SPATIAL ANALYSIS OF HEALTH CARE FACILITIES IN SOBA LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA

BY

Zailani, SHEHU

P14SCGS8204

A DISSERTATION SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES AHMADU BELLO UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN

REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT, FACULTY OF PHYSICAL SCIENCES,

AHMADU BELLO UNIVERSITY,

ZARIA, NIGERIA

AUGUST, 2020

DECLARATION

I hereby declare that this research dissertation titled SPATIAL ANALYSIS OF HEALTH CARE FACILITIES IN SOBA LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA is the ultimate result of my effort in the Department of Geography and Environmental Management, Ahmadu Bello University, Zaria under the supervision of Professor E. O Iguisi and Professor S. A.Yelwa. All secondary information have been duly acknowledged by way of references.

_____ ----------
_____

ZAILANI ShehuSign Date

CERTIFICATION

This research dissertation entitled Spatial Analysis of Health Care Facilities in Soba Local Government Area of Kaduna State, Nigeria meet the requirement governing the award of Masters of Science degree in Remote Sensing and Geographic Information System of the Ahmadu Bello University Zaria, and is approved for its contribution to knowledge and literacy presentation

---------- ---------- ----------
Prof. E. O. Eguisi Sign Date
Chairman supervisory Committee

---------- ----------
Prof S. A. Yelwa Sign Date
Member Supervisory Committee

---------- ---------- ----------
Dr.Shehu AbbasSignDate
Head of Geography Department

---------- ---------- ----------
Prof SaniA AbdullahiSignDate
Dean, School of Post Graduate Studies

DEDICATION

I dedicate this project to my parent.

ACKNOWLEDGEMENT

Alhamdulillah RabbilAlamin. All praise be to Almighty Allah for giving me the opportunity to carry out this research work successfully.

My profound gratitude goes to my supervisors, Prof. E.O. Iguisi and Prof. S.A. Yelwa for their encouragement, contribution and time throughout the period of this research work.

My sincere appreciation to the staff of Geography Department and Environmental Management, A.B.U Zaria especially Dr. A. K. Usman Dr I. Mukhtar, Dr.M.Isma'il, Dr R. O. Yusuf, Dr S. Abbas, Dr (mrs) Arigbede, Mal Ahmad Hamza Abdullahi, malam Hassan Muazu for their tremendous contribution towards the success of this study

My special appreciation goes to my late father, MallamZailaniIsahand my mother HajiyaHannatu Muhammad. My gratitude goes to my affectionate and beloved wife, SafiyaYakubu for her support and encouragement. I remain grateful to my beloved brother, Barrister BuhariZailani for his maximum support. I want to appreciate my brothers, sisters, friends and the entire family of MallamZailaniIsah for their prayers, support and best wishes towards the success of this work.

Appreciation also to my colleagues Dr (mrs) Bello, Dr Adedokun, Dr U. S. Bambale, Dr. Y B Akut, Gaddafi Adamu, SalamatuSulaiman, Yunusa Musa, AlhajiShehuIya, Mr Wale Arigbede, Imrana Hari, Saad Abubakar Zailani and others too numerous to mention for their support. Thank you all.

ABSTRACT

Primary health care is considered to be one of the most important aspects of the health care system in any country, which directly helps in improving the health of the population. Potential spatial accessibility is a very important component of the primary health care system. The aim of the research is to analyse the spatial distribution of health care facilities in Soba local government area of Kaduna state, Nigeria. The coordinates of the health care facilities were obtained using the handheld GPS. In determining the accessibility of the health care facilities, random points were generated to represent the centroid of the wards within the wards boundary, and the average distance taken (travel time from each ward to each healthcare facility (HCF) along the road network) were calculated using the network analyst functionality in ArcGIS 10.3. This involves the use of Origin Destination (OD) Matrix analyst tool. The distance between every ward geographic centroid and all the healthcare facilities were further structured into a geo-database to harness and determine the distance in kilometre from all the wards to the various healthcare facilities in Soba and determine the distances in accordance with the World Health Organization criteria. The result shows that the forty nine (49) health care facilities were randomly distributed across the study area and out of which, Turawa ward had the highest allocation with eight (8) that is about 16.33% followed by Kinkiba with seven (7) 14.29%, while Danwata ward hadthe least allocation with only one (1) healthcare facility that is (2.04%). Soba Ward have the highest population with 50,917 people but only had 5 HCFs while Turawa with 32,982 people have 8 HCFs. Danwata ward with population of 33,069 people which is higher than Turawa ward have only 1 functional HCF. From the result, it is clear that Turawa ward is well served with health facilities with a population ratio of 1:4,123. This could be attributed to fact that, Turawa is more centrally located than the other wards and also have road connectivity with the neighbouring ward. The equipment available in the health care facilities are mostly basic

diagnostic (blood pressure monitor, thermometer), break room appliances (refrigerators and freezers), body weight scale, protective equipment (hand gloves, eye wears and face marks), sharp containers, stainless steel equipment. It is therefore, recommended that, Government should speed up efforts in renovating, building and equipping more health facilities especially in largely rural districts where the availability of these facilities is either low or non-existent. In the short-term where the facilities are available but in poor condition, government can mobilize funds to renovate and equip these facilities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Health care is one of the most important services provided by the government in every country of the world. In both the developed and developing nations, a significant proportion of the nation's wealth is devoted to health. For example, the World Health Reports (2006) gave Nigerian government's expenditure on health as a percentage of the nation's Gross Domestic Product (GDP) for year 2001, 2002, and 2003 as 5.3 percent, 5 percent, and 4.7 percent respectively. This is to show the fact that Nigerian government health care expenditures are not only significant in absolute terms but also relative to the Gross Domestic Product.Health is a universal human right and focus of social and political concern worldwide (Ujoh&kwaghsende, 2014). The World Health Organization (WHO, 1978) defines health as "a state of complete physical, mental and social well-being". Such an ideal state may be desirable but is practically limited as some of humanity would be unhealthy at all times and in many cases without access to health services.

