studies has in the past adopted this method in explaining the urban growth process and patterns.

The research is primarily motivated by the huge investment in the road transport sector in Gombe State. Given the priority accorded to road development, especially in the State capital, the question that always arises is, to what extent has the investment in road development improved physical growth in Gombe? Again, government recognized road development as a catalyst for development, but has the capital investment in road development over the year's influenced urban growth and commercial activities in Gombe metropolis?This is the focus of this study and constitutes the gap in knowledge.

It is against this background that this study was conceived. Based on the foregoing, the study seeks answers to the following questions:

i. What is the extentof increase of road transport network in Gombe metropolis from 1996-2014?
ii. What is the pattern of urban growth?
iii. How has road transport network development affected urban growth in Gombe?
iv. What are the effects of road transport development on the growth of commercial activities in the study area?

1.3 AIM AND OBJECTIVES

The aim of this study is to examine the effects of road transport development on urban growth and commercial activities in Gombe metropolis. However, the specific objectives of the study are to:

i. determine the changes in road network development over three periods (1996, 2005 and 2014);
ii. examine the pattern of urban growth between 1996 and 2014 in the study area;
iii. analyze the effects of road network development on urban growth over the period of time under study;
iv. examine the effects of road transport development on commercial activities in the area.

1.4HYPOTHESIS

The following null hypothesis guided the conduct of this research:There is no significant relationship between road transport development and urban growth in Gombe metropolis.

1.5 SCOPE OF THE STUDY

In terms of spatial scope, the study was designed to cover the road transport in Gombe metropolis. For better understanding, the content scope of the research was limited to the road transport development in the study area, the pattern of urban growth and the effects of road transport development on commercial activities.The temporal scope; the research was also restricted to the period when Gombe State was created and Gombe became the capital of the state in 1996. The study was further designed to cover three time periods (1996, 2005 and 2014). In order to make the analysis successful, the study the focused on the interval of 9 years cutting across different military regimes and democratic administrations.

1.6 JUSTIFICATION OF THE STUDY

The provision of a high quality transportation system has been identified as a pre-condition for the fullparticipation of remote communities in the benefit of national development (Camemark, 1979). Though, there are different conventional modes of transportation system such as: road, air, rail and water. All these modes of transportation are important in one way or the other with road transport serving the other modes of transportation and provides door – door services (Onakomaiya, 2012).Roadtransportation open up new areas of economic activities, increases agricultural production, and revitalizes tradingactivities and impacts positively on urbanization process (Olubomehin, 2012).

The importance of road as infrastructure cannot be overemphasized. Its efficiency acts as a catalyst for development as such calls for concern. Gombe State Government over the years has been investing heavily on road transport around the state and in the state capital in particular. Thus, an analysis of the effects of road transport in Gombe metropolis

will provide an insight in to the worth of the investments. Furthermore, improving efficiency in to the movement of people and goods can lead to increase in trading, and agricultural activities around the state as well as its concomitant increase in commercial activities and urban growth within the metropolis.

Generally, the main purpose of the study is to come out with the baseline data for better management and planning of road transport network. The research will also be a standard reference in terms of policy generation that will benefit Gombe state and the country at large and also to help in proposing effective maintenance of roads in order to minimize accidents and traffic congestion in the study area.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

In this Chapter,theoretical frameworks that are relevant were adopted for this study. Theories and concepts are essential to guide the study towards attaining thestated aim and objectives and determine if the research findings confirm or contradictthem. Furthermore, available literatures were reviewed alongside subject matter of the research, which are road transport development, urban growth and commercial activities. To addressthe theme, this chapter undertakes a review of literature on individual components ofthe central theme and combinations of such individual components, as basis fordeveloping the researcher's ideas on the general concept of the study. The review ofliterature, in addition, aims at providing detailed account of earlier studies in order toidentify 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 thecentral themes were studied. Specifically, emphasis was on previous writings ontransportation, road network pattern and analysis, intra-urban accessibility, centrality, urban growth and commercial activities.

2.2 CONCEPTUAL FRAMEWORK

2.2.1 The Concept of Road Transport Network

Transportation systems are commonly represented using networks as an analogy for their structure and flows.The term networkrefers to the framework of routes within a

system of locations, identified as nodes. A route is a single link between two nodes that are part of a larger network that can refer to tangible routes such as roads and rails, or less tangibleroutes such as air and sea corridors (Chapman, 2008).

Network is defined as the interconnectivity or linkage of a set of components of a system in to a complete whole to produce a spatial and structured pattern. Network may be either static feature at a point in time or a dynamic phenomenon which is subject to change through time (Chapman, 2008). This means that a road network grow with time. Smith (1977) identified three elements in a network called by various names. These are nodes, vertices or points, the edge, linkage or route. These nodes, vertices or points refer to the settlements while the edge, linkage or route refers to the roads. In the course of making the nodes and linkages easily identifiable, a network is transformed into a topological graph which is a representation of the geometry of a network showing the relationship between nodes and linkages without considering the scale of the map and morphology of the actual route.

In order to make the analysis successful, map analysis is normally done on road network using topological abstractions that actually represent series of vertices (nodes) and set of edges (links). Furthermore, various indices have been developed describing the extent to which a network approaches maximum connectivity, which requires the existence of a direct link between each node (Kansky, 1963). These indices are all based upon the relationship between the number of edges and vertices in a network which is regarded as a topological graph. Thus, the Beta Index, the Gamma Index and Alpha Index were used to determine the change in road connectivity over time.

The Beta Index; $\beta = \frac{e}{v}$ …….. (1)

The Gamma Index; $\gamma = \frac{e}{3(v-2)} \times \frac{100}{1}$ …….. (2)

The Alpha Index; $\alpha = \frac{e-v+1}{2v-5} \times \frac{100}{1}$..... (3)

- ✓ The Beta Index expresses the number of edges present in relation to the number of vertices to be connected and therefore, may be viewed as indicating the average number of links leading into or out of each node. When the average of each is considered the period with the highest value indicates the one with maximum connectivity while the one with least indicate least connected.
- ✓ Gamma Index is the ratio of the number of edges in a network to the maximum which may exist between specific numbers of vertices. The denominator in the expression reflects the fact that the addition of a single vertex necessarily increases the number of possible edges by 3. In an event of comparing the various periods, the network with the highest percentage indicates the period with the highest connectivity while the one with the least percentage is least connected.
- ✓ Alpha Index is a ratio based on the number of circuits in a network rather than the number of edges. Alpha index is closely related to gamma index. A circuit is defined as a path through a network which begins and ends at the same node without passing over any edge more than once. This implies that when a traveler is faced with a network with $\alpha=0$ it means he can only proceed along a single path while several options exist in the case of a network with $\alpha=1$. This therefore means that the period with the highest connectivity is the one with the highest ratio.

To describe the degree of network accessibility, using topological maps. Nodes or vertices and edges or links were counted; this was achieved through devising a matrix, from which the Shortest Path Matrix, the Associated Number Index and the Shimbel index were calculated for each of the periods under study.

The Shortest Path Matrix; refers to the number of arcs used in the shortest path between all possible pairs of nodes. Using topological map, the lowest possible numbers of arcs that can be used from one node to the other are counted. The value obtained is written in the matrix box of the row against column. The totals of each row were added up and the lowest total indicates the town which is most accessible while the highest number or total connotes the least accessible.

The Associated Number is the number of arcs needed to connect a node to the most distant node from it. It is the highest number in each row. The highest number among all the numbers of the row for each town under consideration is the associate number. The row with the least associated number value indicates the most accessible while the row with the highest value indicates the least accessible.

The Shimbel Index highlights the total value for each row in the matrix table. It indicates the number of arcs needed to connect any node with all other nodes in the network by the shortest path matrix. The numbers of each row is added for each town. The town that has least total among all the rows is the most accessible while the highest total among the entire rows is the least accessible.

Inyang (1993), in a study of the road network in Ondo State, discovered towns like IkereEkiti, Ado Ekiti and IseEkiti to have the highest accessibility in the state. The shortest path matrix analysis revealed the need for proper maintenance of the Ado Ekiti – Ikere,

Ekiti – Akure road. Foin (2002) carried out a study on the effect of road transportation on agricultural produce marketing in Giwa L.G.A. of Kaduna state. He found that road transport network alone without the provision of other farm inputs cannot bring any good yield in agricultural activities. The study also shows that although road network has increased over the years, it has not influenced agricultural produce marketing much. He added that the efficiency and quality of road network is very important in any economic activity of the study area.

From the above review, it is clear that transport improvement has effects on development. Areas served with good network of road show increase in productivity, standard of living and improve its social economic development.

2.2.2 The Concept of Urban Growth Patterns

Urban growth patterns are characteristics of spatial changes that take place in metropolitan areas (Aguilera et al., 2011). The spatial configurations and the dynamics of urban growth are important topics of analysis in the contemporary urban studies (Bhatta, 2011). Wilson et al. (2003) identified three major types of urban growth as: infill, expansion, and outlying. Infill development is a new development within remaining open spaces in already existing built up areas where as expansion or sometimes called urban extension or edge expansion is a non-infill development extending the urban foot print in an outward direction and sometimes called urban fringe development. Outlying or leap frog development is a change from non-developed to developed land cover occurring beyond existing developed areas. Leap frog development is also referred as urban sprawl. That is the expansion of urban area in a way that demands the extension of public facilities.

Tian et al., (2011), compared the spatial and temporal dynamic pattern of the urban growth for the five urban areas of Shanghai, Nanjing, Suzhou, Wuxi and Changzhou in the Yangtze River Delta region, china. The result of their research revealed during the fifteen years, urban growth patterns were dramatically uneven over three periods. The size distribution of the five urban areas became more even with the rapid urbanization process. The landscape matric analysis across concentric buffer zones indicates the coalescence process occurred during the rapid urban growth from 1990 to 1995 and the moderate growth period from 2000 to 2005, but different urban growth period between 1995 and 2000. This approach indicates that the coalescence process was the major growth model for the region and they conclude that the diffusion coalesce dichotomy represent endpoints rather than alternate states of urban growth.

2.2.3 The Concept of Remote Sensing Technique

Several methods and techniques have been developed and applied to quantify and characterize the urban growth process and patterns. Traditionally, visual interpretations of high resolution aerial photographs were used to acquire comprehensive information for mapping of urban areas. This mapping technique is expensive and time consuming for the estimation of urban growth. However, with the gradual advancement and availability of high temporal and spatial resolution remote sensing imagery, the possibilities of monitoring urban problems with a better accuracy have become more promising. Hence accurate mapping of urban environments and monitoring urban growth is becoming increasingly important at the global level (Guindon and Zhang, 2009).

Nowadays, there are several remote sensing satellite systems such as Land sat (TM and ETM+), ASTER IKONOS, GeoEye, Quick bird, Rapid Eye, world view providing from medium to high and very high resolution imagery. It is also believed that remote sensing imagery is a powerful tool for acquiring data to analyse and map spatio-temporal land use change and urban growth process at different spatial scale (Huang et al., 2007; Yang and Lo, 2002; Yu et al., 2011). Particularly in developing countries, remote sensing may provide fundamental observations of urban growth and environmental conditions that are not available from other sources (Miller and Small, 2003). Yet, it lacks the ability to fully describe the underlying urban processes (Herold et al., 2005).

2.3 LITERATURE REVIEW

2.3.1 Transportation and National Development

The importance of transportation to a nation cannot be overemphasized. Its efficiency is a catalyst for development, the role of transportation in agriculture, industry, commerce, health, education and tourism among others is remarkable. Transport is the engine of growth of a nation's social, economic and political life, which is the reason for the much attention given to it. The impact of transport improvement on development is illustrated here with few examples from Ogunsanya (1995), in Costa Rica, before the construction of the Inter-American Highway, cattle were brought on hoof from grazing lands to San Jose and this resulted in to 40% weight loss. Today, with improvement in transportation, cattle delivery is possible overnight without a drop in weight. In Thailand, the Friendship Highway opened up the jungles and improved agricultural productivity. Thus, rice, sugar cane, vegetables, bananas and so on, increased fourfold. The level of

interaction and interdependence improved as journeys between Sarabur and Korat which took about 11 hours, was reduced to less than three hours. In Bolivia, the highway from Cochabamba to Santa Cruz reduced travel time from many weeks to a matter of hours. In India, in order to meet the supply of raw materials for improved industrialization, the government in her development plan spent 20% of the development funds on transportation. The development which occurred in Europe and other places following the industrial revolution was partly due to the dynamic changes in the transportation sector of these countries. The increased capital investment in seaports, railways and highways by the colonial and post colonial government in Nigeria and other developing countries was aimed at stimulating the rate of economic growth.

Taaffee, Morril and Gould in Ogunsanya (1995), have shown how the construction of railways and development of feeder roads assisted in opening up the hinterland and boosting internal and external trade in Nigeria. The completion of the railway line from Lagos to Kano brought about profit in agricultural development in the northern region. The railways provided an economic means of transport to the sea. These links contributed to the growth of the cities, like Lagos, Portharcout, Kano and Jos etc. new roads followed the lines of railways and led to the development of most towns along the routes. The town of Jos was a tin mining camp in about 1907. It developed rapidly following the completion of a rail line to Jos in 1914. The history of Jos is closely linked to the prosperity of the tin mining industry and the railway (Inusa, 2002).

Transportation and development are closely related, because each of them influences the fortune and the relative growth of the other in any nation. In short, no society can exist without a good measure of improvement in its transportation system.

Areas with underdeveloped transport infrastructure are more disadvantaged than areas with improved transport system.

2.3.2 Transportation and Local Economic Development

The presence of an adequate, reliable and efficient transport system is a critical factor in local economydevelopment. A well-developed transportation infrastructure provides adequate access to local communities,which in turn is a necessary condition for the efficient operation of manufacturing, retail, labour and housingmarkets. Transportation is a wealth creating industry on its own as well as the life-line of an economy. By“lifeline”, it means that transportation is extremely important for the survival of the economy (Olubomehin,2012).

Indeed, the provision of a high quality transport system has been identified as a pre-condition for the fullparticipation of remote communities in the benefit of national development (Camemark, 1979). Roadtransportation opens up new areas of economic activities, increases agricultural production, and revitalizes tradingactivities and impacts positively on urbanization process. Although, there are other means of transportation suchas air, rail and water, these means of transportation would have been greatly incapacitated but for thecomplementary role played by road transport in the economy. Road transportation is indeed the lifeline of theeconomy in the local regions (Olubomehin, 2012).

Inadequate transportation limits a nation’s ability to utilize its natural resources, distribute food and otherfinished goods, integrate the manufacturing and agricultural sectors; and supply education, medical and otherinfrastructural facilities. There is the need therefore to maintain and improve the existing road transportation andbuild new

infrastructure for national wealth. On the impact on local economies, highway expenditures have beenfound to help increase rural employment, particularly in manufacturing and retail industries, and studies haveshown that new highways tend to benefit rural counties near metro areas (Brown, 1999).

2.3.3 Road Transport Development

Transportation is a very important factor in the socio-economic development of area. According to Sieber (1997), the study of transport network is not new but is becoming more important in recent times. Geographers have now become increasingly aware of the relationship between transport development and economic development of any given region. Most geographers tend to study the effects of transport infrastructural development as it relates to any form of activity. Howel (1984) supported this by stating that transportation is clearly a necessary ingredient of every aspect of economic and social development. It plays a role in getting land into production and in making other services accessible. The different modes of transportation, which are air, road, railway, water and pipelines transports, are all instrumental in one way or the other in bringing about development in an area. The successful and continued existence of a society is crucially depended upon the availability of adequate transport facilities (Adekanye 1971). The selection of a specific transport mode for a particular purpose depends on upon a range of modes available, their relative costs, safety and convenience (Mbaye and Moustier, 2000).

The operation of road transport is handled by government and individuals, partnership or corporate agencies and it offers a wide range of services (Daloeng, 2004). Road transportation has contributed in many ways to development. Babatunde (1998), stated that road transport is significant in the sense of making possible the realizations of

the broad development objectives of the average citizen's social and economic desires. He further explained that road transport helps to open up economic and settlement frontiers of a country. Such as in Nigeria, where the introduction of feeder roads services linked up to the major railway stations along the Lagos-Kano with products such as cocoa, palm produce, groundnut, beans, etc. road construction according to Oguntoyinbo (1978) has brought about a considerable reduction in road traffic accidents on many of the new roads, which are better designed, much wider and stronger than the first generation roads. It has also resulted in providing a variety of ancillary employment generating industries and services that help to sustain the road transport industries. These include: vehicle repairs, petroleum depot and filling stations, etc. Furthermore, Road construction has also been playing an increasingly role in the development of tourism. For example in Nigeria, in some states, new roads have been constructed to provide access to places of tourism.

2.3.4 Impact of Road Transportation on the Nigerian Economy

Roads are strips of land that provide route for movement from one place to another (Filani 1978). They are vital lifelines without which there will be no socioeconomic development in an area (World Book Encyclopedia, 1976). Filani (1978) noted that the socio-economic development of any society depends to a large extent on the nature and structure of the transportation network of the society. According to Orsaki*et al*as cited in Ogunsanya (1995), few technologies have affected modern society more profoundly than has road development. Roads have eliminated rural isolation, transformed urban development patterns, opened up new forms of recreation and changed our behaviour and life style. More than any other contemporary invention, road transport has left a deep and permanent imprint on virtually every aspect our lives.

Road transport now dominates the transport systems of most countries more than any other mode. It has improved the mobility and accessibility of the majority of the world's population. Hilling (2001), on a study in Nigeria, stated that the road is the only mode of transportation by which all the states in the federation are linked. Road transport has become the most ubiquitous mode of transport and available to and made use of by the greatest proportion of the populace and covers the largest part of Nigeria's land area. In support of this, Abiodun (1985) stated that the vast majority of Nigerian national transport movements are performed by the road transport sub-sector, with railway and inland waterways playing important, although primary roles. Today, road transport account for more than 90% of the country's goods and passengers movements (Filani, 2002). Furthermore, the Federal Government of Nigeria considers road as the key to realizing the nation's economic potentials (Guardian Newspaper, Feb. 13, 2007).

The Nigerian economy is a developing one. The inter-connection between her road transport system and herlocal economy has long been recognized as it has impacted her severally. The process of development requiresgoods, services and people to be moved for one reason or the other and from one place to another. As the peoplemove, they help to generate economic activity which enhances economic development. This assertion was justifiedby Ighodaro (2008) who affirmed that the potential significance of road development for investment, trade,growth and poverty alleviation has long been recognized. Not only does road transport infrastructure facilitatethe direct provision of services to consumers, it also provides intermediate inputs that enter into the productionof other sectors and raise factor productivity. This is exemplified by the opening of many residential areas acrossthe nation as a result of road construction or improvement.

Road transport services facilitate and help to maintain an economic balance through the distribution of resources(such as labour, equipment and raw materials) and finished goods across the nation. Carapetis*et al*(1984), adequate, reliable and economic transport is essential for the social and economic development of ruralareas especially in developing world. They further noted that the absence of regular and reliable transportservices condemn remote communities to subsistence production in perpetuity. Moreover, Mallon (1960) arguesthat transportation has an important role to play not only in serving the productive sectors such as agriculture andindustry but also in bringing about economic growth. He points out that it was no coincidence that the period ofintensive railway construction in Britian, the USA, Pre-Soviet Russian, Italy and other countries were also theirperiods of most rapid economic development.

Unlike other means of transport such as rail (train), water (ship) and air (aero plane), the flexible nature of roadtransportation facilities opens up remote and rural areas, making them more and easily accessible, therebystimulating economic growth. The items of trade (whether raw materials or manufactured goods) need to bemoved from the areas where they are produced to the area where they are demanded. Farm products are usuallyproduced in the rural areas and traded in the cities. Where there is a good transport link between the producingareas and the market, the prices of products are reduced. Otherwise, they become expensive and middlemenusually capitalize on the poor transportation to inflate prices of agricultural products to the urban markets(Ahukannah*et al*, 2003). This advantage extends to delivery of goods to the door-step of consumers.