Hence, healthcare institutions are service-oriented establishments that provide medical care facilities comprising of observational, diagnostic, research and therapeutic and rehabilitative services to the public. Adequate and effective distribution of health care facilities contributes immensely to health care service provision and needs of the people (Ujoh&kwaghsende, 2014). According to Berman (1998), most sub-Saharan African countries have attempted to provide universal health services to the population through primary healthcare provisions. These developing countries are overwhelmed by emerging situation where the carrying capacity of existing public health systems declines in the face of

a growing need for essential/basic health care diminishing ability of governments to provide public resources for effective healthcare delivery (Amer, 2007)

The provision of adequate basic health services in developing countries is becoming increasingly difficult by the day. Rapid population growth, widespread poverty and lack of financial resources for the provision of health facilities/infrastructure are identified as the key factors responsible for the poor health care delivery systems in the developing world (Espagnet, 1989). The provision of central facilities now emphasis on social and spatial justice and focus has shifted from mere provision to the degree of accessibility of these facilities (Udoh, 2014).Accessibility to health care facilities can be describe as travel impedance (distance or time) between patient location and health care service points (Guagliardo, 2004). With regards to healthcare service utilization, accessibility is generally influenced by the spatial structures of healthcare service supply and demand, neither of which is distributed uniformly in space (WangLuo, 2005).

According to United Nation Population Fund Agency (UNFPA, 2010)a health care facility is any place where medicine is practiced regularly. The type of health care facilities ranges from primary, secondary to tertiary health care facilities. The primary health care level is made up of public health care facilities and clinics, dispensaries, private clinics and maternity facilities. The secondary care level consists of general, cottage and mission hospitals, while teaching and specialist hospitals exist at the tertiary level. These tiers, by design, are closely related to one another with the higher tier designed to assist the lower care levels by handling referral cases from the lower facilities. Responsibilities for health at the primary level reside with the local government while the Federal government has responsibility for policy formulation, monitoring and evaluation of the nation's health system. The states manage secondary facilities and provide logistic support for the local

government in form of personnel training, financial assistance, planning and operations (Federal Ministry of Health 2004).

Since the types of health care facilities ranges from simple to complex hospitals, primary health care facilities should be located within residential areas to provide easy access to residents of the communities due to the nature of services they provided to the peoples. In view of this, the United Nation recommends that the primary health care facilities should be located at not more than 4km distance from a target community. Secondary health care facilities like hospitals on the other hand should be located in urban and some few rural areas while tertiary facilities should be located in main towns or capital cities (WHO, 1997).

Access to health care can be defined in a variety of ways. In its most narrow sense, it refers to geographic availability. A far broader definition identifies four dimensions of access: availability, accessibility, affordability, and acceptability. Some define access as the opportunity to use health care; others draw no distinction between access and use. Limited access to healthcare poses a significant barrier to long-term social and economic development around the world. Currently, one-third of the world's population does not have access to essential medicines. In addition, with the global population projected to reach 9 billion by 2050 and with most of this growth in developing countries, ensuring broad access to medicine and healthcare is a critical issue (NITD, 2015).

In the health sector, much concern has been expressed pertaining to the pattern of distribution of heath care facilities and level of utilization. According to Inyang (1998), distributive equity in healthcare facilities indexes accessibility. In other words, the level of access to health care facilities is a function of the degree of fairness in spatial distribution of the facilities. According to Atser and Akpan(2009), inequality in facilities distribution is of crucial significance particularly in developing societies where there are dual problems of limited health facilities and low personal mobility. Accessibility in this context has spatial

theme and signifies the ease with which potential health care seekers get to the health facilities where health care services are delivered.Essentially, the challenge in many countries is to reach the whole population with adequate health care services and to ensure their utilization. Despite the health for all declaration by the WHO, healthcare services continue to be sub-standard or low in access, expensive and under-utilized (Akingbola, 2009).

1.2 Statement of the Research Problem

Urbanization in the third world countries generates a lot of problems especially difficulties in controlling urban growth and provision of amenities to meet the increasing needs and demands for essentials public services like housing, education and healthcare delivery (Adamu, 2001).

Geographical distribution of health care facilities is known to influence health service delivery. As population grows, accessibility to healthcare becomes an issue of concern. In Nigeria, much has been focused on providing the basic needs of the people as a strategy to reduce the level of poverty in the society and the concern for the spatial patterns of the basic facilities that affect the wellbeing of the people. This concern derived greater inspiration from the level of the United Nation through the setting of 2015 as a target period for achieving the Millennium Development Goals (MDGs) (WHO, 2000).

According to Nuhu and Ezikiel (2004), it is in recognition of the importance of healthcare facilities to sustainable development that various levels of government in Nigeria budget huge amount of money for the health sector. Despite this financial commitment to health sector, many citizens are still being denied easy access to good healthcare services mainly as a results of the inability of the government to respond as quickly as possible to increasing demands for healthcare facilities to match the rate of urbanization (Adetunji, 2013). The World Health Organization (WHO) has been using mapping techniques coupled with surveillance to monitor the global health situation and present it through user friendly

and modern tools such as Geographical Information Systems. Public health mapping utilizes the technology of Geographical Information Systems to add value to information for public health planning and decision making (David, 2011).

Several works had been carried out with respect to the health care accessibility. Brabyn and Skelly (2002) used cost path analysis to estimate the geographical accessibility of public hospitals in New Zealand. This analysis was applied to 38,000 census enumeration district centroids in New Zealand allowing geographical access to be linked to local populations. Average time and distance were calculated for local populations by modelling the total travel of a population if everybody visited the hospital once. The minimum travel time and distance to closest hospital via a roadnetwork was determined. The study showed that the northern and southern parts of New Zealand have average travel distance to hospital services.

Ajala, Lekan and Adeyinka (2005)analysed the accessibility of healthcare facilities in Osunstate. Abbas, Auta and Naiya (2012) investigated the spatial distribution of healthcare facilities in Chikun local government area of Kaduna, Nigeria using GIS. The study observed that there is high concentration of public healthcare facilities in Eastern part of Chikun and low concentration in southern part of the area with only 3 in other part of the study area. David (2011) assessed the spatial distribution of public healthcare facilities in Kaduna metropolis where he found that such facilities are evenly distributed within the metropolis

In planning for healthcare services at all levels of government in Nigeria, sectoral approaches are adopted without giving much concern or thought to the spatial dimensions of the facilities provided. This often brings about lop-sidedness in the spatial distribution of these facilities with one section experiencing over allocation while the other sections suffer lack of it (Lekan, 2010).

However, a lot of studies have examined the spatial distribution of healthcare facilities in different part of Nigeria using one or more GIS techniques, but none of these studies to the best of researchers knowledge has attempted to analyse the spatial analysis of healthcare facilities in Soba local government areas and no comprehensive information on spatial pattern of healthcare facilities is available in Soba Local Government Area of Kaduna state, hence the need of the study.

This study therefore seeks to answers the following research questions:

1. Where are the healthcare facilities in Soba Local Government area located?
2. What is the pattern of distribution of health facilities in Soba Local Government area?
3. How accessible are the healthcare facilities to the peoples of Soba Local Government area?
4. What are the equipmentavailable in healthcare facilities in Soba Local Government area?

1.3 Aim and Objectives of the Study

The aim of this study is to analyse the provision and distribution of healthcare facilities in Soba using remote sensing and GIS.

The stated aim were achieved through the following specific objectives

i. identify and map the healthcare facilities inSoba Local Government.
ii. examine the spatial pattern of the healthcare facilities in Soba LGA.
iii. determine the spatial accessibility of the healthcare facilities to the peoples ofSoba LGA.
iv. examine the availability of personnel and functionality of the equipment in healthcare facilities in Soba LGA.

1.4 Scope of the Study

The spatial scope of this research is Soba LGA located within Latitudes 11^0 04`00`` to $11^0$ 06`00``N and Longitudes $7^0$7`00``E to $7^0$42`00``E. This research employed the use of GIS and remote sensing techniques to identify and map public healthcare facilities, determine the spatial pattern and accessibilities of healthcare facilities for all registered public primary, secondary and tertiary healthcare facilities in the area as at 2016 and then compare minimum distances to various healthcare facilities from the wards based on WHO criteria.

1.5 Justification of the Study

Health is very important to the general wellbeing of man hence there is need for provision of adequate healthcare facilities by both public and private organizations at all levels.Abdulrahman (2011) noted that public policy and healthcare provision in Nigeria over the years addresses the distribution and spatial equity question mainly at regional level while neglecting the distribution of such facilities within towns and cities. As such, their provisions within towns and cities level are haphazardly distributed due to lack of tangible and reliable planning information.

However, despite the importance of these facilities to the people, analytical enquiries into the spatial distribution and accessibility of healthcare facilities in the areas have not been explored. This has consequently made policy on healthcare needs difficult.However, Assessment of physical access to health services is extremely important for planning. Complex methods that incorporate data inputs from road networks and transport system are used to assess physical access to healthcare in developed world. However, such data inputs hardly exist in many developing nations like Nigeria. Straight line distance between the services location and resident population are easily obtained but their relationship with driving distance and travel time is unclear. Moreover, Soba Local Government area faces with urban challenges such as high population growth, economic hardship, illiteracy, malnutrition, unsafe drinking water, as well as some form of environmental pollution. These

in turns encouraged high prevalence cases of child and adult diseases such as malaria, typhoid, diarrhoea, cholera, tuberculosis, cardio-vascular diseases and other respiratory diseases as well.This became pertinent to improve the present condition through the use of reliable data and information through integration of GIS to assess the spatial distribution pattern and accessibility level of healthcare facilities as well as the availability and functionality of the facilities withinSoba local government areas. The outcome of this research will enlighten the peoples about the location of healthcare facilities and the kind of services rendered as well as helping the government and other concern bodies in the health sector to plan, formulate and implement health policies and improved upon the services provided by the healthcare facilities to the residents of Soba local government areas.