An efficient transport system lowers the cost and reduces the time of moving goods and service to where theycan be used more efficiently. Since roads penetrate more into

such areas (with relative greater flexibility) theirdevelopment adds value and spurs growth. Overtime, this process has resulted in increasing the size of marketwhich is a pre-condition for realizing economies of scale. Good road projects have clearly contributed to povertyreduction in the country by improving the living conditions of people and by augmenting the opportunitiesavailable for trade and employment. The economic development of Nigeria has reflected the development of hertransport systems. This is particularly true of the road transport system, which is by far the most widely usedmode of transport in the country. Of all commodity movements to and from the sea-ports, at least two thirds arenow handled by road transport while up to 90% of all other internal movement of goods and persons take placeby roads (Onakomaiya, 2012).In a study on the impact of transportation on agricultural production in a developing country which focuses onkolanut production in Nigeria, it was revealed that an improved transportation will among other things havepositive impact on farmers' productivity, income, employment and reduce poverty level in the rural areas(Ajiboye and Afolayan, 2009). Transport infrastructure is critical to sustain economic growth because peoplewant to improve their standard of living and they see increased income as the way to achieve that goal.

Transportation system enhancement is in turn a means of maintaining or improving economic opportunities,quality of life and ultimately income for people in a particular region. Investment in transport infrastructure iscritical to sustain economic growth. Mobility studies show that transportation is absolutely essential to economicproductivity and remain competitive in the global economy. An international study found that for every 10percent increase in travel speed, labour market expands by 15 percent and productivity by 3 percent.

It is universally recognized that road transport is critical for sustained economic growth and modernization of anation. Adequacy of this vital infrastructure, Muktar (2011) reiterates, is an important determinant of the successof a nation's effort in diversifying its production base, expanding trade and linking together resources andmarkets into an integrated economy. It is also necessary for connecting villages with towns and market centresand in bringing together remote and developed regions closer to one another. Road transport, therefore, forms a key input for production processes and adequate provision of transport infrastructure and service helps inincreasing productivity and towering production costs in Nigeria.

The provision of road transport infrastructure and services helps in reducing poverty. It needs no emphasis thatvarious public actions aimed at reducing poverty cannot be successful without adequate road transportinfrastructure and service. It is difficult to visualize meeting the country's targets of universal basic educationand health care without first providing adequate transport facilities.

2.3.5 Historical Development of Road Transport in Nigeria

Drawing upon the account of Anyanwu (1997), the historical development of road transport in Nigeria can betraced to 1940, when Lord Luggard attempted the construction ,.of a mule road Linking Zaria and Zungeru both inthe Northern state of Nigeria. The road was later extended from Zaria to Sokoto, Katsina and Maiduguri.However, the road linking Ibadan and Oyo constructed in1906 was recorded to be the first motorable road everconstructed in Nigeria.In 1925, the Central Government of Nigeria set up a Road Board that proposed a skeletal trunk road system tolink the major administrative centres in the Country in 1926. These roads were designed as a frame upon whichthe network of

secondary roads could be built thus, enabling the general road system to be considered as acoordinated whole rather than as a jigsaw of small disjointed sections. The total length of roads maintained bythe government rose from 6,160 km to 9,453km.

At independence in 1960, the Nigerian landscape was dotted with a skeletal network of trunk roads as well assecondary and feeders roads that exhibited the characteristics which reflected the purpose of their construction.They were narrow and winding, being simply meant to facilitate the evacuation of agricultural produce from theinterior to the ports for export in addition to serving as links between scattered settlements thus permitting easeof administration.The various data published by the Federal Office of Statistics in Nigeria, show that as at 1951, out of the total of44,414km of road in Nigeria, 1,782km were surfaced, though the roads were lacking in standard designs andwere single lane with sharp bends and poor drainage system. By 1980, the total length had increased from44,414km in 1951 to 114,768km, while tarred roads increased in length from 1782km in 1951 to 28,632km in1980, and earth/gravel road increased from 4,232km in 1951 to 8,613km in 1980. According to the Central Bankof Nigeria (2003) the estimated total road network length in Nigeria was about 200,000km.

2.3.6 Road Transport Development and Urban Growth

The importance of transportation cannot be over-emphasized. Transportationcentrally affects the relationship between physical space and society and changes intransportation affect the organization of human activity in urban and regional space. Itstructures the built environment, spurs urban growth, as well as orders relationshipsamong cities in a national urban system (Yago, 1983). Transportation is vital in the development of a city. It plays a pivotal role in facilitating and regulating the

essential links between residence and employment and between producers and consumers of goods and services without which all meaningful interactions will be greatly reduced (Wang and Leh, 1993).

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

Road transport is a form of land transport which involves the movement of people and goods by motor cars, trucks, buses, motorcycles, and bicycles (Areola *et al*., 1999). In Nigeria, road transport is the most popular and developed. In consequence, both the federal and state governments have made enormous capital investment in the development of road transport in the country, especially in the urban centres. In spite of the development of road transport system in Nigeria as a whole and in urban centres in particular, the urban centres are still experiencing many transportation problems which include: traffic congestion, especially during working hours, decrease in travel speed, increase in travel time, deteriorating travel environment for pedestrians and non-motorized modes of transportation (Odeleye, 2001, Olaliyola*et al*., 2005). This is because the provision of transport facilities is expanding at rates slower than rates of growth of the urban population and expansion of urban area thus creating a wide margin between demand and supply of urban infrastructural facilities and services (Atubi and Onokala, 2003).

Urban transport is both a catalyst in economic and social activities. It is the life wire of any urban environment and is central to the flow of knowledge, information and commercial goods. It provides the means by which people and goods are moved in space and time (Ladan, 2007). Improvement in urban transport will therefore, facilitate economic growth, effectiveness of government activities and improved social interaction. Furthermore, urban centres in Nigeria are witnessing growth and development of different land uses (Musa, 1994). It has therefore, received considerable attention in different parts of the country. Its role in the development of Nigerian urban centres has been well articulated by Ogunsanya (2002), where he remarked transport was a "maker and breaker" of cities. Even though the provision of urban transport has enabled people to live further apart from their places of work, it has brought about an increase in the ownership and number of vehicles plying the roads and at the same time increased spatial distribution and diffusion of goods, services and ideas in the Nigerian urban space. On the other hand, improvement in urban transport has increased competition for urban space (Aderamo, 2002).

2.3.7 Urban Road Transport Infrastructure

Road transport infrastructure forms the foundation of the urban system. Urban transportation infrastructures include roads, intra city rail lines, ferry routes terminals and all associated road complementary facilities: terminals, bus stops, service garages, road signs, etc. as well as other facilities for non-motorized transport. Urban transport is usually road-based and its infrastructures are looked at from the perspective of roads and their complementary facilities. Urban road transport infrastructures are characterized by a planning and design oriented towards the private car, poor physical conditions, poor

management, poor connectivity, high incidence of misuse and a resultant low productivity. Narayana (2009) suggested that urban transport system must typically address six key criteria: connectivity and accessibility, efficiency, safety, urban aesthetics, financial viability and affordability. Cities must implement an urban transportation system using multiple options; particularly road capacity must be enhanced. Existing shortages in roads should be addressed through the introduction of parallel service roads and the construction of priority taxi, bus and truck lanes.

Constantly, urban transport infrastructures in Nigeria are owned and managed by government.The failure of existing funding mechanism of government accounts for the deterioration of these infrastructural facilities and the difficulty in the provision of additional ones. In virtually all urban centers in Nigeria, very little attention is given to urban transport infrastructural provision including non-motorized modes like walking and bicycling. Others are: interchanged point, bus stops, terminals, parking facilities among others (FRN, 2003). In addition, there is an observable widespread misuse of the limited available urban transport infrastructures. Major roads are partly occupied by roadside traders, bus stops and for domestic waste disposal.

Transportation system however is expected to provide a reliable, safe, comfortable and easily accessible service at reasonable costs to satisfy both temporal and spatial travel demand of the society within which it operates (Jacoby *et al.*, 2008).

Nigeria's inter-urbanpaved road system was massively expanded during the oil boom in the 1970s, but failure to maintain roads subsequently has led to severe deterioration in recent years (Porter, 1996). In support of this, a study conducted in 36 rural and urban communities across Nigeria in 1995, showed that infrastructure issues (roads,

water supply and health) dominated as a development priority in all allocations (Escobal*et al,*2004). It is estimated that post-harvest food losses in Nigeria amount to 20-25% of total output of which a substantial portion must be attributable to transport failure. Furthermore, recent studies in individual regions of Nigeria by the Ministry of Agriculture and Rural Development (2004), suggested that the scale of current rural access problems and the linkages between poor road access and poverty.

2.3.8 Effects of Transport, Commercial Activities on Urban Growth

Transportation and commercial institutions are ubiquitous to urban development. Economically defined, the city is a settlement, the in habitants of which live primarily off trade and commerce rather than agriculture (Mondal, 2012). It is difficult to establish whether commercial activity determines the man-made geographic structure of the towns or the structure of the towns determines the commercial activity. Ronald (2011) earlier stated that, transport and commercial services are basically urban objects and very important drivers of economic activity within urban centres. Furthermore, effective transport infrastructure forms the backbone of the economic development in urban areas. As the economist Paul Krugma pointed out that weak urban transport systems constrain economic growth as they limit urban agglomeration, reduce labour mobility and economies of scale. Unfortunately, there has been little focus on building efficient urban transport systems in most of the cities of the developing world. Access to major roads provides relative advantages consequent upon whichcommercial users locate to enjoy the advantages. Modern businesses, industries,trades and general activities depend on transport and transport infrastructure, withmovement of goods and services from place to place

becoming vital and inseparableaspects of global and urban economic survival (Said and Shah, 2008).

The urban landscape is dominated by commercial establishments and these commercial activities have had their impact on transport and create certain tendencies for urban growth. The commercial landuse in towns is a complex areal phenomenon. This is the space mainly used for commercial purposes i.e. retail, wholesale, markets, storage, restaurants, commercial banks, and insurance. The spatial pattern of commercial activity inside the city continues to be dominated by the concentration of largest and most important business establishment in the main centre or Central Area or Central Business District (Button, 1991). Throughout the rest of the urban area there seems to be a rather haphazard arrangement of mainly retail activities grouped together in different kinds of business configurations (Mondal, 2012). The three urban landuse models developed by a sociologist, a land economist and two geographers indicate the importance of commercial landuse in the city. These three models are:

i. Concentric Zone Model by Ernest W. Burgess (1925)
ii. Sector Model by Homer Hoyt (1939)
iii. Multi-Nuclie Model by Harris and Ullman (1951)

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.

2.3.9 Transport and the City

As far back, Cooley (1894) stated that two factors influence the location of the cities: local facilities for production and location relative to transportation. The former act mostly through the coarser and primary manufacturing industries while, the later seek the most convenient centres of distribution that is of transportation. Ratzel (1903) emphasized the role of transport in shaping and the evolution of cities. Cities arise at the end of a transport route or at a junction where for instance, a land transportation route ends and a waterway begins. But the process of city growth and development is complex. It involves several factors none of which is capable of singularly effecting a change in the process of a city growth and development. In spite of this, transport stands out clearly as a catalyst in the process that led to the growth and development of urban centres in the world.

A modern city is a centre for industry and commerce. It is also a point for the production, collection and distribution of commodities of all kinds. Its location and the location of the various landuse within it must therefore be as accessible as possible. However, cities do not produce all they require for their existence. They depend in one way or the other on the rural areas for food and raw materials. Goods manufactured in the cities must be transported or distributed to spatially dispersed consumers. To pay for these goods, urban dwellers must go to work. Again, to maintain city facilities, there must be an efficient transport to move the municipal workers. Cities as we know them today are therefore, not possible without transport which allows the movement of people, goods,

services and information to make the city function. Modern cities in all their ramifications are therefore, a product of transport (Orski, 1980).

Several attempts have been made to generalize the growth inducing influence of transport on cities. At the regional level, it has been found that the existing urban hierarchies owe their spatial pattern to transport. Rimmer (1977) demonstrated how the colonialists used the development of hybrid transport to penetrate the developing countries. The result is the restructuring of the pattern of city development and resource use. The first stage of this evolutionary process shows a developing country and a more developed country separated by a long and unconnected distance. The developing country is characterized by scattered small settlements linked with tracks, while the more developed country has relatively well built roads. The second stage depicts contact by see between the two countries and the development of foothold settlements in the form of trading ports and garrisons. The third stage involves some fundamental change in the transport system of both countries. The introduction of railways, roads and port facilities lead to diversification in the economy, especially in industrialization and commercial agriculture. The fourth stage has to do with a further diversification of the economy.

Modern transport system evolves and leads to specialization, adaptation and selective investment in response to changing demand. The overall result is the restructuring of the pattern of city development and resource utilization, rapid urbanization with the initial and major urban centres located along the coasts where maritime transport provides interaction linkage with the hinterland. Apart from Rimmer (1977), the works of Taffee, Morrill and Gould (1963) and Vance (1970) have similarly explained the interrelationship between transport and the growth of cities. The Taffee, Morrill and Gould Model is

particularly significant as it represents the parallel evolution of economic, political and city development in Ghana and Nigeria. A similar effect of transport also exists at the intra-city development level. Cities are made up of different land uses. Transport helps to explain the locational arrangement of these land uses. Furthermore, in the pre-motorized period, when the means of movement was by foot, cities were essentially concentric with landuse arranged in a circular form around the city centre. The use of horses, cars and trains led to a ribbon city form. The advent of automobile in the cities results in complex city form with criss-crossing road networks and their complex traffic.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 STUDY AREA

3.1.1 Location, Position and Size

The study area is located betweenLatitude 10° 15′ 02”N – 10°20′00”N and between longitude 11°05′00”E – 11°15′05”E. It shares common boundary with Akko Local Government Area in south and west, Yamaltu-Deba L.G.A. to the east and Kwami L.G.A. to the north (fig. 3.1). It also occupies a total land area of 52Km^2.It is the capital of Gombe state with a population of 266,844 (NPC, 2006). Today the population is projected to be 399,531 persons using 3.2% growth rate Gombe State Office, (NPC, 2009).

Gombe is well linked to other regional centres by trunk “A” roads. A single gauge railway line on the Bauchi – Maiduguri route also links the town, in addition to an international airport. Furthermore. The studyis divided into different residential quarters which include: GRA, Federal Low Cost, Arawa, State Low Cost, Kumbiya-kumbiya, Pantami, Jekadafari, Tudun Wada, Madaki, Dawaki, Bolari, Yalanguruza andShamaki etc.

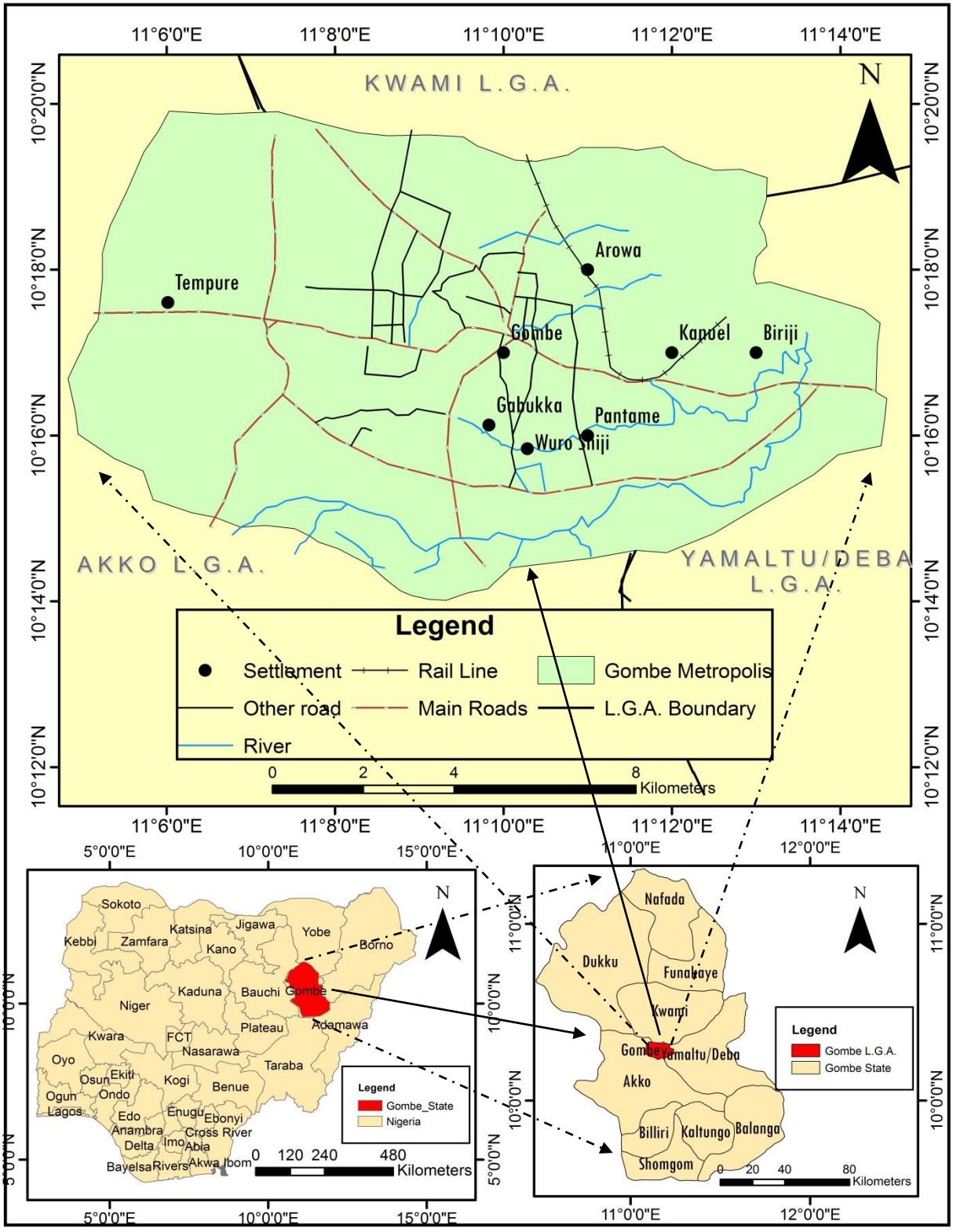


Fig. 3.1: Gombe Metropolis
Source: Ministry of Land and Survey Gombe State

3.1.2 Climate:

The climate around Gombe metropolis is the same with most part of Sudan Savanna. It enjoys a subtropical climate. It also has two distinctive seasons which are wet and dry seasons. As in other parts of the Nigerian Savanna this precipitation distribution is mainly triggered by a seasonal shift of the Inter -Tropical Convergence Zone (ITCZ). The average annual rainfall is concentrated between May and October with a single maximum in July/August. Much of the rainfall especially in July and August is associated with storms of high intensity.The mean maximum monthly temperature is 34^{o}c occurring in (March – May), the mean minimum monthly temperature is 18^{o}c occurring in (December - February). While, the mean annual precipitation is 835 mm and the mean annual temperature is about 26°C. Relative humidity has the same pattern being 95% in August and dropped to less than 10% during the hammattan December/January (Udo, 1970).

3.1.3 Relief and Drainage

The relief of Gombe developed on complex geologic crystalline bedrock. Although, much of the area is underlain by the ancient crystalline basement complex, sedimentary formation during the late cretaceous period has influenced the topography. Subsequent dissection and stream incision in the area have carved a landscape consisting of flat topped to conical hills, a granitic residuals and pediment landscape. The Kerri- Kerri formation forming a plateau extends into Gombe town marking its northern boundary. The southern edge is marked by a breached and discontinuous escarpment rising in some places to form sandstone ridge over 150m above the surrounding plain. The area is generally surrounded by hilly terrain with steep side on the lower part of an east-facing (2°–3°), gently undulating slopes. As for the drainage, there are stream flows west to east such as the River

Magariya and Kware. These waterways gradually transformed into gullies partly due to rapid demographic pressure on land (Pentagon Design Consultant,2003).The entire land is drained by the head waters of the river Dadinkowa which is a tributary of theGongola River (Balzerek, 2003).

3.1.4 Geology and Soil

The study area has prominent landforms consisting of Lijji, and the Gombe hills, which falls within a stretch of the Benue Trough known as Zambuk ridge. The stratigraphy consists of the alluvium, the Kerri Kerri Formation, Gombe Formation, Pindiga Formation, Yolde Formation, Bima Formation and the basement rocks as the oldest. Alluvium includes most soils and comprises those deposits formed in situ by the chemical and physical decomposition of the bedrocks. Alluvium is generally poorly developed over erinaceous member of the Cretaceous Formation in the study area, the extent of alluvium cover increases westward but it can be estimated that 10% of the Gombe Formation is covered by alluvium (Obaje, 1999).

The Kerri-Kerri Formation was laid down in a continental environment ranging from lacustrine to deltaic, being derived from the weathering of the basement rocks as well as of Cretaceous Sedimentary Formations. It outcrops around F.C.E (T) and Tumfere area lies unconformable on the Gombe Formation. In the western part of the plateau, which coincides with the western edge of the area, the Kerri-Kerri Formation overlies the basement complex, but the contact is almost completely masked by abundant alluvial deposits. The maximum thickness of this formation is about 200m (Arabi, *et al* 2009). The formation has not been subjected to folding and has the lowest fracture density of all the

Formations present in the area. This is probably because it was laid down after the main tectonic phase had occurred, and on the poorly cemented nature of the lithological components of its upper part (Arabi, *et al* 2009).

The Gombe Sandstone outcrop is a narrow north-south belt of the study area where it unconformable lies on shale and limestone of the Pindiga Formation and is unconformably covered by the Kerri-Kerri Formation. The Gombe Formation is a continental sequence of sandstone, shale, siltstones and ironstone, with maximum thickness of 300m and its sequence can be divided into two parts: The Upper 223m mainly consisting of sandstones and the lower which consist of shale and contains ironstones layers up to 200m thick (Arabi *et al.*,2009).

The PindigaFormation conformably overlies the Yolde Formation, while an unconformity separates it from the overlying Gombe Sandstone (Upper Maestrichtian). It outcrops and cuts across the study area in a north-south direction. It is also found in the southeast and the northeastern part. The Pindiga Formation consists of a series of marine, blue-black shale with interblended fossilferrous limestone at the base (Arabi *et al.*,2009).

The Yolde Formation conformably overlies the massive coarse sandstones of the Bima Formation (Albian- Cinemania) and is conformably bounded at the top by the marine shale of the Pindiga formation. The Yolde Formation is present in the study area around the south-east, the central area and the north, it constitutes the transition fancies between continental and marine sedimentation. The Gombe Sandstone, Pindiga and Yolde Formation are susceptible to erosion due to porous nature of the soils.

The Bima formation is the oldest, most extensive and thickest of the Cretaceous sedimentary Formations in northeastern Nigeria, outcropping in northwest and south of the

study area. The Bima Formation rests directly on the Precambrian basement complex and is covered without any break by the Yolde Formation in the Zambuk ridge area. The Bima Formation consists of Yellow-brown, massive cross-bedded feldspartic sandstones, with some white saccharin sandstones, ferruginous sandstones and pebble bands. The age of this formation is uncertain, however, various pointers indicate that it runs from Upper Albian to Lower Turonian(Arabi,*et al.*,2009). The basement complex includes all the pre-Mesozoic rocks and is thus the oldest formation of the Nigerian stratigraphic series. It is composed mainly of granites, gneisses and migmatites with subordinate basic rocks. In the northeastern part of the area it outcrops as biotite and coarse porphyritic granite and as anateticmigmatites around the Gombe-Hill.

The study area (Gombe town), consists of two types of soil: sandy and clayey. These correspond to the two rock formations from which they are derived (Orazulike, 1992). Sandy soil is found to the northwest of the metropolis and is underlain by Gombe Sandstone from which it was derived. Soil depths vary between 0-2cm as in the area where gullies originated and as deep as 15-20cm in some other places (Orazulike, 1992 and Arabi*et al* 2009). The soil is red and contains nodules of ironstone.

The soil is marked by deposits of iron oxide pebbles and is loose, very permeable and deficient in plant nutrients (Orazulike, 1992). Clayey soil occurs to the south and southeast of the town and around railway station. The soil is either derived from the Pindiga Formation or a clayey of Gombe Sandstone. The soils are rich in montmorrillonite and possess an appreciable shrink- swell capacity (Orazulike, 1987) and therefore are susceptible to all forms of erosion.

3.1.5 Vegetation

The natural vegetation of the study area is guinea savannah woodland. This can be observed at the boundaries and outskirts of the town. But as a result of rapid population pressure on the landsuch as urban expansion, cultivation, livestock grazing etc., the natural vegetation has disappeared resulting in exposure of land to gully erosion phenomenon (Balzerek, 2003). Although afforestation is being encouraged, the rate of their survival does not match rate of deforestation.

3.1.6 Development and Population Growth of Gombe

Originally Gombe (called Old Gombe or Gombe Abba) on the bank of the Gongola River 90 km northwest of the present Gombe capital was founded by BubaYero, in the early 19th century (Tiffen, 2006). In 1913, the British Colonial administration transferred the headquarters of Gombe to Nafada, where British trade companies had already established a seasonal entrepot. Six years later the British shifted the capital of their Division together with the traditional headquarter of the 'Gombe Emirate' a second time from Nafada to Gombe-Doma, which was by then only a small village. Due to new direct road access from the Provincial Headquarter Bauchi, to Gombe, and the implementation of the British Development Plans (since 1946) a systematic agricultural progress took place(Tiffen, 2006).

The spatial and temporal analysis of Gombe's urban layout disclosed centrifugal growth, building densification and urban layout modification (Balzerek, *et al.,* 2003). This development resulted in the unification of the traditional settlement and the peri- urban areas in the 1997 to formed a single urban body, which reached the size of 30km^2 in 2000 ((Balzerek, 2003). This expansion has led to an urban intrusion into the peri-urban environs far beyond the original town borders and is followed by significant change in land-use

which has increased the sealed surface thereby reducing the infiltration rate of the rain water (Balzerek, *et al.,* 2003).

The pattern of population growth of Gombe town was slow from 1900-1952 (300 - 18,500 people) while, from 1964 to 1991 the population growth has increased tremendously from 47,000 to 138,000.However, from the year 1996, when Gombe became the State capital, there was a noticeable sharp increase in population from 169,894 (1996) to 219,946 in 2000 (Tiffen, 2006) and 312,467 in the census 2006 and is projected to reach about 400,000 in 2010 (NPC, 2007). This population explosion resulted in high demographicpressure on land and consequent developmental processes such as building of houses.

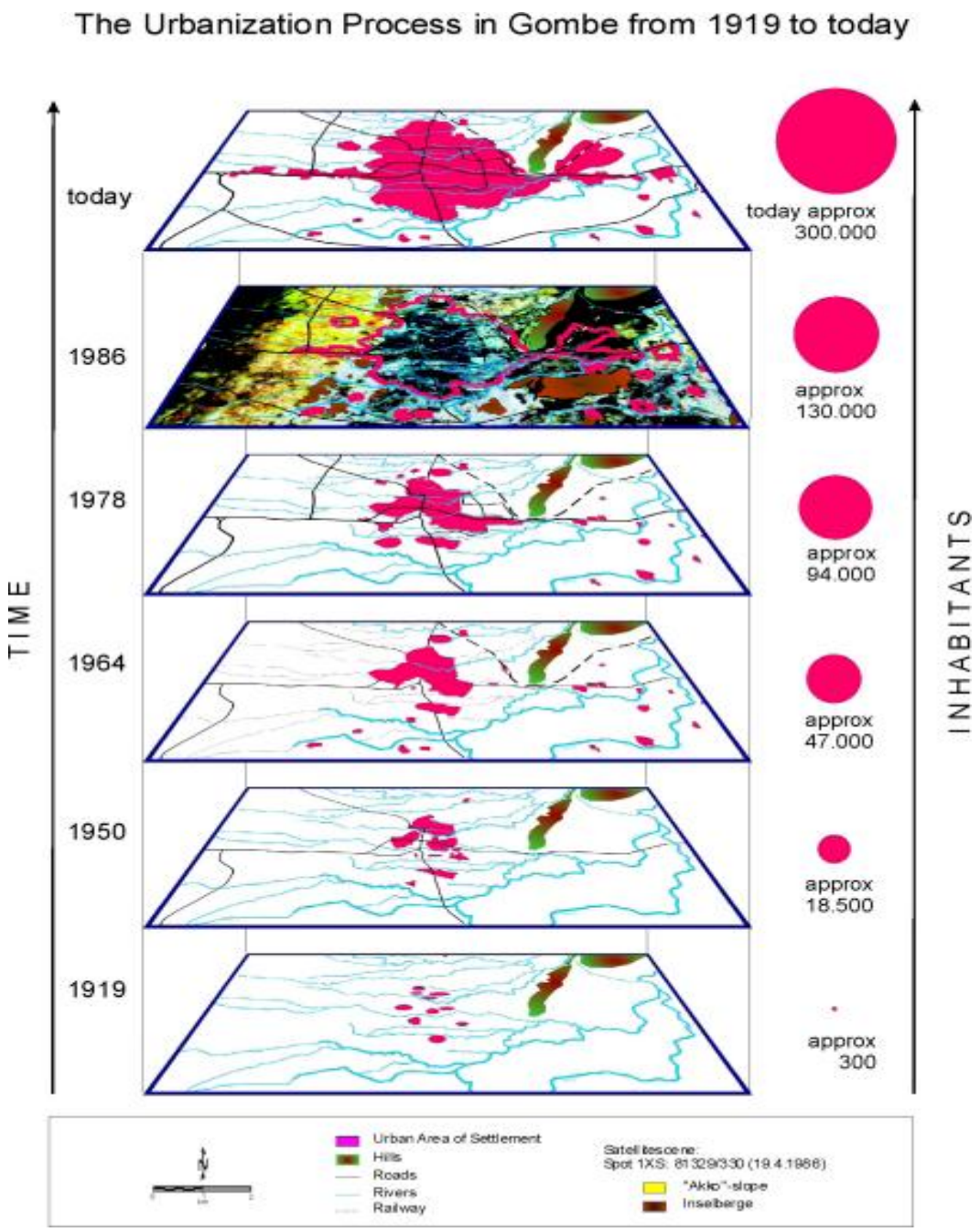


Fig. 3.2: Change in urbanization Processes of Gombe Town (1919 – 2003)
Source: Balzerek,*et al*., (2003)

3.1.7 Land Use Changes

Urban growth is usually accompanied by human transformation of the landscape at the point of concentration. In the initial stages of urbanization of an area the transformation starts with gradual but profound changes in land use. The advanced stages of transformation may be so profound that the landscape is almost completely covered by cultural features.In the early stages in the urbanization of an area, the land is cleared of vegetation to make room for human occupancy. This leads to reduced infiltration capacity of the urban land (Sagua,L 1988: 269). As urbanization progresses and construction work goes on, the landscape becomes more compacted, reduces infiltration capacity of the land, thereby increasing runoff. In the advanced stage of urban growth, much of the land is covered by man -made structures such as commercial, industrial, houses, pavement of street network, and building of gutters.

Most urban centres in Nigeria witnesses high density of buildings in the residential areas and the percentage of impervious surfaces is high including most of the Government Reservation Areas (G.R.A). The impervious surfaces substantially increase the runoff and so promote flooding and increase the potential for accelerated erosion. Thus, urbanization increases the Hydrologically Significant Impermeable Areas (H.S.I.A) and so increases runoff (Sagua*et al.,* 1988). The net effects of urbanization on erosion according to Okoye, T.O (1988) include the following: a high proportion of the rainfall is translated into runoff, the runoff occurs more quickly, flood peak are generally high and the recurrence interval of flooding is increased.

When most of the available land in an urban area is built-up, increased pressure on land might lead to extension of urban landuse to the stream channels, flood plains and restriction of streams to artificial channels. Okoye, T.O (1988) stated the extension of building in Ibadan into the flood plains of the Ogunpa and Kudet rivers was due to the introduction of cement as a building material in the town. His investigation further revealed that, the mean distance of buildings along the Ogunpa river valley was about eleven metres from the river bank, whereas the mean distance of the floodable land is ninety metres. Also increased human population in the late stages of urbanization and increased number of urban activities result in increased refuse generation. Where urban sanitation facilities are inadequate, some of the refuse may be dumped in the stream channels blocking the smooth discharge of flood water and resulting in destructive floods in the built-up parts of the flood plain. This was the major cause of the disastrous Ogunpa flood incidence of 1984 to date.The impending ecological and environmental threats resulting from rapid urbanization includes, increase in the volume and rate of surface runoff, a decrease in ground water recharge and base flow, flooding, altering of natural hydrologic condition within a watershed and modifying water balance (Rosa *et al.*, 2004) .

3.1.8 People and Occupation

In Gombe metropolis, commercial land use is predominant used for and it encompasses a wide range of activities ranging from banking and insurance, retail stores and other professional services such as blacksmithing, carpentry, tailoring to mention but a few. The Gombe main Central Business District (old CBD) and the new CBD are almost located at the center of the town figure, served as a commercial hub or market center in the metropolis.

Rearing of domesticated animals is also practiced by the inhabitants. Production of hide and skin for leather industry is an important activity of the people. Gombe urban area serves as a collection center for food and other agriculture produce which are found in large quantity for transportation and redistributionto other parts of the country for eventual marketing and consumption.

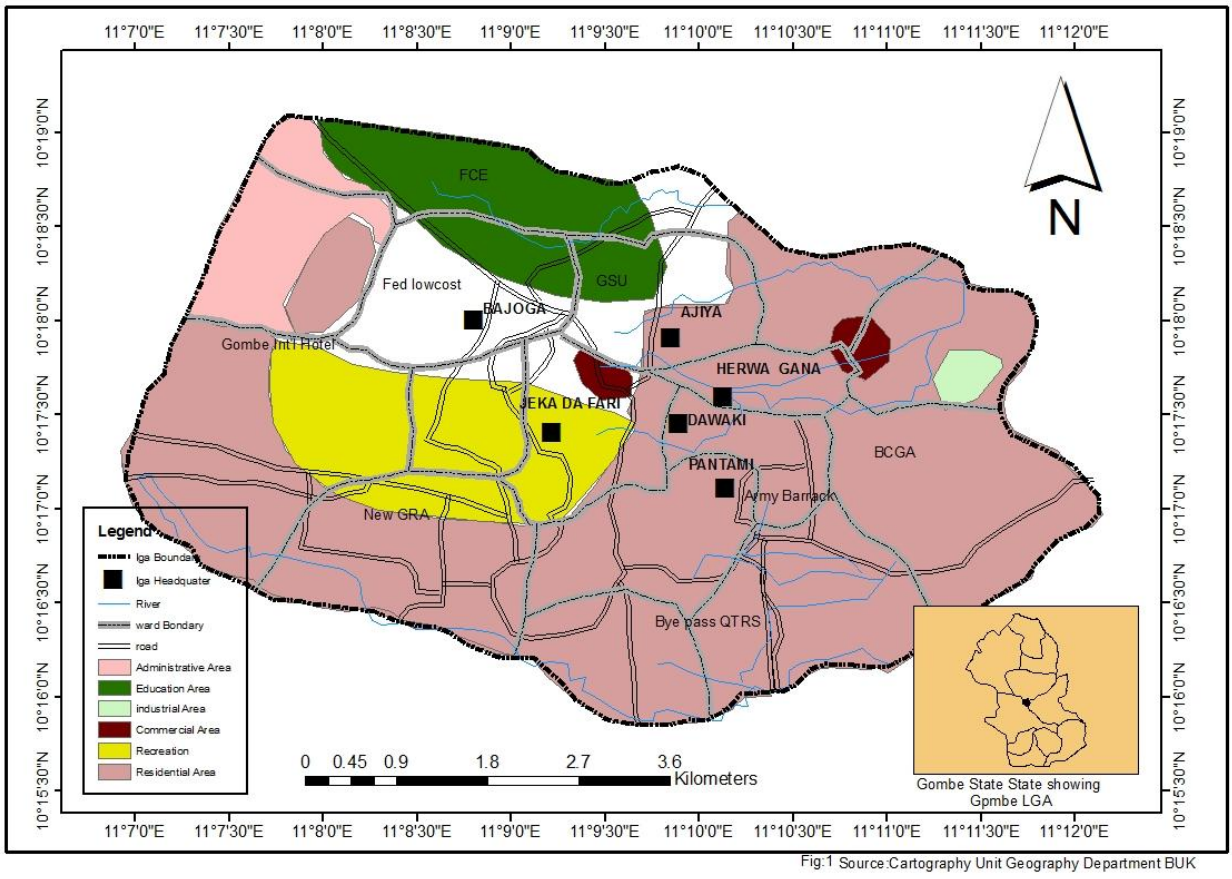


Fig. 3.3: Land use map of Gombe Urban Area
Source: Gombe State Ministry of commerce and Industry.

Gombe metropolis has three major tertiary institutions which include: Gombe State University, Federal College of Education (Tech), School of Nursing and Midwifery. Goni Muktar Polytechnic, School of Higher education. Gombe urban area has several health institutions ranging from Federal Teaching Hospital, Gombe (FTHG), and Gombe

Specialist Hospital, to other fully equipped government and private hospitals. These include: eleven (11) Maternities, seven (7) primary health care centrers, thirty four Dispensaries and thirty five (35) private owned clinics.

Gombe state is blessed with abundant mineral resources both metallic and nonmetallic which could be tapped for industrial growth. They include: Kaolin, uranium, limestone, gypsum, coal, bararite, silica sand and lateritic clay, etc. these minerals serve as raw materials to a wide range of industries such as cement, ceramic, building and construction and energy. Others are metallurgical, paint, electronics and cosmetics etc.

3.2 METHODOLOGY

3.2.1 Reconnaissance Survey

Reconnaissance survey was conducted in order to: get the researcher acquainted with the study area; determine the nature of the roads; discover better ways of obtaining information and identify possible problems to be encountered during the proper research. The survey revealed that there are 24 major roads with heavy commercial activities. Physical counting of commercial outfits was also conducted to determine the population and sample size.

3.2.2 Types of Data

The following data wereobtained and used in carrying out this research:

i. Road maps of Gombe metropolis for (1996, 2005, 2014);
ii. Satellite imageries to show the pattern of urban growth under the period of study:

    Land Sat ETM (1996) of 30m spatial resolution

    Land Sat ETM+ (2006) of 30m spatial resolution

    Landsat-8 (2014) of 30m spatial resolution
iii. Information on the types of commercial activities along major road corridors;
iv. Data from ministry of commerce
v. Related literatures

3.2.3 Sources of Data

Two sources of data were utilized in the course of carrying out this research work. These include:

3.2.3.1 *Primary sources*

Information acquired through reconnaissance survey, questionnaire, personal interviews, satellite imagery and the researcher's observations.

3.2.3.2 *Secondary sources*

Informationwere acquired through the use of textbooks, thesis and projects materials and publications, journals and internet. Other important information on road transport development were obtained from Gombe State Ministry of Works and Transport, Gombe State Ministry of Finance, Ministry of Urban and Regional Planning, Federal and State Office of Statistics, Central Bank of Nigeria (CBN) and F.R.S.C. to complement the research work.

3.2.4 Sample Size and Sampling Technique

There are 24 major road corridors that form the road network in Gombe metropolis. The roads are alphabetically arranged and ranked in ascending order. Therefore, the identified roads formed the sample points where the questionnairewere administered to the respondents. See Table 3.1 below.

A total number of 282samples weretaken to the commercial outfits in the identified major road corridors. Yamane (1967) provides a simplified formula to calculate sample size with 95% confidence level and 5% sampling error assumptions.