CHAPTER TWO

CONCEPTUAL FRAMEWORK, THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

This chapter is basically segmented into three broad divisions detailing the study's conceptual and theoretical framework and review of relevant literatures. General concepts and theories presents relating to the spatial distribution of healthcare facilities were the concepts of spatial location, accessibility, pattern, healthcare facilities and GIS Central place and locations theories.

2.2 Conceptual Framework

2.2.1 Concept of spatial location

The term location is used to identify a point or an area on the earth's surface in which human activities take place. It generally implies a higher degree of certainty, which often indicates an entity with an ambiguous boundary, relyi333ng more on human or social attributes of place identity and sense of place than on geometry (Agnew, 2011). Examples of such entities includes: a house, a room, a factory, school and hospitals. Thus, each health care facilities in a street or a road has its own location but the arrangement of the health care facilities viewed in different scales inevitably form a distribution over space (Rushton, 1991).

However, Amer (2007) added that the spatial location of health care services in general concerns the identification of suitably locations for a given number of facilities in a

defined territory, in such a way that the health care needs a spatially dispersed population are in an optimal way.

2.2.2 Concept of spatial pattern

Spatial pattern refers to the organization and placement of people and objects in human world. It may mean the distances between them or the regularity of distribution among them. In other words, it refers to how resources, activities, human demographics or features of the landscape are arranged across the surface of the earth (Golledge, 1995). Spatial pattern can be derived from the primitive concept of location but are themselves not considered primitive (Golledge, 1995). In contrast, work by the French geographer Brunet (1980) considers a limited number of spatial patterns themselves (or, to be more precise, the processes that lead to specific spatial patterns) as being primitive to a language space. In the light of the latter, the analysis of spatial patterns becomes particularly intricate if we look not onlyat spatial patterns created by the location that entities have in space, but at the combination of spatial and attribute values.

Spatial analyses have also established a framework that allows for grounding the characterization of spatial patterns on the mathematically established principle of randomness. This is considered a pre-requisite to establish statistical significance, which is comparing observed patterns to a set of patterns that could be the result of a random process (complete spatial randomness/ independent random process) (O'Sullivan and Unwin, 2003). However, the problem of understanding randomness is a research topic in many disciplines, and this is rather astonishing, as the difficulty of understanding random spatial process is pronounced in case visual representations are involved: human tend to see patterns inmaps and readily interpret patterns ignoring the possibility that they might be the outcome of a chance process (O'Sullivan and Unwin, 2003).

Conclusively, facilities such as healthcare are often irregularly distributed, as such, it becomes necessary to try to understand the patterns of the facilities, since such unevenness affects the coexistence of people, given that "point" may be clumped or over-dispersed at multiple spatial scales (Chesson, 2000).

2.2.3 Concept of spatial accessibility

Literally access means availability of resources and the ability to reach and use them without constraints (Osotimehin, 2009). Webster (1993) define access as permission, liberty or the ability to enter, to approach or communicate with or pass to and from, freedom or ability to obtain or make of; ability or means to participate in, work in or gain insight or the ability to reach a desired need when and if available. Accessibility is an important feature where people have a need to reach destinations situated away from their residence. It can be the ability to go shopping, get to school, to reach jobs or hospitals etc (Oliver and Mossiales, 2004).Accessibility can also affect the quality of life for instance, being able to visit friends and family, go on vocations and tours etc (Guagliado, 2004). In terms of health care services, access means that healthcare facilities are unrestricted by spatial/physical, economic, social, organizational, or linguistic barriers (Osotimehin, 2009).

Spatial accessibility often referred to as geographic or physical accessibility is concerned with the relationship between population distribution and the supply of healthcare facilities, it thus has a strong underlying geographic components. Although it is intuitive that the level of public health of a population may be affected negatively by the distance to healthcare services, there remains limited quantitative information regarding this impact. Spatial access may be measured by modes of transportation, distance, travel time, and any other physical barrier than could keep the clients from receiving care (Guagliado, 2004).

Economic access refers to the affordability of products and services for clients. Social or Cultural access relate to services acceptability within the context of the clients cultural

values, beliefs, and attitudes. For example, family planning services may not be accepted if they are offered in a way that is inconsistent with the local culture. Organisational access refers to the extent to which services are conveniently organised for prospective clients, and encompasses issues such as clinic hours and appointment systems, waiting time, and the mode of service delivery.

Black, (2004) pointed that this concept identifies the different dimensions of patient to service provider relationships as it puts into consideration the concept of geographical and physical barriers to healthcare accessibility. Moreover, Adetunji (2010) noted that, accessibility is often quantified using the concept of cost of reaching the service where cost is defined in a number of ways such as distance, time or economic cost. If accessibility is measured by distance, then Euclidean distance is often used, but Dahlgren (2008) pointed that, Euclidean distance does not normally give a realistic value of the accessibility as in most cases, it is impossible to travel along a straight line between two points; therefore it is more common to measure distance along road network.

Thus, Osotimehin (2009) opined that physical accessibility largely depend on quantity and quality of connectivity which determines the travelling time, travelling distance, speed determined by the road and its surface condition, sinuosity, matter of choice for travelling as per road condition etc.