$n = N/1 + N(e)^2$……(1)

Where:

n = Sample size
N = Population size
e = Sampling error

To determine the proportion of the respondent, Yamane (1967) sampling method for determining of respondents was also used;

n (k)/N ……. (2)

Where:

n = number of commercial outfits on each of the routes
N = number of commercial outfits on all the identified routes
k **(**constant) = 282

Table 3.1 Distribution of Sample Size by Road Corridors

S/N	Name of Roads identified	No. of commercial Activities identified	Sample Size	Percentage of the Respondents
1	Abacha Road	30	9	3.19
2	AliyuModibbo Road	45	13	4.61
3	Bauchi Road	154	46	16.31
4	Bello SabonKudi Road	27	8	2.83
5	Biu Road	122	36	12.77
6	Bypass Road	74	21	7.45
7	Dukku Road	38	11	3.90
8	Gandu Road	15	4	1.42
9	Good luck Jonathan Road	34	10	3.55
10	Gov't. House Road	15	4	1.42
11	GRA-K/Pilato Road	11	3	1.06
12	HerwaGana Road	38	11	3.90
13	Idi P/Ground road	37	11	3.90
14	JaloWaziri Street	28	8	2.84
15	Jankai Road	13	4	1.42
16	Kashere Road	17	5	1.77
17	Kasuwan Mata Road	30	9	3.19
18	Pantami Road	28	8	2.84
19	PDP Street	18	5	1.77
20	Railway Road	54	16	5.67
21	Sabonlayi-Pantami Road	45	13	4.61
22	State Low cost Road	27	8	2.84
23	University Road	33	10	3.55
24	Yusuf MaitamaSule Road	16	5	1.77
	Total	**949**	**282**	**100**

Source: Field Survey, 2014.

3.2.5 Method of Data Analysis

The following three graphic theoretic measures were used in analyzing the road network connectivity: Alpha, Beta and Gamma indices. The road networks in Gombe metropolis during each period were converted into topological graphs. These graphs were then analyzed to determine the alpha, beta and gamma indices using the following formulas:

The Beta Index; $\beta = \frac{e}{v}$ …….. (1)

The Gamma Index; $\gamma = \frac{e}{3(v-2)} \times \frac{100}{1}$ ……... (2)

The Alpha Index; $\alpha = \frac{e-v+1}{2v-5} \times \frac{100}{1}$ ..... (3)

Where;

β = refers to beta index

γ = gamma index

α = alpha index

e = number of edges or links

v = number of vertices or nodes

These indices help to determine the connectivity level.

Objective two was achieved using GIS and remote sensing techniques. In this respect, satellite imageries were analyzed to reveal the pattern of urban growth and also to determine whether urban growth has linkage to road transport improvement. Supervised Classification technique was adopted using Erdas Imagine software and ArcGIS software.

Objective three was achieved using the inferential statistical technique Paired T-Test (t). This was used to determine the relationship between road transport network development and urban growth. It was calculated using SPSS Version 22 and was also used to test the research hypothesis.

Descriptive statisticswas used to achieve the last objective. The method employedinclude the use of percentages, frequency distribution, tables, graphs and pie charts for the presentation of findings on the effects of road transport development on commercial activities.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

In this chapter, the outcomes of this research are presented and discussed in detail. Starting from the analysis of road transport development in the study area to the quantification of urban growth over time, it goes through the most important findings of growth pattern. Furthermore, information collected using questionnaire were presented and discussed. Effects of road transport development on urban growth and commercial activities are being highlighted. Most of the discussions are supported by maps, tables and illustrative graphs.

4.2 CHANGESINROAD NETWORK DEVELOPMENT

4.2.1 Road Network Connectivity in Gombe Metropolis

In order to determine the changes in connectivity over time in Gombe Metropolis, Gombe State, three graphic theoretic measures were used in analyzing the network connectivity, which are all based upon the relationship between the number of edges and vertices in a network. They include: ***Beta, Gamma and Alpha*** indexes.

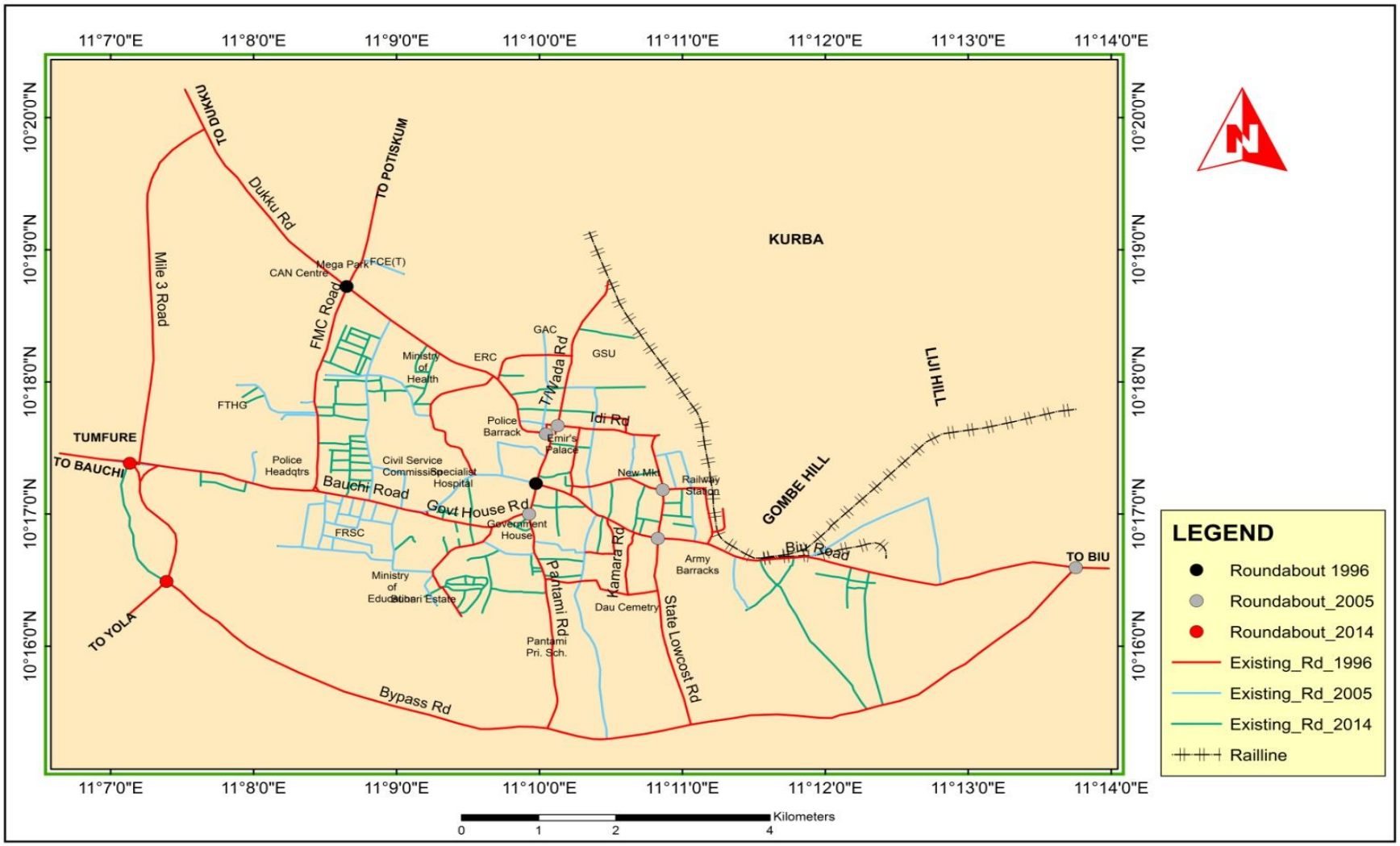


Fig. 4.1: Present Road Network of Gombe Metropolis (2015)
Source: Bappia Global Resources Ltd. 2013

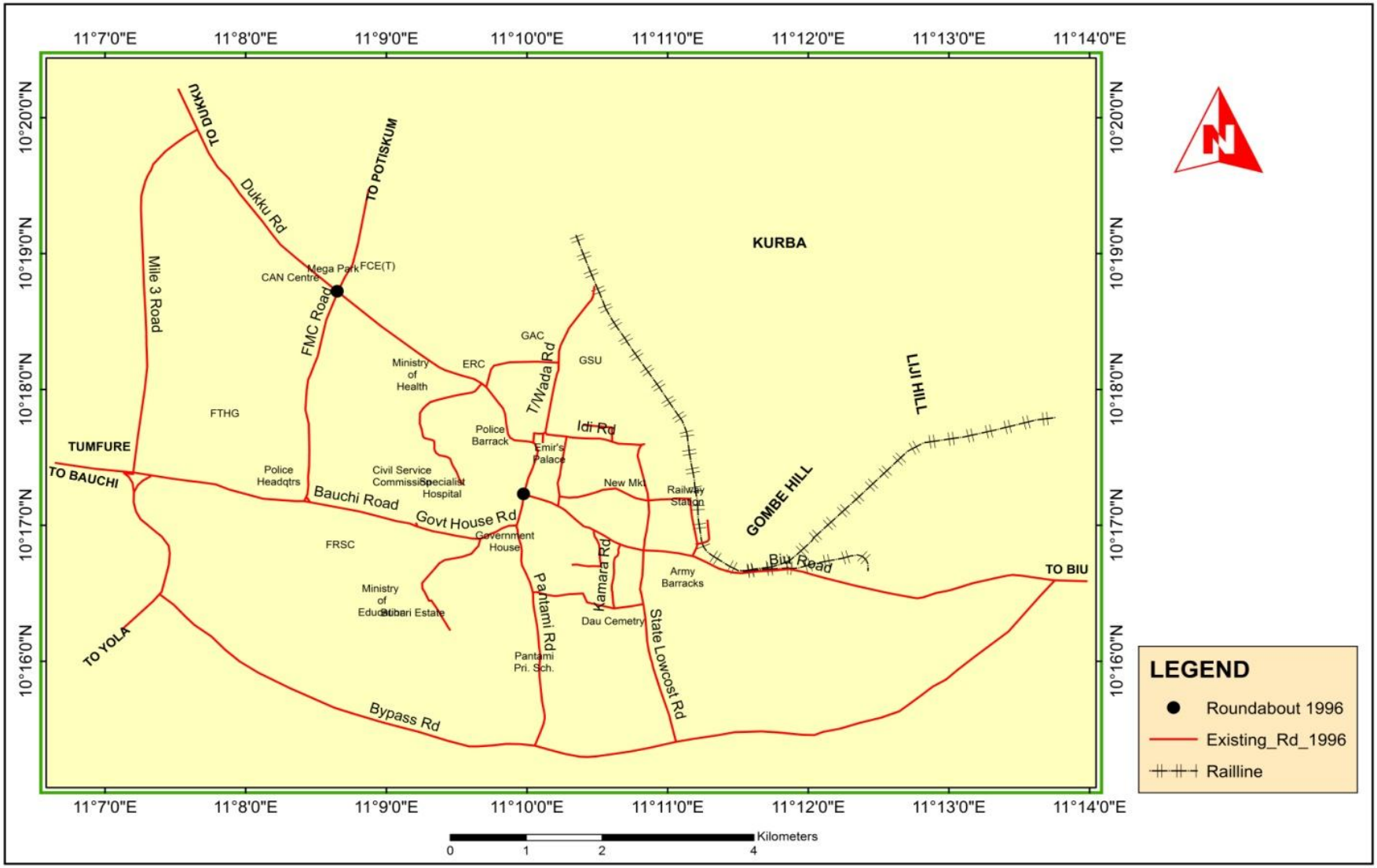


Fig. 4.2a: Gombe Metropolis Road Network (1996)
Source: Bappia Global Resources Ltd. 2013

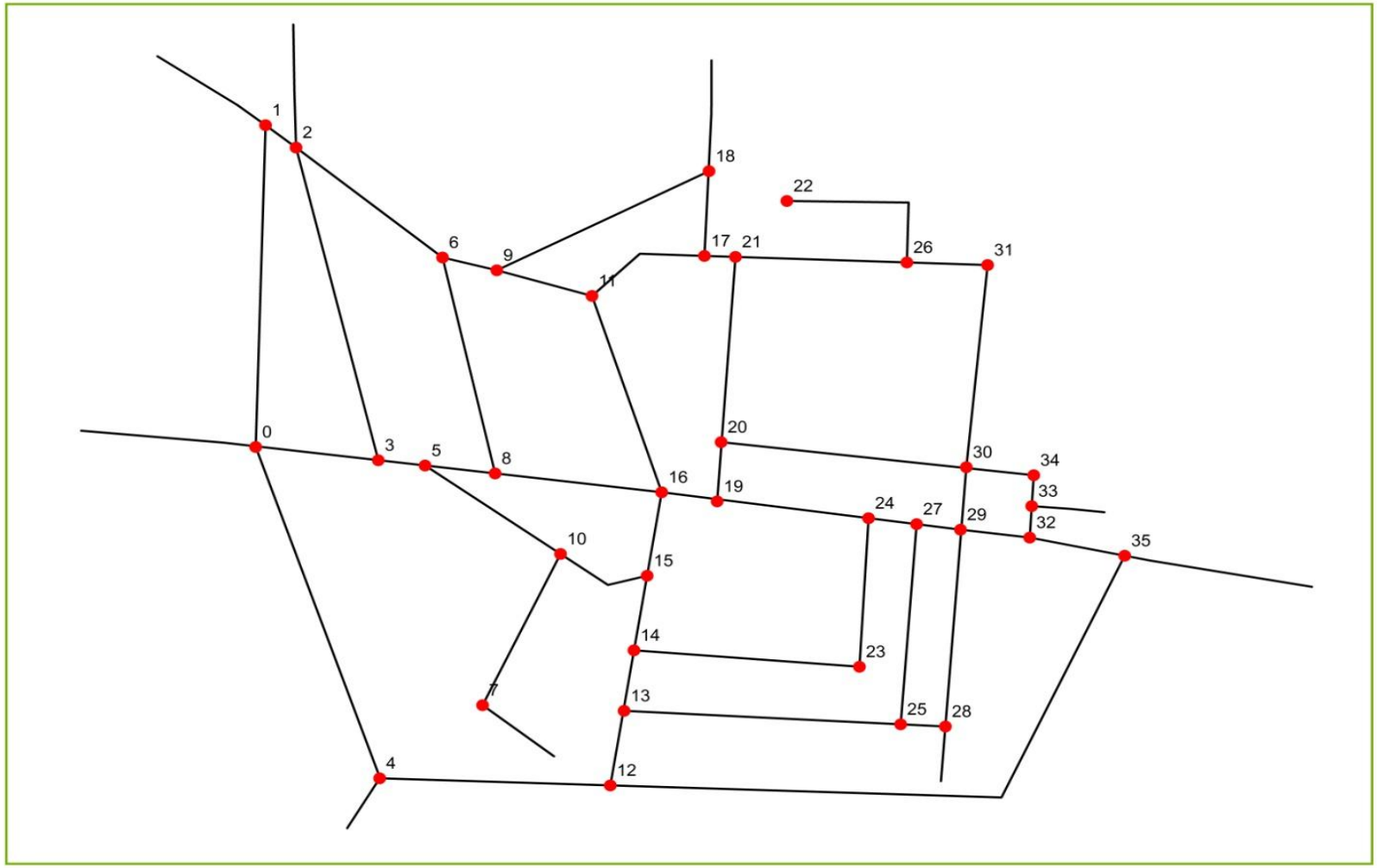


Fig. 4.2b: Topological Graph of the Road Network of Gombe Metropolis (1996)
Source: Author's Analysis, May(2015).

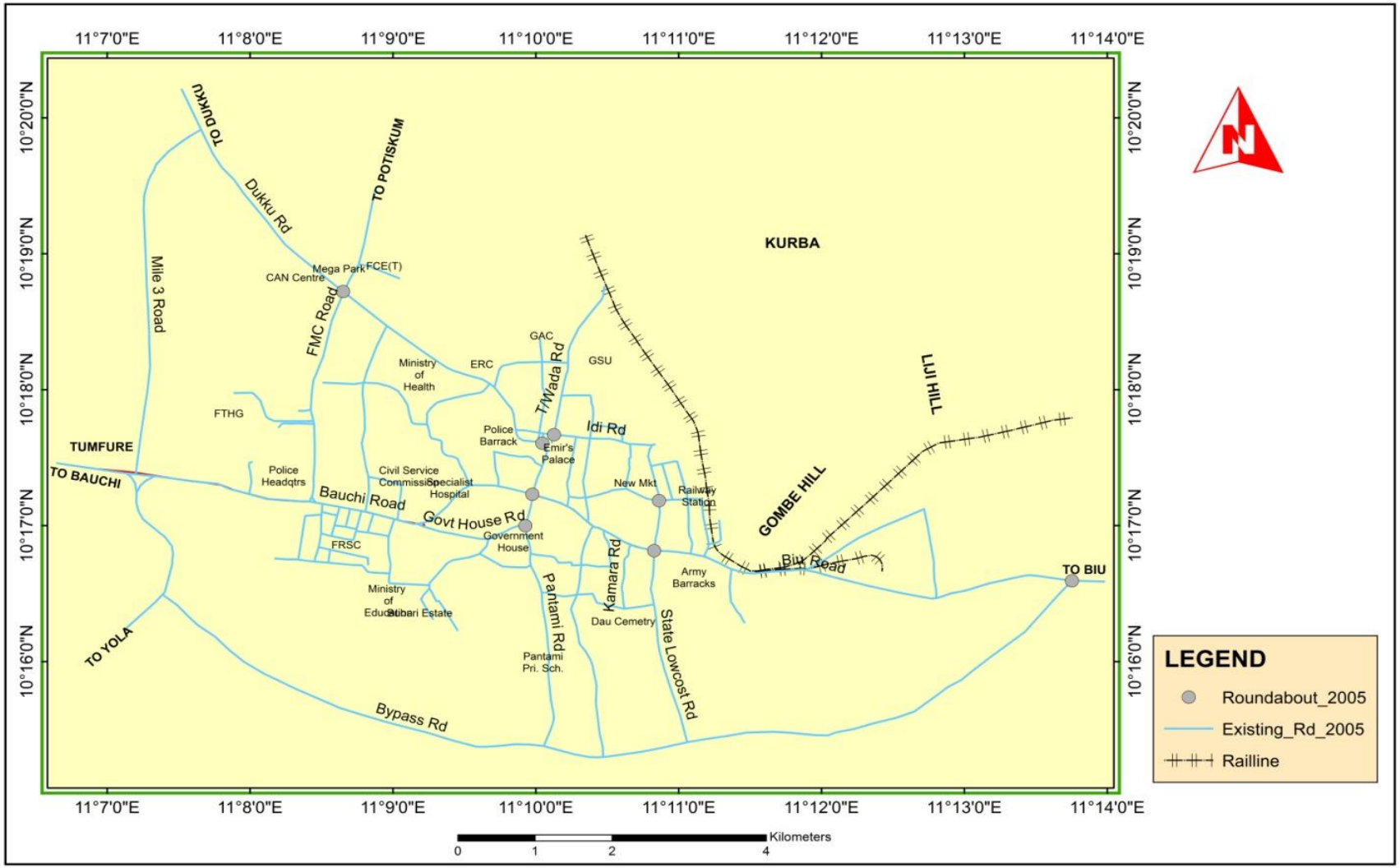


Fig. 4.3a: Gombe Metropolis Road Network (2005)
Source: Bappia Global Resources Ltd. 2013

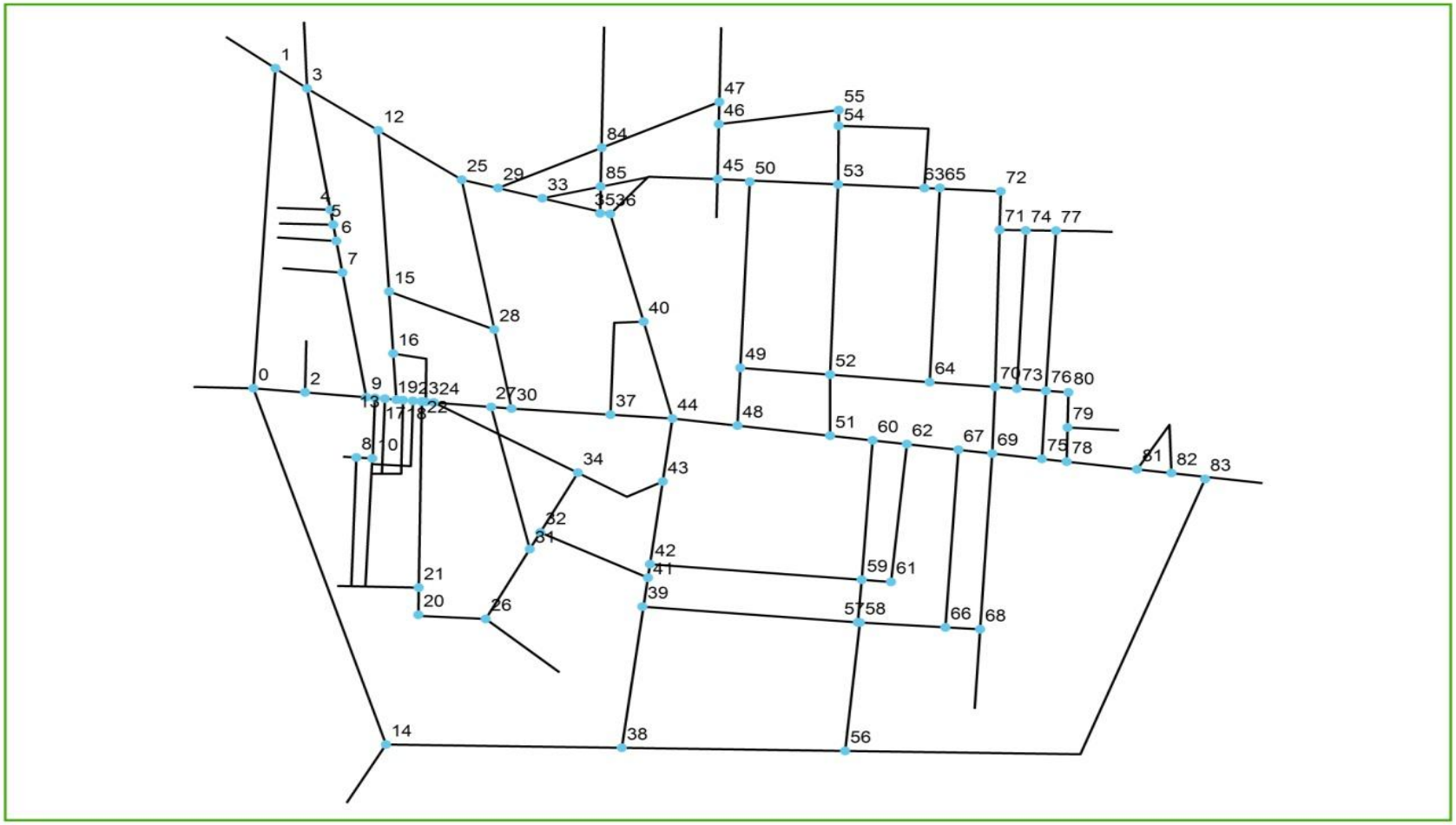


Fig. 4.3b: Topological Graph of the Road Network of Gombe Metropolis (2005)
Source:Author'sAnalysis,May(2015).

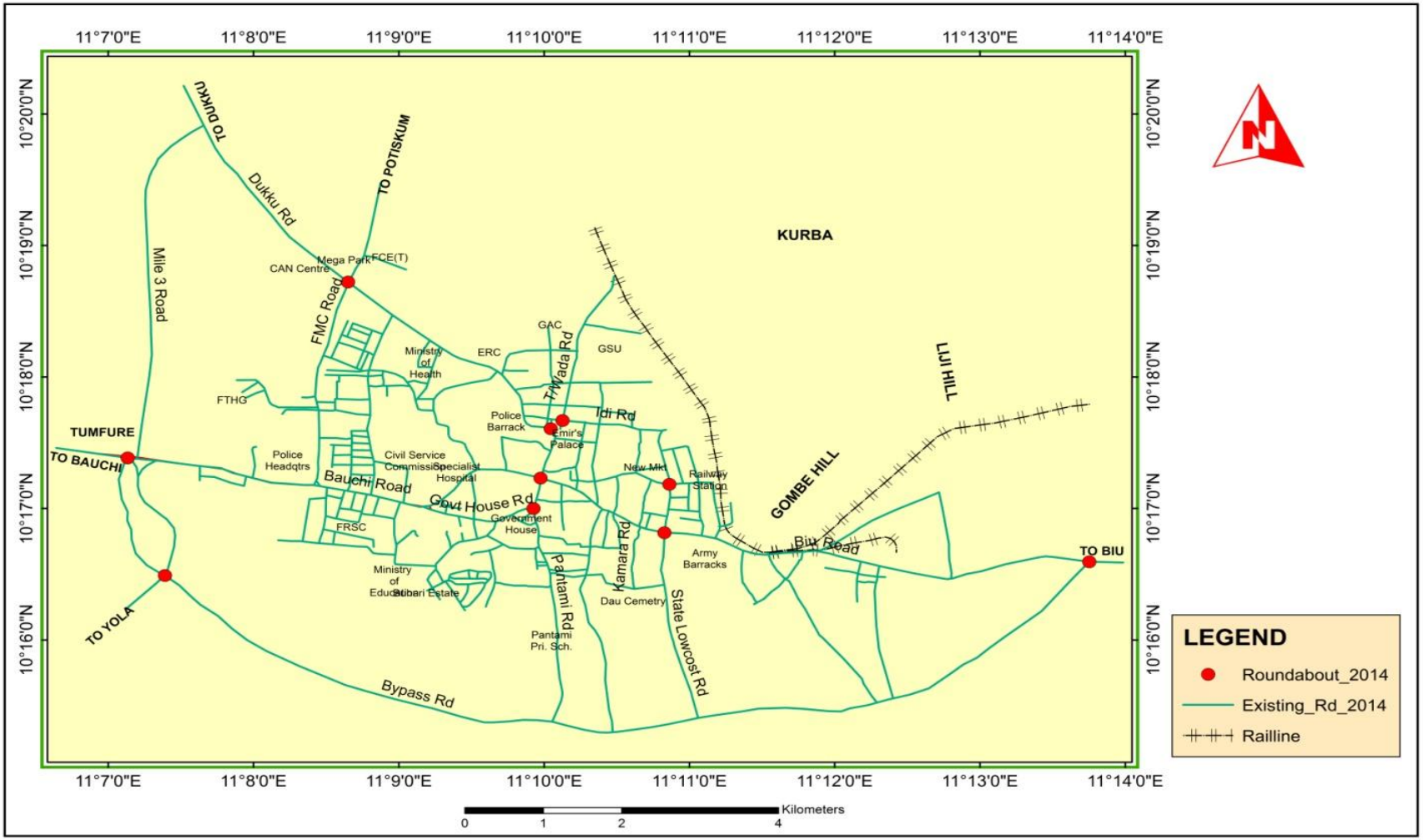


Fig. 4.4a: Gombe Metropolis Road Network (2014)
Source: Bappia Global Resources Ltd. 2013

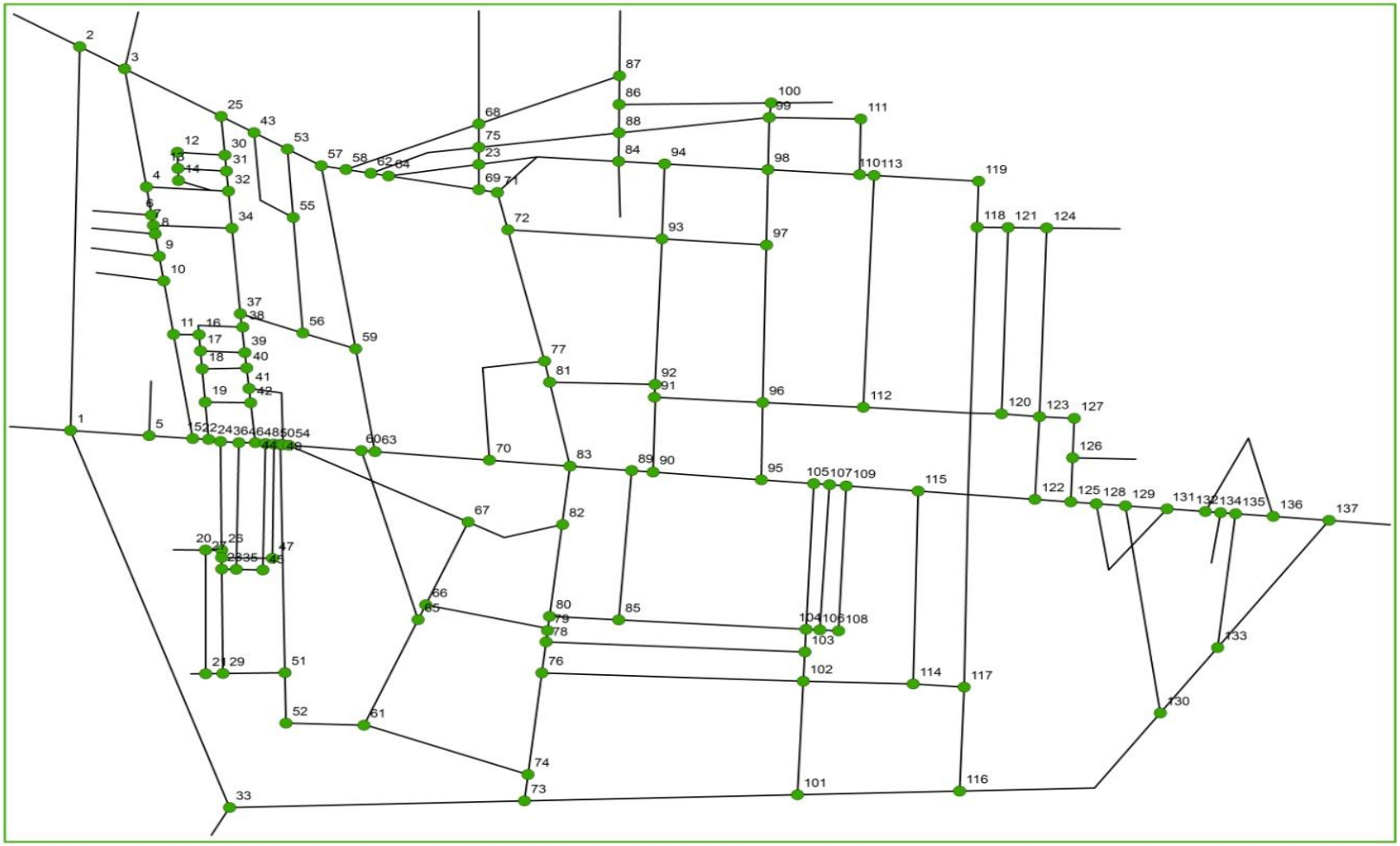


Fig. 4.4b: Topological Graph of the Road Network of Gombe Metropolis (2014)
Source: Author's Analysis, May (2015).

From Table 4.1 it is clear that the number of both edges and vertices continue to increase from 1996 through the 2005 to 2014. That can best be seen from the summarized topological graphs (fig 4.2b, 4.3b and 4.4b). The alpha, beta and gamma indices were calculated from the topological maps to show the degree of connectivity in Gombe Metropolis. Fig. 4.5 also presents the information clearly and also demonstrate graphically the trend of road network development in the study area.

Table 4.1: Numbers of Road Edges and Vertices in Gombe Metropolis (96,05& 2014)

Periods	No. of Nodes (vertices)	No. of Links (Edges)
1996	36	58
2005	86	146
2014	122	216

Source: Author's computation, May (2015)

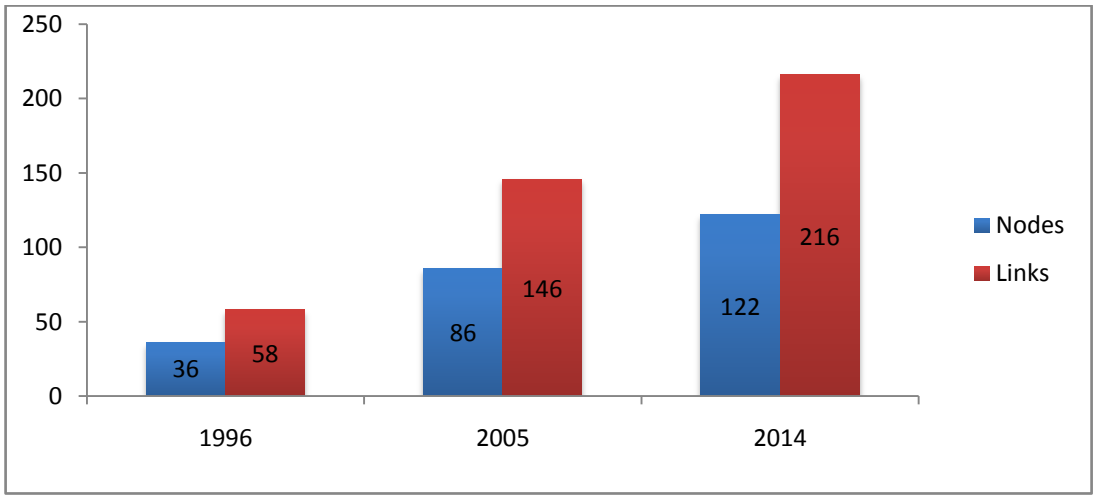


Fig.4.5: Road Edges and Vertices of Gombe Metropolis
Source: Author's Analysis, May(2015)

The result of the measure of connectivityon table 4.2 portrays the degree of changes in connectivity of road network in Gombe Metropolis. The results of the computation of gamma, beta, and alpha indices indicated that there is a significant increase in road connectivity in Gombe metropolis from 1996 through the 2005 to 2014. The beta index

revealed that there is increase in connectivity in the area from 1.61 in 1996 to 1.70 in 2005 and 1.80 in 2014. In the case ofalpha index, connectivity was 31.3% in 1996 but increased to 35.3% in 2005 and 38.9% in 2014. Lastly, thegamma index further revealed an increase in road connectivity over the last two decades. The result shows that road connectivity witnessed an increase from 56.9% in 1996 to 57.9% and 60.0% in 2005 and 2014 respectively. (See appendix ii in page 105 for details of the computation).

In a nutshell, all the three indices calculated have indicated improvement in connectivity in Gombe metropolis. Without doubt therefore, it can be concluded that a lot has been done in the area in terms of road construction for the period under study.

Table 4.2 Road Connectivity Indices of Gombe Metropolis over three time period

S/N	Year	Beta	Gamma	Alpha
1	1996	1.61	56.9%	31.3%
2	2005	1.70	57.9%	35.3%
3	2014	1.80	60.0%	38.9%

Source: Author's computation, May (2015)

4.3 PATTERN OF URBAN GROWTH IN GOMBE METROPOLIS (96-2014)

4.3.1 Images Used for the Study

Different Remote Sensing and Geographic Information System (GIS) data from reliable sources have been used in this research. Three medium resolutions Landsat ETM, Landsat ETM+ images of 1996, 2005 and Landsat-8 of 2014 were used to detect urban land cover change patterns of the study area (Plate4.1a, b and c). These images were obtained from United States Geological Survey (USGS) website as standard products, i.e. geometrically and radio-metrically corrected. In order to avoid the impact of seasonal variation, all images are selected from the same season in such a way that the cloud cover

will not exceed 10%. The images are also of the same level of spatial resolution of 30m which makes it easier for comparison of changes and patterns that occurred in the time under consideration.

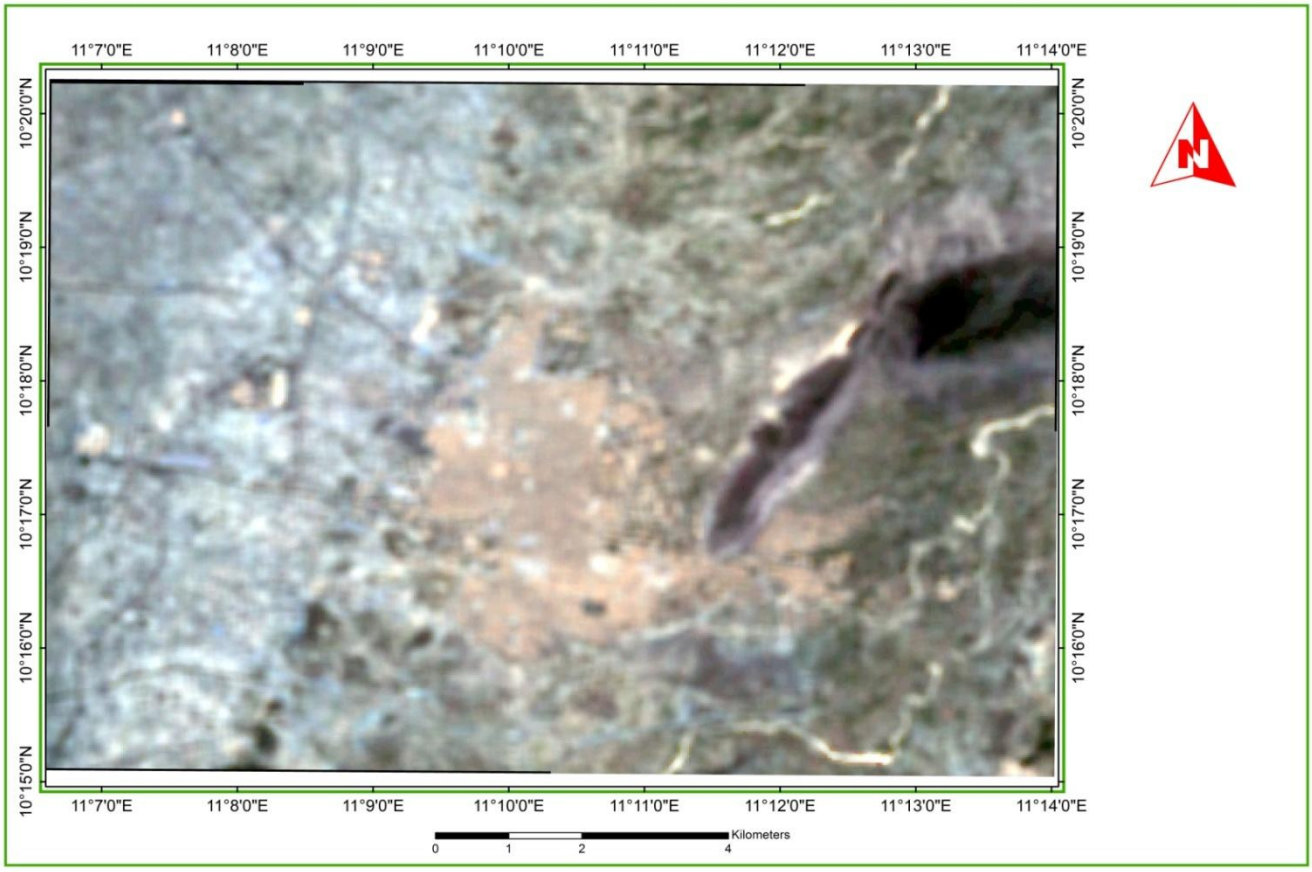


Plate4.1a: Landsat ETM Image of Gombe Metropolis (1996)
Source: United State Geological Survey (USGS)