2.2.4 Concept of healthcare

Health has been defined by one of the most commonly used medical dictionaries. Stedman's (1995) as a state that is characterized by anatomical, physiological integrity; ability to perform personally valued family work and community roles; ability to deal with physical, biological, psychology and social stress; a feeling of wellbeing. The world health organization (WHO) defines health as a condition that exists when an individual or group is able to realize aspirations and safety needs to change or cope with the environment, (Dines

and Cribb, 1993) and defines health in its broader sense in 1946 as a state of complete physical, mental, mental and social wellbeing and not merely the absence of diseases or infirmity (WHO, 2006).

These definition to health confirms that the health is one of the important factors that plays an important role to human survival and thus must be given particular attention and managed at all times. Therefore, top priority must be given to location, distribution and accessibility to such facilities for society to improve. Healthcare is generally involves adequate provision of health treatments required by patient in need. Equal accessibility and distribution of healthcare facilities across the Nigeria has been the focus of Government over the years, putting in place policies and programmes to ensure these is achieved. The provision of these services to the populace could be hindered by a variety of factors (FMOH, 2009).

Penchansky and Thomas (1981) identified five independent dimensions of access to health services (affordability, acceptability, accommodation, availability and accessibility). Availability and accessibility, the two geographic dimensions of access are defined by John, et al (2000) as the adequacy of the supply of health care and the travel time to health care services respectively. Penchansky (1981) noted that, because geographic access is an important determinant of treatment seeking behaviour which can be potentially be affected by public policy, it is important for health services researchers to develop accurate measures of availability and accessibility.

2.2.5 Concept of health care facilities

Onokerhoraye (1999) define healthcare facilities as all units owned by public and private authorities as well as voluntary organizations and which provides health care services including hospitals, health and maternity facilities. In other words these are organizations or decision making units whose mission and resources are devoted to improving patient's health

through health intervention measures and services such as curative, preventive, protective and health promotion activities.

In many countries the system of health care delivery comprises a range of institutions which are classified on the basis of their specialization, sophistication and the level of care they can provide. Basically, in Nigeria, the National Health Policy represents the collective will of the government and people of this country to provide a comprehensive health care system. However, the policy describes the goals, structures and strategy and direction of the health care delivery system in Nigeria. It defines the roles and responsibilities of the three tiers of government without neglecting the non- governmental actors (FMOH, 2004).

Therefore, the system is decentralized into a three tiers of government i.e Federal State and Local government (FMOH, 2004). Concurrently, all the three tiers are involved to some extent in the healthcare delivery system. Therefore, three main levels were identified these are primary, secondary and tertiary health care systems (Adamu, 2001; Pavignani, 2007). The primary health care system comprises of those small health care facilities which are based in the community and are more accessible to patients and their families. They include dispensaries/health posts, health clinics and primary health facilities.

Thus, dispensaries and health post are the type of health institutions where minor treatments are giving to patients. Its establishment is to provide easy access to residents of a particular community therefore, be located within residential areas, so that minor cases of treatment which do not require the attention of a specialist medical personal could be immediately attended to. While health clinics provide first treatment to cases like diarrhoea, dehydration and so on. Whereas primary health care facilities provide a good complement of preventive and curative health care services including antenatal care services. In these type of institutions patients are admitted (Adamu, 2001; Pavignani, 2007; WHO, 1997).

Next is the secondary level care, more commonly called general hospitals, to which patients from wide surrounding area or district are referred when necessary by the primary care units for more serious diagnosis or treatment. Hospitals are usually located in urban areas and some few rural areas. Apart from out- patient components, they offer surgical and emergency services. In many cases, the out- patient component is quite large. It is however, note-worthy that hospitals are very expensive element in any health services delivery system as they are costly to build and equip and the money necessary to staff and run them can be enormous. Their annual running cost may be as much as about a third of the initial capital cost of constructing and equipping them (WHO,1997).

Finally, the large specialization teaching hospitals (tertiary), usually located in the main towns and often only in the capital cities. They are equipped with higher technology and mainly devoted to in patient care. This is usually large than the hospitals and has a greater emphasis on teaching, particularly of doctors (Adamu, 2001; Pavignani, 2007; WHO, 1997).

The National Health Policy has been formulated within the context of NEEDS and Millennium Development Goals. Underlying Principles and Values: the principles of social justice and equity and the ideals of freedom and opportunity that have been affirmed in the 1999 constitution of Federal Republic of Nigeria; health and access to quality and affordable health care is a human right in which primary health care shall remain the basic philosophy and strategy for national health development; to provide general health services of preventive, curative care; promote and rehabilitate nature to the population as the entry point of the health care system (Obionu, 2007).

However, this category of medical care was the key to attaining the goal of health for all people of Nigeria. It shall form an integral part both of the national health system, of which it's central function and main focus is the overall social and economic development of the community. As such, was developed to strengthened the system and this helped to

improve some of the health status indicators. Among other things, include routine immunization coverage increased and this led to reduction in infant and child mortality rates (Obionu, 2007).