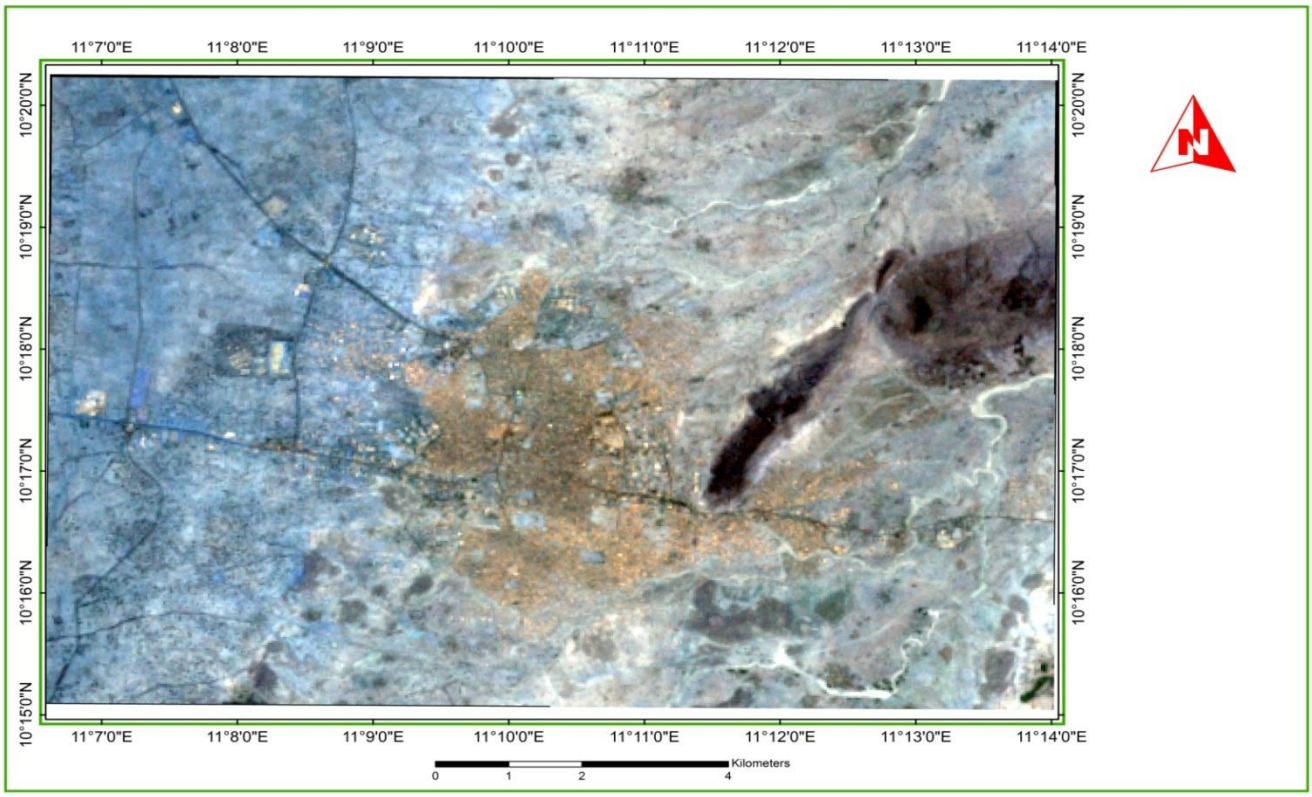


Plate4.1b: Landsat ETM+ Image of Gombe Metropolis (2005)
Source: United State Geological Survey (USGS)

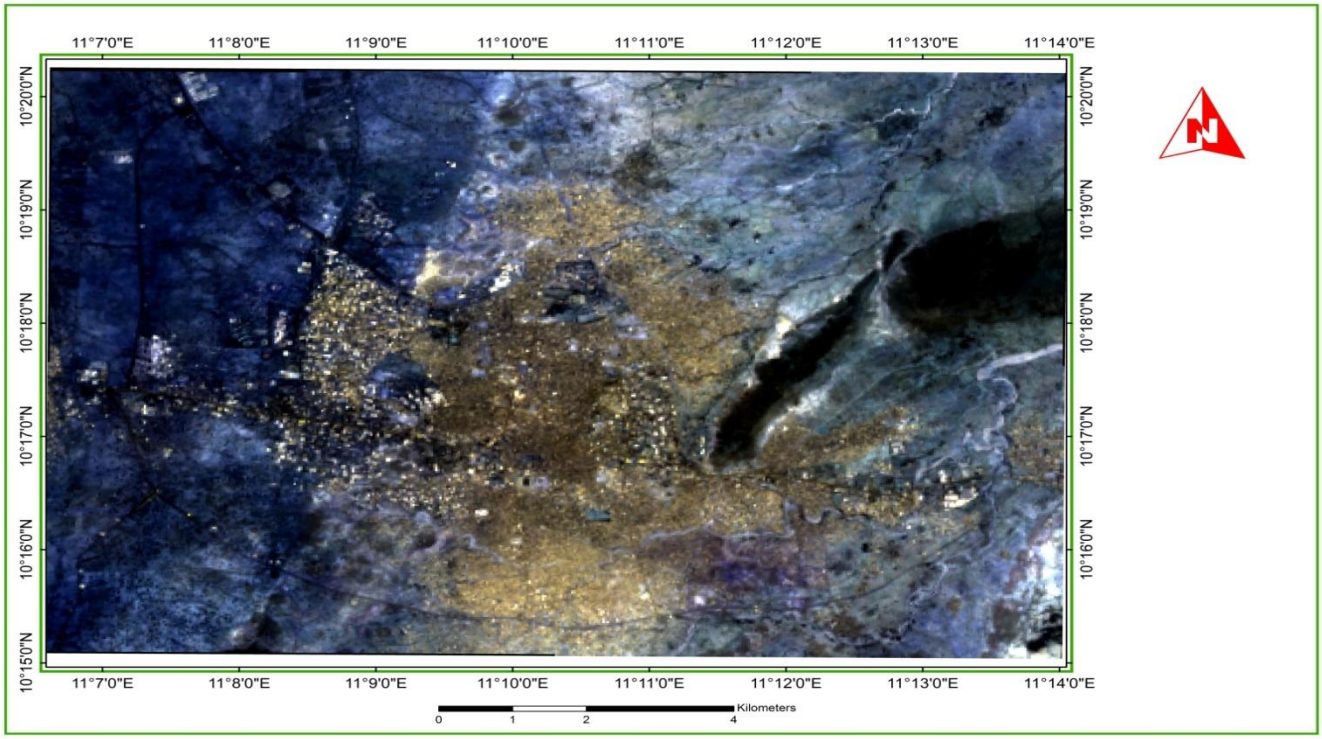


Plate 4.1c: Landsat-8 Image of Gombe Metropolis (2014)
Source: United State Geological Survey (USGS)

The detail description of the characteristics of all images used in this study was summarized in Table 4.3

Table 4.3: List of Satellite Images Collected of the study Area

Satellite Data	Spatial Resolution	Acquisition Date	Source
Landsat ETM	30m	27/2/1996	USGS
Landsat ETM+	30m	19/1/2005	USGS
Landsat-8	30m	28/1/2014	USGS

Source: United State Geological Survey

4.3.2 Results of Image Classifications

The classifications of multi-temporal satellite images in to built-up and non-built up areas for the three different time periods of 1996, 2005 and 2014 has resulted in a highly simplified and abstracted representation of the study area (Plate 4.2a, b and c).These maps show a clear pattern of increased urban expansion prolonging both from urban centre to adjoining non-built up areas along major transportation corridors. The maps show the urban growth pattern in the study area.

Post classification comparison of the classified images revealed the growth pattern of the city in different directions, the infilling of the open spaces between already built up areas and the dynamics of urban expansion in the study area. However, it is important to support the findings with statistical evidences as it is useful to describe the spatial extent and the different patterns of urban growth that have been occurring in the area. This will help understand how the city is changing over time and to compare the various growth patterns taking place in different time periods quantitatively.

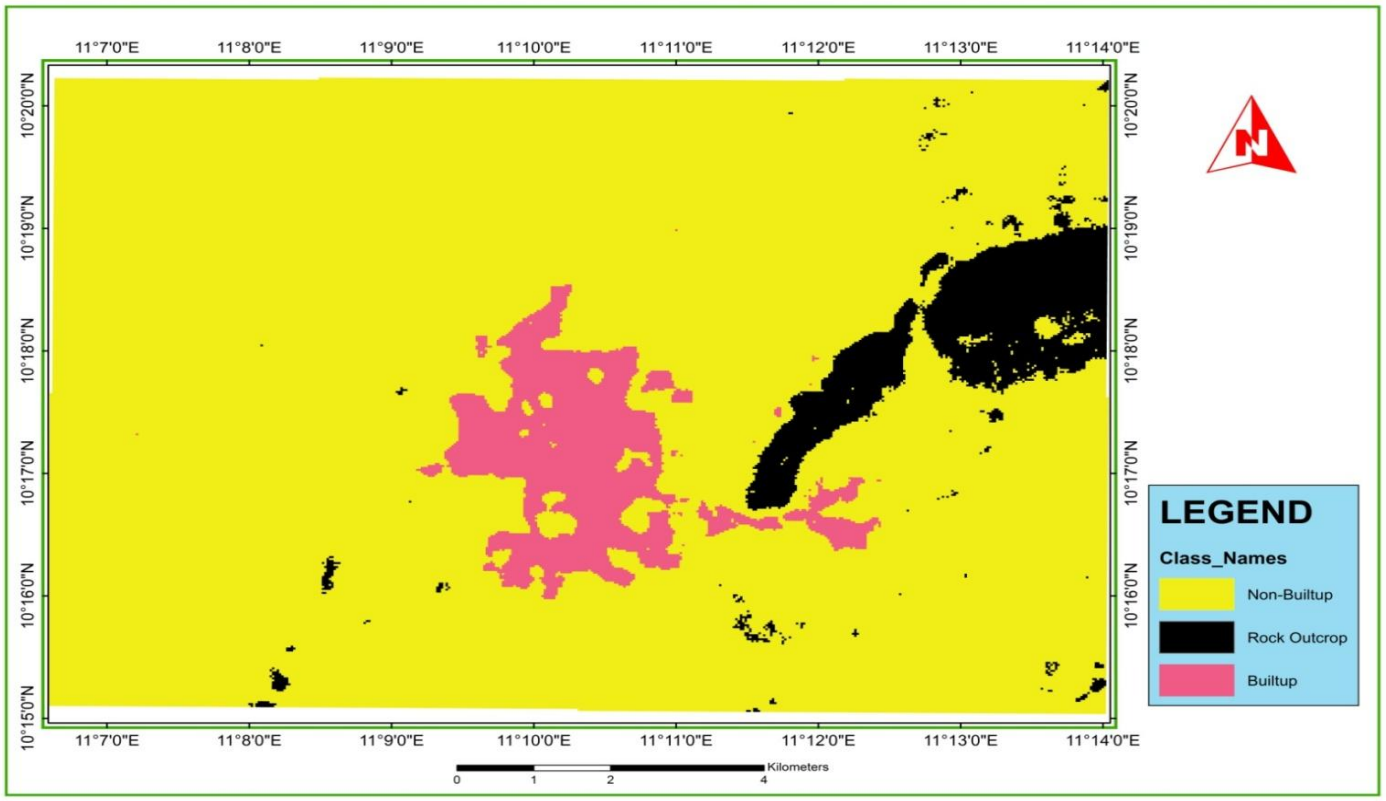


Plate 4.2a: Classified Image of Gombe Metropolis (1996)
Source: Author's Analysis, May (2015)

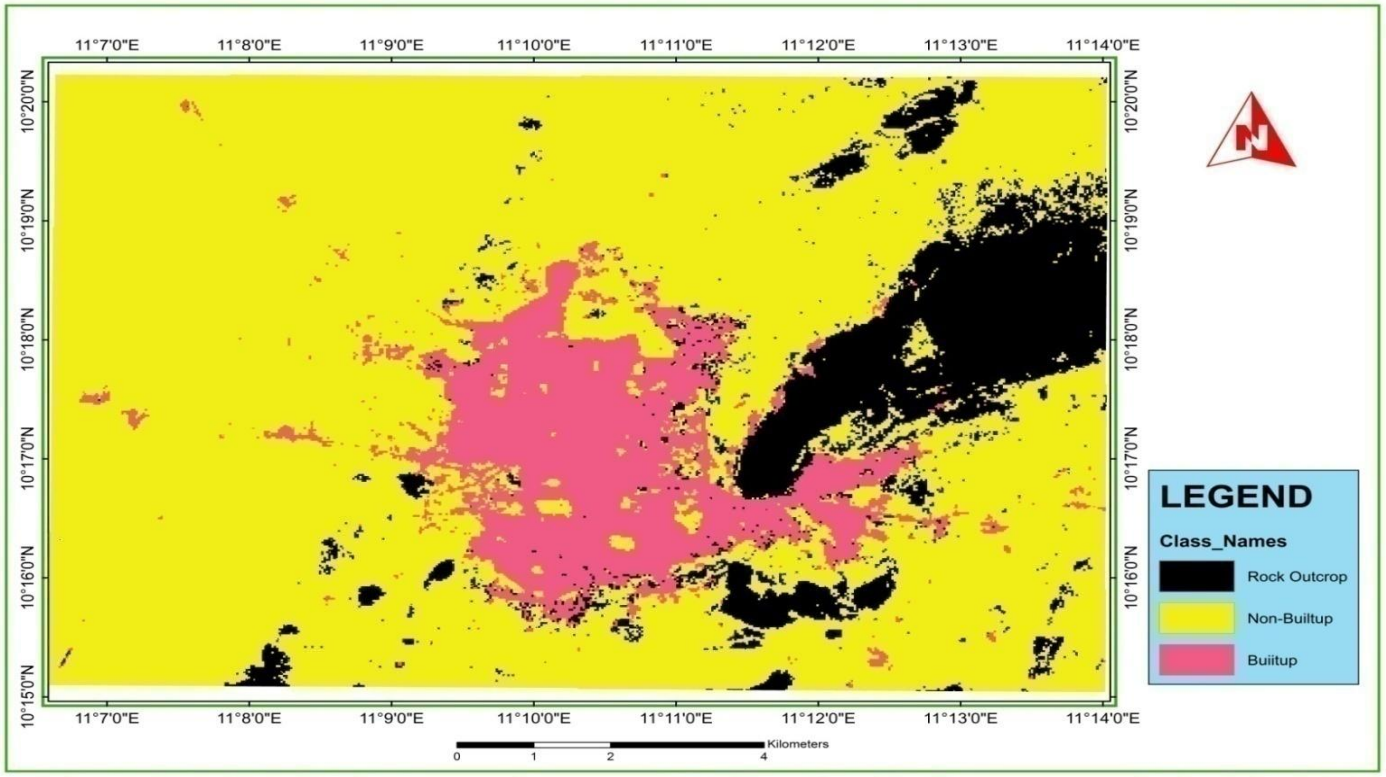


Plate 4.2b: Classified Image of Gombe Metropolis (2005)
Source: Author's Analysis, May (2015)

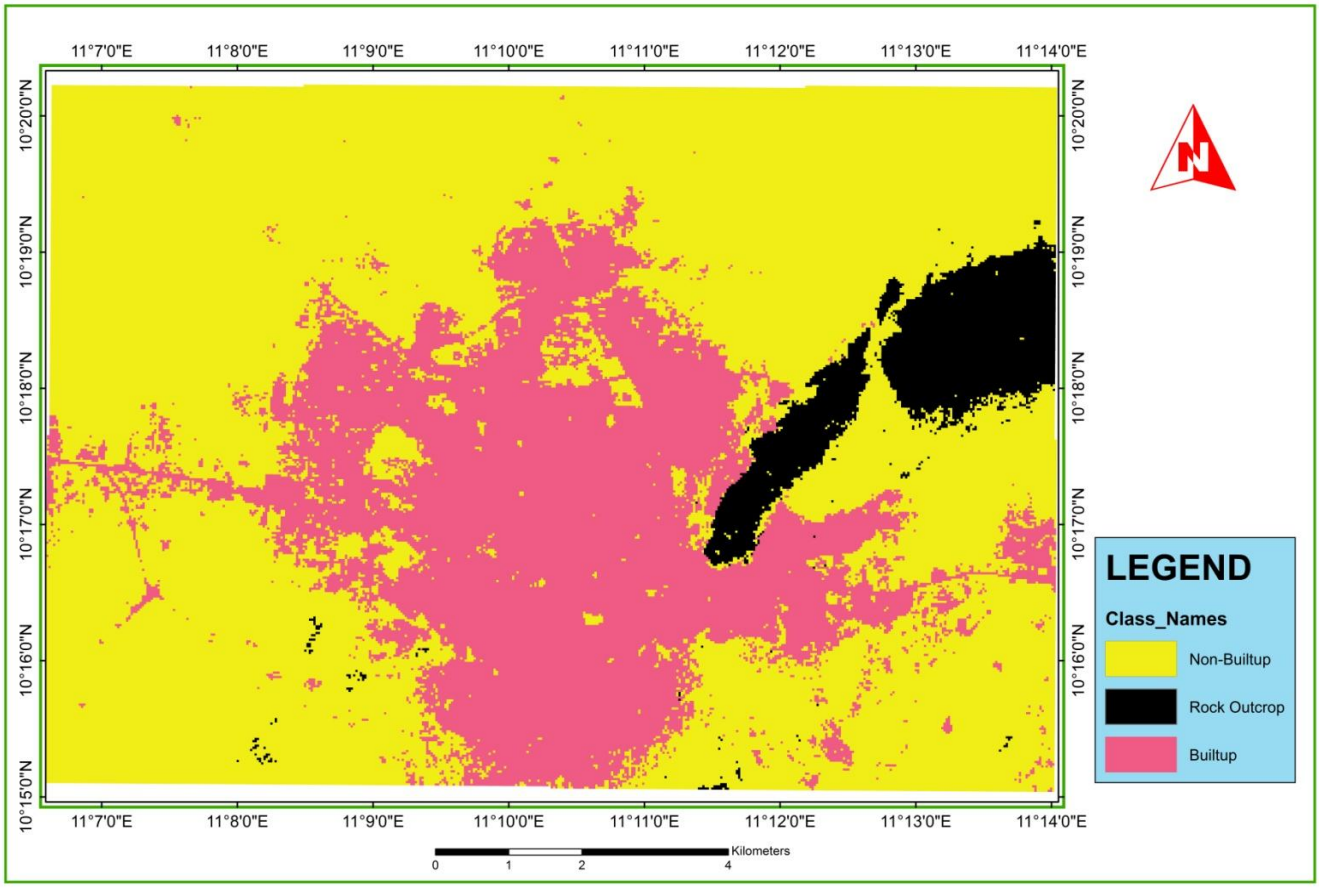


Plate4.2c: Classified Image of Gombe Metropolis (2014)
Source: Author's Analysis, May (2015)

4.3.3 Analysis of the Pattern of Urban Growth

The results presented in Table 4.4 showed that the total built up area (TBA) has grown from 809.28 hectare (8.29km^2) in 1996 to 1,655.05 hectares (16.55km^2) in 2005 and to 3,689.01hectares (36.89km^2) in 2014. The highest rate of urban growth is observed during the third period of urbanization (2014) in which the built up area increased more than twice (60%) within 9 years interval. This is followed by 13.2% and 26.9% during the first (1996) and the second (2005) periods of urbanization respectively. This indicates a more rapid urbanization has been taking place in the study area during the period of (2014) compared to the two other periods (1996 and 2005).

Table 4.4 Analysis of Built up Area Expansion Based on Total Area

Study Period	Change: Hectare/Km^2	Change Percent (km^2)
1996	809.28h / 8.93 Km^2	13.2%
2005	1,655.05h/ 16.55Km^2	26.9%
2014	3,689.01h / 36.89Km^2	60.1%

Source: Author's Computation, (2015)

It should be noted that the third period of urbanization (2005 to 2014) in terms of absolute land cover change remains the fastest witnessing the conversion of 2,879h of non-built up land to urban land. This isfollowed by the second study period (1996 to 2005) with 1,655h. The first period cover all the years that preceded 1995 and had a total built up area of 809h. Totally, 2,879h of non-built up land has been converted to built up land over the period of 1996 to 2014.

Furthermore, rapid urban growth process in the study area has been revealed by the continuous rise of the number of patches (NP) in the landscape throughout the study periods. This could be an indication of the heterogeneous and fragmented urban growth process taking place over time. Significant change is observed during 1996 to 2005. However, the pick occurred between 2005 to 2014, indicating the continuing development of scattered and fragmented urban patches in the area under study. Thus, the situation can be attributed to the emergence of small and patchy built up areas in and around the periphery of the city.