2.2.6 Concept of Geographic Information System

The World Health Organization (2004), describes GIS as an excellent tools for analysing epidemiological data, revealing trends, dependencies and interrelationships that would be more difficult to discover using traditional tabular approach. Burroughs (2001) sees GIS as the science and technology related to the powerful set of tools for collecting, storing, and retrieving at will, transforming and displaying spatial data from the real world. A Geographic information system (GIS) is an organised collection of computer hardware and software, geographic and tabular data, and personnel and knowledge designed to capture, store, manipulate, update, analyse, and display spatial data Swain and Davies, (1978).

The use of geographic information system (GIS) as a major technology for map, storage, production and dissemination has been fully recognised. GIS and mapping are closely linked. Maps are digitized to become an integral part of geographic information system, and GIS technology produces maps with layers of spatial dimension and surveillance data that can be presented or visualised in ways, including in tables, graphs and maps. Maps incorporate two major types of data: thematic and spatial. They allow the full incorporation, online manipulations, classification and visualization of data (Ogunbodede, 2007).

Geographic information system (GIS) are designed to capture, edit, store, retrieve, process and disseminate spatial and attribute data which are to some predefined geographic/geodetic referencing systems. The superior data handling and data processing capabilities of GIS are responsible for the increasing adaptation of the system in varying field of application to real life phenomena which is widely growing and cuts across professional barriers. Almost all life phenomena that have spatial relationship can be conceived to benefit

from GIS functionalities (Ogunbodede, 2007). GIS provides a method by which geographically dependent data can be recorded, stored, analysed and displayed in an easily understandable visual format for better understanding and review (Chang, 2004). Burrough, (1998) defines GIS as a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from real world for particular set of purposes. The spatial modelling capacity offered by GIS has great potentials and has been used in different fields which includes; military, government, education, planning, housing, law enforcement, agriculture, health, etc.

Essentially, the application of GIS in this health care research could encompass Geo-database creation for relevant queries explore spatial pattern and the physical dimensions of access. Since health care decisions are strongly influenced by the type and quality of services available in the local area and the travel distance, time, cost and ease of travelling to reach those services. Therefore, mapping and visualization of health disparities and their relationship to the geographical location of health care services can allow for better resource allocations to contrasting and underserved populations (Parker and Campbell, 1998).

2.2.6.1 Modern trend in database design:Ryan and Ronald (2001) defined database as a collection of logical related data, designed to meet the information needs of an organization. It's a large repository of data used simultaneously by departments, institutions and even individual and group users. More, et'al., (2005) instead of disconnected files with redundant data, all data items are integrated with a minimum amount of duplication (Fiebig and Moerkotte, 2000). The objects that comprise a database include: Database schema (conceptual and physical models as well as application interface), Schema objects (that resides within a schema), tables, field and columns, records and rows, keys, relationships and data types (More et'al., 2005).

A spatial database system according to Ryan and Ronald (2001) is a database system that offers spatial data types in its data model and query language and supports spatial data types in its implementation, providing at least spatial indexing and spatial join methods. Brinkhoff, Kriegel and Schneider (1993), added that, spatial database system offers the underlying database technology for geographic information systems and other applications.

Ryan and Ronald (2001) added that, in various fields there is need to manage geometric, geographic, or spatial data, which means data related to the space. The space of interest can be for example the two dimensional abstraction of the surface of the earth that is, geographic space. Most prominent example is a man-made space like health care facilities. Hence according to Ryan and Ronald (2001), database design is the process of converting objects/models into tables and views, where model components such as entities and attributes are converted into tables and columns. They opined that, constraints are added to columns where necessary in order to enforce data and referential integrity, views of tables might be created in order to filter the data that a user sees, or to simplify the query process.

After the database itself is designed, an application for the end user must be designed because the user cannot be expected to fully understand the structure of the database (Becker and Guting, 1992). With a basic understanding of database and the different types of database environments, then a database that is best for a certain organisation is chosen, which could be either: Flat-file database model, Hierarchical database model, Network database model, Relational database model, Object oriented database model or Object relational database model (Ryan and Ronald, 2001).

The Flat-file database required data to be stored in readable files on the host operating system, with the hierarchical model, information was stored in tables using parent/child relationships, but with many limitations compared to later models, the network model improved on the hierarchical model in the area of parent/child relationships (Ryan and

Ronald, 2001). Relationships are easier to manage, and it's much easier to navigate to different tables within the database (Aref and Samet, 1991).

Nearly all problems with previous data models were solved with the development of the rational models (Ryan and Ronald, 2001). The relational model improved on parent and child table relationships and proved a way to reduce the amount of redundant data stored (Aref and Samet, 1991). The goal of object-oriented was to make data storage more compatible with object-oriented programming tools, which has yet to be refined (Aref and Samet, 1991). Finally, the object-relational model displayed an attempt to combine the concepts of object-oriented programming with the relational database, which also needs much improvement (Aref and Samet, 1991).

A general-purpose database management system (DBMS) on the other hand, is a software system designed to allow the definition, creation, querying, update and administration of databases (Abel, 1989 and More, et'al., 2005). Well-known DBMSs includes MySQL, PostgreSQL, SOLitem, Microsoft SQL Server, Microsoft Access, Oracle, Sybase, dBASE, FoxPro, and IBM D2 (More, et'al., 2005). A database is not generally portable across different DBMS, but different DBMSs can inter-operate by using standards such as SQL and ODBC or JDBC to allow a single application to work with more than one database (Fiebig and Moerkotte, 2000).Database and DBMSs can be categorized according to the database model(s) that they support (such as relational or XML), the types of computer they run on, the query language(s) used to access the database (such as SQL or XQuery), and their internal engineering, which affects performance, scalability, resilience and security (Fiebig and Moerkotte, 2000).