Generally, the analysis of urban growth of Gombe metropolis over time as described above indicates that urbanization has substantially changed the land cover with a significant land conversion. Built up area has been undergoing fragmented development process in all the study periods, with a substantial increase in built up area during the second and the third periods (2005 and 2014). In addition, the analysis also revealed that

the city is experiencing infill and edge expansion around the urban core, mainly during second period (2005). It also unveiled the increasing patch shape complexity of the study area which could be as a result of infilldevelopmentor the mergerof new patches with the existing patches.

4.4 DETERMINATION OF THE RELATIONSHIP BETWEEN ROAD TRANSPORT DEVELOPMENT AND URBAN GROWTH

This section tried to test the hypothesis earlier formulated. Thus, thehypothesisis stated as**:**there is no significant relationship between road transport development and urban growth in Gombe metropolis. It is as well utilized to achieve objective number three.

Paired T-test was used in testing the hypothesis. The result shows that the significant 2-tailed or P-value result is 0.024. Note that,it is considered to be significant if the P-Value is less than 0.05. The P-value is 0.024. Since the P-value is less than 0.05, the $H_0$is rejected and therefore, concluded that there is a significant relationship between road transport development and urban growth in the study area.For details see (Appendix II page 107).

Though, road network development has significant relationship with urban growth in Gombe, it may not be the sole determinant because other factors like: migration, personal increase in income, the desire to own personal home and loan scheme from banks are also contributors.

4.5 DETAILS OF THE SURVEY

4.5.1 QUESTIONNAIRE ADMINISTERED

A total of 282 copies of questionnaire were distributed and 280 were recovered for the analysis. Direct methodof questionnaireadministrationwas used and carried out personally by the author. Information collected on the bio-data, socio-economic characteristics and the effects of road transport development on commercial activities were summarized, presented and discussed. Various responses were analyzed using non-inferential statistics.Othertools used were Stat-graphic statistical software and Microsoft Excel Spreadsheet.

4.5.2Demographic and Socio-Economic Characteristics of the Respondents

An account of the demographic and socio-economic characteristics of the respondents were considered to be crucial, as such formed the first section of the questionnaire administered. These include information on sex, age composition, marital status, level of education, occupation and income of the respondents.

Table 4.5 Socio-Demographic Characteristics of the Respondents

Sex	**Frequency**	**Percentage**
Male	224	80
Female	56	20
Total	280	100
Age Group	**Frequency**	**Percentage**
0-14	0	0
15-29	66	24
30-44	140	50
45-59	67	24
60 and above	7	2
Total	280	100
Marital Status	**Frequency**	**Percentage**
Single	72	26
Married	181	64
Divorce	10	4
Widow	17	6
Total	280	100
Level of Education	**Frequency**	**Percentage**
Primary	24	9
Secondary	127	45
Tertiary	77	28
Qur'anic	47	16
No Formal Edu.	5	2
Other	0	0
Total	280	100
Occupation	**Frequency**	**Percentage**
Civil Service	19	7
Farming	9	3
Trading	172	61
Others	80	29
Total	280	100
Monthly Income	**Frequency**	**Percentage**
#10,000 - #20,000	52	19
#21,000 - #30,000	82	29
#31,000 - #40,000	69	25
#41,000 - #50,000	36	13
#51,000 and above	41	14
Total	280	100

Source: Field Survey, 2015

Table 4.5 above shows that the gender of the respondents 80% (224) were male with 20% (56) of the respondents as female. This simply indicates that the majority of the respondents are male and it implies that male engage commonly in commercial activities in the study area than female. Age group of the respondents shows that 24% (66) of the respondents were between the ages of 15 to 29 years while 50% (140) of them were between the ages of 30 to 44 years. Again, 24% and 2% (67 and 7) of the same respondents were between the ages of 45 to 59 and 60 years and above respectively. The analysis of the age groupings of the respondents revealed that the majority of those that their opinions were gathered fall between the ages of 30 to 44 years old. It also indicated that people of that age group participate actively in commercial activities practice in the study area. It means that most of those that are in to commercial activities in study area are from the age of 15 to 60 years and above. It was also found out that the ages 15-29 and 30-44 are more involved in commercial activities. This perhaps is as a result of lack of education and employment available to the youths. Marital status of the respondents equally shows that 26% (72) of the respondents were single, 64% (181) happened to be married, 4% (10) of them were divorce, while 6% (17) of the respondents were widow. This implies that majority of the people that answered the questionnaires given to them are married (64%).

On the other, hand level of education of the respondents further revealed that 9% (24) of the respondents have primary education, 45% (127) have secondary education, 28% (77) obtained tertiary education, and 16% (47) of the respondents have Qur'anic education while only 2% (5) of the respondents have no-formal education. This implies that majority of the respondents are literate. However, those with secondary education

account for the highest percentage of the people that engaged in commercial activities with 45% followed by people with tertiary education, then those with Qur'anic and primary education. Again information on the occupation of the respondents also shows that 7% (19) of the respondents were civil servants, 3% (9) were farmers, 61% (172) were traders, and 29% (80) indicated others as form of their occupation. It was revealed that majority of the respondents practice trading (buying and selling) as their occupation. While majority of those that said others, practice professional services such as: barbing saloon, business centres, GSM repairs, carpenters, and bakery etc. Monthly income of the respondents shows that 19% (52) of the respondents earned #10,000 to #20,000 monthly, 29% (82) earned #21,000 to #30,000 monthly, 25% (69) earned #31,000 to #40,000, 13% (36) earned #41,000 to #50,000 as monthly income while 14% (41) do earned over #51,000 as monthly income. It indicates that majority of the people sampled earn between #21,000 to ##30,000 monthly. Only 41% (41) of the total respondents earn over #50,000 monthly, and this is due to the nature of commercial activities they engage in to, as most of them are in to petty businesses. However, it was clearly understood that lack of capital, inadequate support from the part of government couple with poor economic and commercial policies discourages major investments which eventually affects income level and standard of living of most of the respondents in the study area.

4.6 THE EFFECTS OF ROAD TRANSPORT DEVELOPMENT ON COMMERCIAL ACTIVITIES IN GOMBE MEROPOLIS

Table 4.6: presents the type of commercial activities that the respondents engage in. It shows that 58% (160) engage in retail services, 11% (32) are in to whole sale services, and 4% (12) of the respondent are in to the distribution of goods and services. Furthermore,

23% (64) engage in professional services (barbing saloon, carpenter, suya joints, GSM repairs etc.), while, only 4% (12) indicated others as the types of commercial activity they practice. This indicates that majority of the respondents engage in retail services and 23% of them participate in professional services. This can be attributed to the kind of commercial activities that people engage in are mostly trading (buying and selling) in nature, commonly by using shops and tables as the flat form to carry out their businesses. Furthermore, the economic environment dictated the nature of the commercial activities to prevail in the study area. This is the more reason why retail services account for more percent than the whole sale services and distributors. Another reason is that Gombe metropolis is a consumption city and not production city. In other words it is a commercial centre where by goods are brought to market for sell.

Table 4.6: Types of Commercial Activity Engage by the Respondents

Type of Commercial Activity	Frequency	Percentage
Retail Service	160	58
Whole Sale	32	11
Distributor	12	4
Professional Service	64	23
Others	12	4
Total	280	100

Source: Field Survey, 2015

Fig. 4.6 presents the distribution of the respondents based on the number of years spent at the location of their business. It shows that 25% (70) of the respondents spent 1-4 years at the location they are running the business, 37% (104) have been in that location for 5-10 years, 16% (46) have been in the location for the past 11-14 years, 14% (40) were there for the past 15-20 years and only 4% (20) have been in the location for over 20 years. This indicate that majority of the respondents have been practicing business at different

locations before most of the roads were either constructed or renovated. As such they provided the information needed for the research.

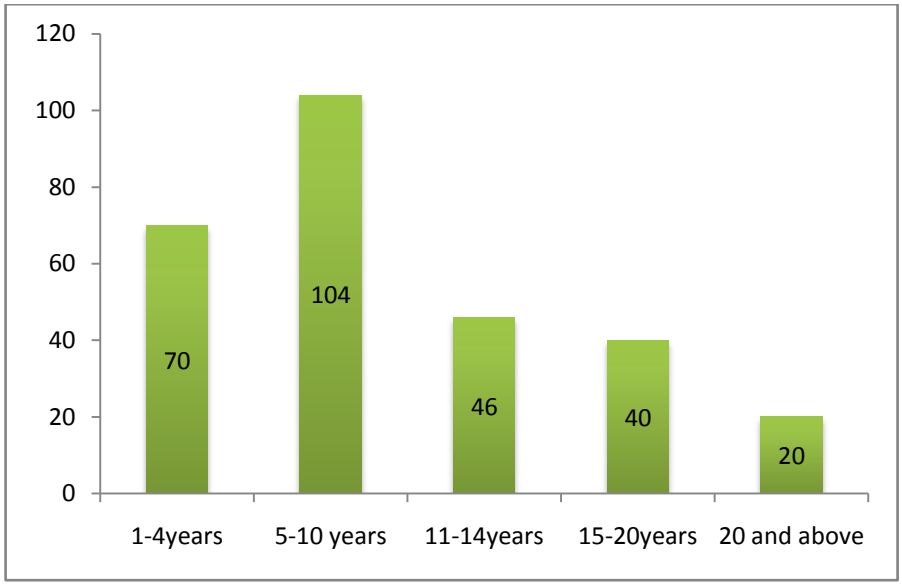


Fig. 4.6: Distribution of Respondents Based on the Number of Years Spent at their Location
Source: Author's Analysis, 2015

Table 4.7: Business Location of the Respondents before the Construction of Road

Business Location	Frequency	Percentage
The Same Location	189	68
Home	28	10
Other Places	63	22
Total	280	100

Source: Author's Computation, 2015

Table 4.7: shows that 68% (189) of the respondents have been practicing the business in the same location long before the state and most of the roads were created, 10% (28) of the respondents were doing the business in the local streets and shops at home before eventually relocating their business to the present location which is by major roads, while 22% (63) of the same respondents have been practicing business at different locations like old market, main market, new market, at round about, at junctions and other

streets as indicated on the questionnaire before relocating to the present location. This is mostly due to the fact that people access their business by locating along major road corridors than locating in places that are less accessible and areas or locations where competition is less and profit is maximized.

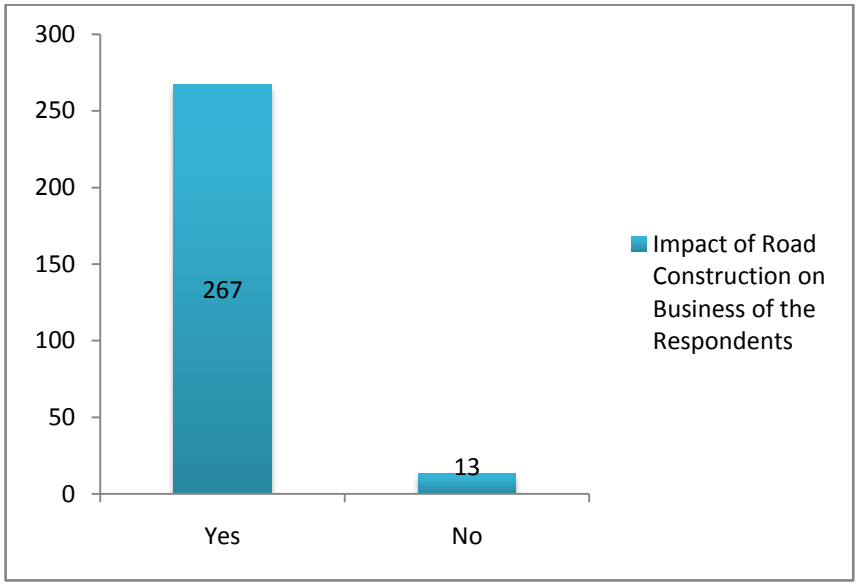


Fig. 4.7: Impact of Road Construction on Business of the Respondent
Source: Author's Analysis, 2015

Fig, 4.7: shows that 95% (267) of the respondents understands and accept the fact that constructing new roads has impacted on their businesses, while only 5% (13) says road construction had no impact on their commercial endeavors. This implies that construction of roads affects business positively and contributes to the development of different commercial activities anywhere in the world, particularly in the study area.

Table 4.8: Type of Impacts of Road Construction on the Business of the Respondents

Types of Impact	Frequency	Percentage
Positive Impact	260	93
Negative Impact	6	2
No Any Impact	14	5
Total	280	100

Source: Field Survey, 2015

Table 4.8: shows that 93% (260) of the respondents describe the type of impact road construction has on their business as positive, while 2% (6) says construction of road has negative impacts on their business. Only 5% (14) of them consider it to have no any impact at all. This implies that construction of roads does not only attract businesses to the road corridors but rather it influences businesses positively. This is because it allows them to have more customers after show casing their products, which reflects to increase or bring about more profit. These are some of the reasons why there is competition in renting and building of commercial outfits along most of the major road corridors in the study area.

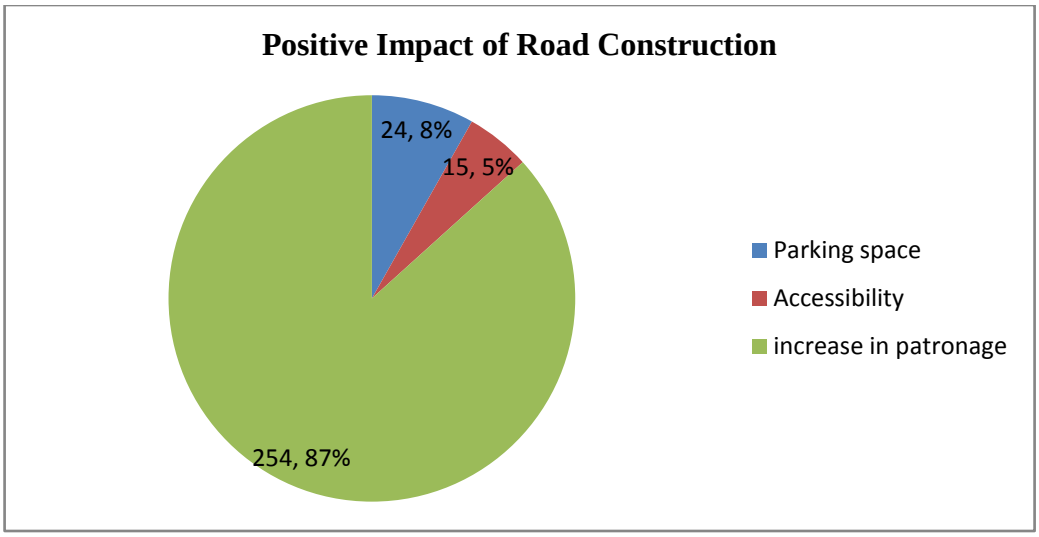


Fig. 4.8a: Positive Impacts of Road Construction
Source: Author's Analysis, 2015

Fig. 4.8a presents some of the positive impacts of road construction. It shows that 8% (24) of the respondents that identified road construction by the Government as a catalyst for economic and commercial activities development highlighted parking spacing as one of the positive effects, 5% (15) consider it to be accessibility, while, majority of the respondents indicated it as the increase in patronage with 87% (254) as the major indicator of the positive effects of road construction.

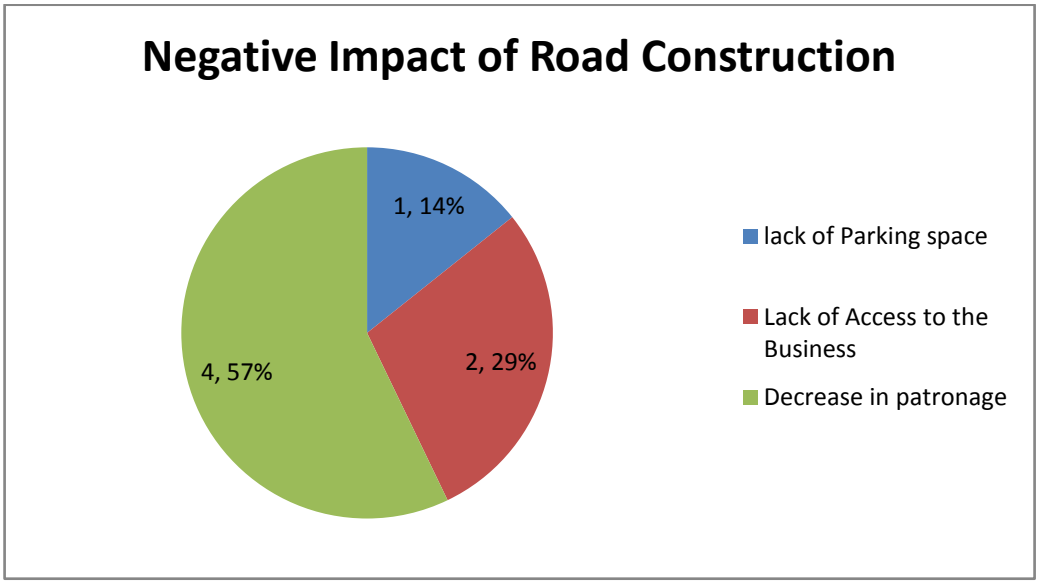


Fig. 4.8b: Negative Impacts of Road Construction
Source: Author's Analysis, 2015

Fig. 4.8b highlighted the negative impacts of road construction as identified by the respondent that considered it to have negative impacts. It shows that 14% (1) of the respondents identified lack of parking space as the one of the negative impacts of road construction. This is one of the major characteristics of the roads. Parking space is not always taking in to consideration when constructing roads. 29% (2) pointed out lack of access to the business as the negative impact, while 57% (4) of the respondents identified decrease in patronage as the major negative impact of road construction.

Table 4.9: Changes Experienced in the Level of Patronage as a Result of Road Construction

Changes in Patronage	Frequency	Percentage
Yes	272	97
No	8	3
Total	280	100

Source: Field Survey, 2015

Table 4.9: presents changes experienced in the level of patronage resulted from road construction. It shows that 97% (272) of the total respondents experiences changes in the level of patronage due to construction of road, while, only 3% (8) have not experience any changes in patronage resulted from road construction. It implies that road construction bring about increase in the level of patronage which eventually reflects in to increase in profits and expansion of the businesses. While most of those that says No, indicated their reasons as: the business started after the road was constructed, others have feelings that due to construction of roads people boycott to other more accessible arteries. It even goes by the saying, “more roads, less money”.

Table 4.10: Benefits of Locating Business along Major Road Corridors

Business Benefit	Frequency	Percentage
Yes	272	98
No	8	2
Total	280	100

Source: Field Survey, 2015

Table 4.10 also show that 98% (272) of the respondents benefits by locating their business along major road corridors. Only 2% (8) who says no benefit at all. This implies that locating along major roads bring about benefits to the business. Some of the benefits include: security, free competition environment, accessibility, increase in profits, increase in patronage etc.