In the relational model, related records are linked together with a ''key''. The relational model also allowed the content of the database to evolve without constant rewriting of links and pointers (Becker and Guting, 1992). Brinkhoff, Kriegel and Schneider (1993)

added that, relational part comes from entities referencing other entities in what is known as one-to-many relationship, like a traditional hierarchical model, and many-to-many relationship, like a navigational (network) model. Thus, a relational model can express both hierarchical and navigational models, as well as its native tabular model, allowing for pure or combined modelling in terms of these three models, as the application requires (Ryan and Ronald, 2001).

For instance, a common use of a database system is to track information about healthcare infrastructures, their names, types, quality, capacity, various hospitals addresses where they are distributed at and so on. In the navigational approach all of these data would be placed in a single record, and unused items would simply not be placed in the database. In the relational approach, the data would be normalized into a name table, an address table and a quantity table. Records would be created in these optional tables only if the variables were actually provided (Ryan and Ronald, 2001 and Becker and Guting, 1992).

Structured Query Language, more commonly referred to as SQL, is the standard language used to issue commands to and communicate with a relational database (Becker and Guting, 1992). With SQL, one can easily enter data into the database, modify data, delete data, and retrieve data (Becker and Guting, 1992). SQL is a nonprocedural language, which means the user can tell the database what data to access, not necessarily what method should be used to access the data (Ryan and Ronald, 2001). SQL therefore, is a standard relational model language supported by all relational DBMS; it was one of the first commercial languages for the relational model (Aref and Samet, 1991).

Most organizations in developed countries today depend on databases for their business operations (Fiebig and Moerkotte, 2000). Databases are not only used to hold administrative information, but are often embedded within applications to hold more specialized data (Fiebig and Moerkotte, 2000; and Ryan and Ronald, 2001); for

exampleengineering data or economic models.Examples of database applications include computerised library systems, flight reservation system and computerised part inventory system (More, et al., 2005). The database application in this study was the distribution of HC facilities and their available equipment which could aid effective decision making processes.

2.2.6.2 ArcGIS neighbourhood and network statistic functionality:The importance of the identification of relevant spatial analysis tools and their links to GIS has been revealed and subsequently appears as a key issue in the research agendas (Masser, 1988). This GIS software packages such as ArcGIS which constitutes ArcMap, ArcCatelog, ArcInfo and ArcView has many functions and tools designed for healthcare studies. Among the other numerous tools include: neighbourhoodStatistics Functions and the Network Analyst Tool.

The Neighbourhood Statistics Functions, for instance, can be used as point data for the location of Health Care Facilities, for spatial demonstration of point-pattern. This method involved the exploring pattern in locational data by comparing graphically the observed distribution functions of event-to-event or random point-to-event nearest neighbour distances, either with each other or with those that may be theoretically expected from various hypothesized models, in particular that of spatial randomness (Upton, 1985).

2.3 Theoretical Framework

From the foregoing, it was observed that, spatial patterns of public facilities (like healthcare) could be recognized because of their arrangement; may be in a line or by a clustering of points. Essentially the application of GIS techniques is capable of analysing both the pattern and the physical dimension of access. However, several theories have been propounded to explain the relationship between spatial arrangement and access to services, among such include the Central Place Theory, and the Location Theory.

2.3.1 Central Place Theory (CPT)

The CPT, propounded by Christaller (1933), is an attempt to explain the spatial arrangement, size and number of settlements. Partly about the location and spacing of service centres or central places, where a service centre is a settlement that provides some kind of service for surrounding catchment area. An important issue here is the main objective of the spatial distribution of service facilities. From the welfare point of view, optimal distribution is largely determined by accessibility to services at the minimum aggregate travel cost. Such an optimal specification links the welfare problem closely with CPT (Mabogunje, 1971).

The main principles of the CPT that are relevant to this study are: the range of good, and the principle of least effort. The range of good refers to the average maximum distance people will travel to purchase goods and services. Different goods and services have different threshold range. While the principle of least effort on the other hand, indicates that people generally travel to the nearest location where a good or service is obtainable. Consumers therefore are guided by the principle of least effort in selecting where they obtain the goods or services they require (Christaller, 1933).

Relating these principles to the present study, healthcare facilities cannot just be located everywhere, even though they are public utilities. Resources cannot be wasted through duplicating similar projects in virtually every locality a single facility can suffice. In similar manner, a facility may be considered as service facility. It would therefore, have an identifiable catchment area. Consequently, hospitals of different grades would have different catchment area. The tertiary healthcare facilities normally have an extensive catchment area (WHO, 1997). Conversely, a village dispensary offers only a limited range of services, which are also offered by its counterparts in other villages. It therefore has small catchment areas which are guided by accessible recommended distance (WHO, 1997).