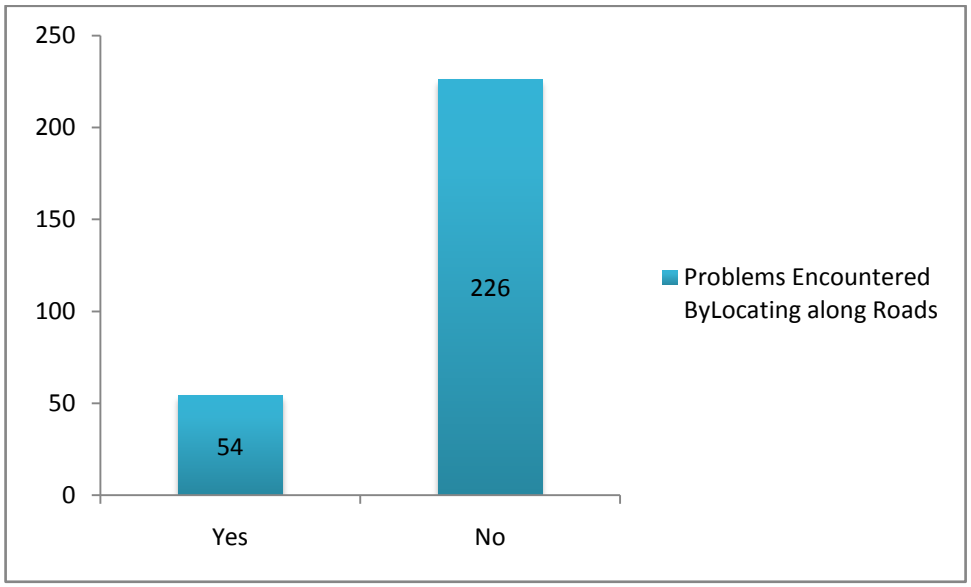


Fig. 4.9: Problems Encountered by Locating Along Road Corridors
Source: Author's Analysis, 2015

Fig. 4.9: shows that 19% (54) of the respondents says to have experienced problems by locating along roads, while up to 81% (226) of the respondents says they have never experience any problems by locating their businesses along major roads. This indicates that people practicing commercial activities rarely witness problems by locating along roads in

Gombe metropolis. This is due to the measures put in place by security agencies especially the Police to curtail any form of crime within the metropolis and along the major roads in particular. Federal Road Safety Commission (FRSC) are also ensuring that the rate of accidents reduced, Fire Service agents are also doing their best to educate the people practicing businesses on the risk and dangers of fire out break to their businesses. Environmental sanitation agencies are doing their best as well by keeping the roads clean and comfortable for the users.

Table 4.11: Problems Encountered by Locating along Roads (Yes Response)

Problems Encountered	Frequency	Percentage
Armed Robbery	4	7
Road Accident	14	24
Noise Pollution	33	57
Air Pollution	2	3
Poor Sanitation	5	9
Others	0	0
Total	58	100

Source: Field Survey, 2015

Table 4.11 shows that 7% (4) of the respondents identified armed robbery as the problem encountered by locating along roads, 24% (14) identified road accidents, 57% (33) pointed out noise pollution, 3% (2) says it is air pollution, 9% (5) described it as poor sanitation along major roads. Therefore, majority of the respondents identified noise pollution and road accidents as the major problems encountered by locating a commercial outfit along roads in Gombe metropolis.

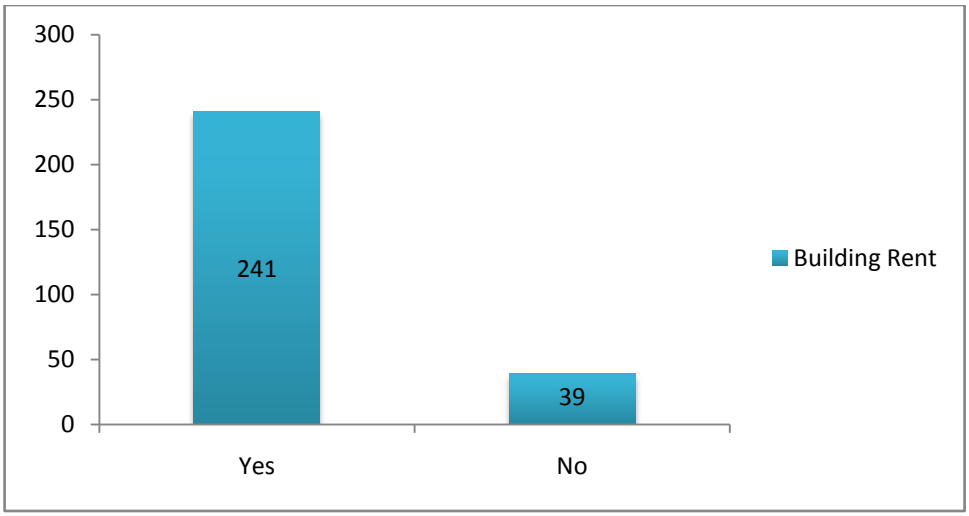


Fig. 4.10: Building Rent Responses
Source: Author's Analysis, 2015

Fig. 4.10: presents the responses of the people sampled on whether the facilities they are using belong to them or they are renting. It shows that 86% (241) of the respondents rent the facility they are using. While, only 14% (39) that owns the building or facility they are using for commercial purposes. This is due to the fact that most of the people practicing commercial activities engage in trading (retail services) and professional services as such cannot afford to build shops. That makes them go for renting of the building and other facilities for business and other commercial purposes.

Table 4.12: Cost of Renting the Building for Business

Cost of Renting	Frequency	Percentage
#1000 - #100,000	131	54
#101,000 - #200,000	80	33
#201,000 - #300,000	20	9
#301,000 - #400,000	6	2
#401,000 - #500,000	2	1
Not Available	2	1
Total	241	100

Source: Field Survey, 2015

Table 4.12 shows that 54% (131) of the respondents pay between #1000 to #100,000 for using the building or facility, 33% (80) of them pay between #101,000 to #200,000 for renting, 9% (20) of the respondents pay between #201,000 to #300,000 for renting, 2% (6) pay more than #300,000 to #400,000 for the use of the building or facility for commercial purpose. While, only 1% (2) of the total respondent that pay for the rent for the use of the building for commercial function pay between #400,000 to over #500,000 per year. However, 1% (2) of the respondents declined to disclose how much they pay for the cost of renting. This implies that more than half of the respondents pay between #1000 to #100,000 yearly for using the building for commercial purpose. The table further revealed that very few people pay for the expensive facilities for their businesses. Some of these include: commercial banks, whole sales, car dealers, suya joints among others. But many of them can afford to go for moderate buildings that the cost is believed to be fair or average.

Table 4.13: Perception on the Cost of Renting the Building

Perception	Frequency	Percentage
Fair	30	12
Average	48	20
High	117	49
Too High	46	19
Total	241	100

Source: Field Survey, 2015

Table 4.13 presents the perception of the respondents on the cost of renting the building. It shows that 12% (30) of the respondents perceived the cost for renting the building for commercial use to be fair, 20% (48) indicated the cost to average. While 49% (117) of the respondents perceived the cost to be high, only 19% (46) of them considered it to be too high. This means that majority of the respondents considered the cost of renting

to be as either high or too high. This is of course due to many reasons such as: lack of access to the owners of the buildings which give chance for the middle men to escalate the price, inadequate capital, competition etc.

Table 4.14: Causes of High or Too High Cost of Renting the Facility for Business

Causes	Frequency	Percentage
Road Construction	90	55
Nature of Building	7	4
Location	64	40
Others	2	1
Total	163	100

Source: Field Survey, 2015

Table 4.14 shows that 55% (90) of the respondents identified road construction as the major reason for the high cost renting the building or facility for commercial use, 4% (7) suggested that high or too high cost of renting is due the nature of the building itself. This in most cases determines how much you pay irrespective of the location, while up to 40% (64) of the respondents reported location of the building as the major cause of the high or too high cost of renting for commercial purposes. Places like: CBD, commercial areas, major road corridors and other strategic locations such as: close to hospitals, schools, praying grounds, stadiums etc. tend to have high cost of renting. This can be attributed to the value of the lands in which these buildings or facilities are located. However, according to the respondents, road construction remains the major factor that led to the high cost of renting in the study area. This is because in most of the streets where roads are constructed or renovated cost of renting the building for commercial use immediately double or increase to about 90% the following year.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY OF THE FINDINGS

The study was on the effects of road transport development on urban growth and commercial activities in Gombe Metropolis. As such, the findings of this research were summarized in this section. Based on the results of road network development presented in the study, beta index revealed that there is an increase in the number of roads leading to each node from 1.61 in 1996 to 1.70 in 2005 and 1.80 in 2014 respectively. Alpha was 31.3% in 1996 but increases to 35.3% in 2005 and 38.9% 2014. Gamma index further revealed an increase in road network connectivity over the period of time under study. The result shows that road connectivity witnessed an increased from 56.9% in 1996 to 57.9% and 60.0% in 2005 and 2014 respectively.

The classifications of multi-temporal satellite images in to built-up and non-built up areas for the periods under consideration i.e. 1996, 2005 and 2014 has resulted in a highly simplified and abstracted representation. The result revealed that the total built up area has grown from 809.28 hectare (8.29Km^2) in 1996 to 1,655.05 hectare (16.55Km^2) in 2005 and to 3,689.01hectare (36.89Km^2) in 2014. The classified images indicated a sharp pattern of increased urban growth prolonging both from urban centre to adjoining non-built up areas along major transportation corridors. Post classification comparison of the classified images revealed the growth pattern of the city in different directions, the infilling of the open spaces between already built up areas and the dynamics of urban expansion. Rapid urban growth process in the study area has been revealed by the continuous rise of the number of patches in the landscape throughout the study periods. It is further described to

be an indication of the heterogeneous and fragmented urban growth process taking place over time.

Paired T-test was used in testing the hypothesis. The result shows that the significant 2-tailed or P-value result is 0.024. Note that, it is considered to be significant if the P-Value is less than 0.05. The P-value is 0.024. Since the P-value is less than 0.05, the $H_0$is rejected and therefore, concluded that there is a significant relationship between road transport development and urban growth in the study area.

Finally, results for the opinion of respondents on the effects of road transport development on commercial activities suggested that 95% of the respondents indicatedthat road construction influence businesses and other commercial activities positively and resulted to increase in profit and rental charges for commercial properties along major road corridors.

5.2 CONCLUSION

The study allows the following conclusions to be drawn:The results of the computation of gamma, beta, and alpha indices indicated that there is a significant increase in road connectivity in Gombe metropolis from 1996 through the 2005 to 2014. In this study, it has been possible to successfully capture the changing pattern of urban growth. The study revealed thatGombe metropolis has been experiencing fragmented urban growth process, particularly at the fringe areas with substantial increase in built-up area, while the city centre underwent relatively compact growth by infilling open spaces and edge expansion over time. In other word, the spatio-temporal analysis of the urban growth revealed that Gombe metropolis is experiencing infill and edge expansion around the urban core mainly during the second period (1996 to 2005) and continue to the third period (2005 to 2014).

Furthermore, Paired T-test computations also revealed that urban growth determined the development of road network in the study area. Although, road network development has correlation to urban growth in Gombe, it may not be the sole determinant of the urban growth because other factors like: migration, personal increase in income, the desire to own personal home and loan scheme from banks are also contributors. Finally, it was also discovered that road transport development brought about improvement in commercial activitiescoupled with increase in profit. Access to major roads provides relative advantages consequent upon which commercial users locate to enjoy the advantages. Good road projects clearly contributed to poverty reduction by improving the living conditions of people and by augmenting the opportunities available for trade and employment.

5.3 RECOMMENDATIONS

The following recommendations are made based on the researcher's findings to point the way forward on the part of road transport development, urban growth process and commercial activities in the study area.

i. The study discovered the importance of road transport infrastructure to the improvement of commercial activities in the study area. It is therefore, recommended that more roads should be constructed, renovated and dualyze in order to improve and diversify the commercial nature of Gombe metropolis.

ii. It was also discovered that urban roads are given more priority in Gombe State. It is also recommended that rural roads should be improved to harness the economic potentials in the state at large.

iii. The study has tried to analyze one of the indicators of road transport development in the study area, which is connectivity indicator. As such further research can explore the rest of the critical indicators such as: accessibility, road density, etc. Other areas to pay attention to in the future include: effects of roadtransport cost, travel distance, travel time savings on commercial activities in the study area. This would go a long way in understanding the important nexus that exist between road transport and commercial activities in most of the cities of the developing world.

iv. Owing to the spatial extent of the metropolitan area, it is imperative to look at driving forces of urban growth at disaggregate spatial scale including more variables such as socio-economic and demographic variables. This could reveal detail causal factors of urban growth at local level.

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Appendix I

DEPARTMENT OF GEOGRAPHY

FACULTY OF SCIENCE

AHMADU BELLO UNIVERSITY, ZARIA

This questionnaire is designed as part of a research work to obtain information on the "**Effects of road transport development on urban growth and commercial activities in Gombe, Gombe state**". The information obtained is purely for academic purpose, as such will be treated as confidential. Kindly tick the appropriate answer or make the necessary statement, where appropriate.

Thank you.

1. Gender (a) Male ( ) (b) Female ( )
2. Age(a) 0-14 years ( ) (b) 15-29 years ( ) (c) 30-44 years ( ) (d) 45-59 years ( )(e) 60 years and above ( )
3. Marital status (a) single ( ) (b) married ( ) (c) divorce ( ) (d) widow ( )
4. Level of education (a) primary education ( ) (b) secondary education ( ) (c) tertiary education ( ) (state type…….) (d) Qur'anic education ( ) (e) no formal education ( ) (f)others (specify)…….
5. Occupation (a) civil servant ( ) (b) farming ( ) (c) trading ( ) (d) others (specify)……
6. Monthly Income (a) #10,000 – #20,000 ( ) (b) #20,000 - #30,000 ( ) (c) #30,000 - #40,000 ( ) (d) #40,000 - #50,000 ( ) (e) #50,000 and above ( )

7. What type of commercial activity do you engage in? (a) retail services ( ) (b) whole sale ( ) (c) Distributor ( ) (d) professional services ( ) (e) others (specify)……...
8. When did you start business here……..?
9. Before the construction of road where were you doing your business…….?
10. Does road construction has any impact on your business (a) Yes ( ) (b) No ( )
11. What type of impact does it have? (a) Positive impact: parking space ( ), accessibility ( ), increase patronage ( ), others (specify……) (b) negative impact: decrease in patronage ( ), lack of parking space ( ), lack of access to the business ( ), others (specify……..) (c) No any impact ( )
12. Do you experience any changes in the level of patronage as a result of road construction (a) Yes ( ) (b) No ( )
13. If Yes (specify why)…….. and if No (state your reason)……
14. Does your business benefit by locating along major road corridors (a) Yes ( ) (b) No ( )
15. Do you encounter any problem by locating along roads (a) Yes ( ) (b) No ( )
16. If yes, what type of problem do you experience by locating your business along roads? (a) Armed Robbery ( ) (b) road accidents ( ) (c) noise pollution ( ) (d) air pollution ( ) (e) poor sanitation along the roads ( ) (f) others (specify)……....
17. Do you rent the building you are using (a) Yes ( ) (b) No ( )
18. If yes, how much do you pay for the rent……?
19. How do you perceive the cost of renting? (a) fair ( ) (b) average ( ) (c) high ( ) (d) too high ()
20. If high or too high, what do you think is the cause (a) road construction ( ) (b) nature of the building ( ) (c) location ( ) (d) others (specify)……

AppendixII

Appendix ii.1 Computation of Road Network Connectivity in Gombe Metropolis over three time period

Beta, Gamma and alpha were all calculated to show the development in road network in Gombe metropolis, Gombe state.

Table4.1 Numbers of Road Edges and Vertices in Gombe Metropolis (1996,2005and 2014)

Periods	No. of Nodes (vertices)	No. of Links (Edges)
1996	**36**	**58**
2005	**86**	**146**
2014	**122**	**216**

Source: author's computation (2015)

The Beta Index(1996) Beta index: $\beta = \frac{e}{v}$ …… (1)

Where: β = Beta

e = No. of Edges

v = No. of Vertices

Therefore,

$$\beta = \frac{58}{36}$$

= **1.61**

The Gamma Index (1996) **Gamma index** $\gamma = \frac{e}{3(v-2)} \times \frac{100}{1}$ …… (2)

$$= \frac{58}{3(36-2)} \times 100$$

$$= \frac{58}{102} \times 100$$

= **56.9%**

The Alpha Index(1996) **Alpha index** $\alpha = \frac{e-v+1}{2v-5} \times \frac{100}{1}$ ..... (3)

$= \frac{58-36+1}{2 \times 36-5} \times 100$

$= \frac{58-37}{72-5} \times 100$

$= \frac{21}{67} \times 100$

$=$ **31.3%**

Note; that the above calculation of beta, gamma and alpha indices in (1996) shows that there were about 1.61 roads leading to each node according to Beta Index. While the Gamma and Alpha indices both indicated a connectivity ratio of 56.9% and 31.3% respectively.

The Beta Index(2005) Beta index $\beta = \frac{e}{v}$ ..... (1)

$\beta = \frac{146}{86}$

$=$ **1.70**

The Gamma Index(2005) **Gamma index** $\gamma = \frac{e}{3(v-2)} \times \frac{100}{1}$ ..... (2)

$= \frac{146}{3(86-2)} \times \frac{100}{1}$

$= \frac{146}{252} \times 100$

$=$ **57.9%**

The Alpha Index (2005) **Alpha index** $\alpha = \frac{e-v+1}{2v-5} \times \frac{100}{1}$ ..... (3)

$= \frac{146-86+1}{2 \times 86-5} \times \frac{100}{1}$

$= \frac{146-87}{172-5} \times 100$

$= \frac{59}{167} \times 100$

= **35.3%**

The Beta Index(2014) **Beta index** $\beta = \frac{e}{v}$ …… (1)

$\beta = \frac{216}{122}$

= **1.80**

The Gamma Index(2014) **Gamma index** $\gamma = \frac{e}{3(v-2)} \times \frac{100}{1}$ …… (2)

$= \frac{216}{3(122-2)} \times \frac{100}{1}$

$= \frac{216}{360} \times 100$

= **60.0%**

The Alpha Index (2014) **Alpha index;** $\alpha = \frac{e-v+1}{2v-5} \times \frac{100}{1}$ ..... (3)

$= \frac{216-122+1}{2 \times 122-5} \times \frac{100}{1}$

$= \frac{216-123}{244-5} \times 100$

$= \frac{93}{239} \times 100$

= **38.9%**

The above measure of connectivity has so far attempted to establish the degree of changes in connectivity of road network in Gombe Metropolis. The result of the above computation of gamma, beta, and alpha indices indicated that there is a significant increase in road connectivity in Gombe metropolis from 1996 through the 2005 to 2014. The beta index revealed that there is increase in the number of roads leading to each node from 1.61 in 1996 to 1.70 in 2005 and 1.80 in 2014 respectively. Alpha was 31.3% in 1996 but increases to 35.3% in 2005 and 38.9% 2014. Gamma index further revealed an increase in

road connectivity over the last two decades. The result shows that road connectivity witness an increased from 56.9% in 1996 to 57.9% and 60.0% in 2005 and 2014 respectively.

Appendix ii.2 T-Test

Table Ap.2 Samples for Hypothesis Test

S/N	Year	Road Network Km	Urban Size (Built Up Area)
1	**1996**	**72.045km**	**8.29km^2**
2	**2005**	**106.118km**	**16.55km^2**
3	**2014**	**149.090km**	**36.89km^2**

Source: Author's Computation, 2015

T-TEST PAIRS =Road Network with Urban Size (Paired) /CRITERIA=CI (.9500) /MISSING=ANALYSIS.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Road Network	1.09084E2	3	38.608061	22.290374
	Urban Size	2.05767E1	3	14.719053	8.498049

Source: SPSS Computation, 2015

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Road Network & Urban Size	3	.985	.110

Source: SPSS Computation, 2015

Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Road Network - Urban Size	8.850767E1	24.239900	13.994913	28.292418	148.722916	6.324	2	.024

Source: SPSS Computation, 2015

Paired T-Test Results Interpretation

SPSS software was used in testing this hypothesis using Paired T-Test. The result shows that the "**t**" value is 6.324 while the significant 2-tailed result is 0.024. H_0 is accepted if the P-Value is greater than 0.05. Since the P-value 0.024 is less than 0.05 it implies that there is a significant relationship between road transport development and urban growth in the study. As such the H_0 was rejected. The result of the SPSS computations also revealed that urban growth or expansion always determines the development of road network in the study area. The results further revealed that the paired samples of corrections (0.985) indicated a very strong relationship between urban growth and road network development. Correlation result is believed to be strong or very strong when it is 1 or close to one. But when it is zero (0), it is always considered to be weak and the relationship between the samples under test is eventually described as weak.