Likewise the principle of least effort is also relevant in this study, since people are more likely to patronize healthcare facilities close to them, due to higher cost of travelling to distant ones. This is true especially with remote areas, where low income and low level of education, may make other alternative sources of medical care, like traditional medicine being relatively cheaper and without the trouble of overcoming the frictional effect of distance (Onyemelukwe and Ariyo, 1996). Generally, in the CPT, movement is recognized by the frequent reference to distance and travel cost. And travel costs affect the range of good or service and the size of the complimentary region within which it is offered. The complimentary region is the tertiary in which the central place or service facility has competitive advantage because of the factor of distance (Morrill, 1970). Travel costs are therefore less for consumers within a facilities threshold than for those outside it. For this reason, demand decreases with increasing distance.This pattern of fall in demand reflects the effects of distance on movement in general and on the consumption of central goods and services in particular, and is associated with travel costs. Again ‘’these costs occur because of the friction component of space that can be overcome only by expending energy for travel. The effect of this friction component of space is to restrict travel distance in the interest of limiting travel costs (Bush and Gauthier, 1968). Ultimately, it is best to locate healthcare facilities in central places that possess a higher degree of convenience.

2.3.2 The Location Theory

In location theory, the spatial pattern of economic activities is explained mainly in terms of transport cost. Therefore, Rodrigue, J. P., Comtois, C., & Slack, B. (2016) remarked that the expenses and inconveniences of moving finished goods to distance customers and producing raw materials from distance sources induce producers to locate near their markets or their sources of raw materials. That is, industrialists tend to locate where aggregate transfer costs are at minimum. Thus, the location that is more likely to minimize travel costs for the

user population is those at strategic points in the transport (for people and consumers) rather than the transfer cost (of materials by the supplier) is more important in public facilities, which involves mainly the movement of people to points where services are located; in this study, patients to healthcare facilities.In the location of healthcare facilities, therefore the main objective is the maximization of social utility or the minimization of social costs for a given population. At the same time, all patients should have access to medical care. For this reason, the basic issues to note are that a non-monetary criterion is very important in the location of such public facilities. Efficient location from the user point of view is necessary if societal resources are not to be unduly wasted in overcoming distance. An efficient set of locations can save human effort and monetary resources that can be devoted to many other things (Abler, 1987).

2.4. Literature Review

A review of empirical studies concerning the pattern of the distribution of these facilities in Nigeria and some developed nations would show the present picture which would aid subsequent analysis and conclusions in the case study.

2.4.1 Accessibility to healthcare facilities

Kwaku (2008) discovered that uneven distribution of healthcare facilities and increasing distance of settlements to hospitals are the major cause of inaccessibility to healthcare facilities in Ajumako-Enyam-Essiam and Denkyira district in Central Ghana. As a result, most rural residents rely on the use of traditional medical practices, which have serious consequences on their health status. It is evident from the studies that the location of healthcare

facilities has a great impact on attendance by citizens. This suggests that for residents to enjoy the facilities it must be strategically located in such a way that it is accessible to them irrespective of their location within the city.

Musa and Abdulhameed (2012), explained how accessibility problems affect the level of utilization of the health facilities in Jigawa state, Nigeria. The result identified three types of rural settlements: those with PHCs and road connectivity, those with no PHCs but road connectivity and those with PHCs and no road connectivity. The findings further showed that the mean distances were 3.2 km, 5.7km and 10.5km respectfully for the three categories. Therefore, rural settlements with PHC and no road connectivity cover more distance to obtain health services. The findings also revealed that 12.2% of the respondents complained of non-availability of drugs, 10.3% complained of cost of transportation, 11.1% complained of distance, 11.4% complained of cost of services rendered, 11.7% complained about the long waiting hours of doctors and services and only 5.9% can afford the services rendered by the PHCs. Hence, accessibility problems have reduced the utilization of PHCs in Jigawa state, Nigeria.

Abdurrahman and Nurönnisa (2013) explored the use of GIS for modelling the spatial distribution and accessibility of healthcare delivery system in Yola. The findings revealed that there were 56 healthcare facilities in Yola, of which 64% were public and 36% were private. However, 71.43% of these healthcare facilities were located in the southern and western parts of Jimeta and Yola-Town, which had larger population sizes but a limited supply of healthcare facilities. Although 71.43% of the healthcare facilities were located in Jimeta, Yola-Town had a higher density of physicians. The findings further revealed that parts of the Rumde, Yelwa, Alkalawa, Luggere, Nassarawa and Doubeli wards in Jimeta and Mbamoi, Makama A and B, and Toungo wards in Yola-Town were the high density areas. These wards were generally high density residential areas, while the low population density areas comprised of medium and low

density residential areas. The spatial pattern of the Yola population indicated an increased density in the old city facilities and a decreased density in the southern and western areas of Jimeta and in the southern area of Yola-Town. This increasing population density in the old city facilities suggested that healthcare services demand in these areas were high relative to other parts of the city. The Buffer analysis revealed that some areas in Yola were located outside of the 1 kilometre municipal planning standard accessibility zones, especially in the western and northern parts of Jimeta. However, it was clear that the existing healthcare facilities served catchment areas that are larger than the standard size used. Based on the output, different parts of Yola were determined to have low healthcare accessibility.

Ruishan*et al.,* (2013) employed and enhanced two step floating catchment area method to study the spatial accessibility of health services to determine areas with physician shortages in Donghai County in rural China. The results shows that 69% of villages have access to lower potential spatial accessibility of health services than the average of Donghai County, and 79% of the village scores are lower than the average for Jiangsu Province. The potential spatial accessibility of health services diminishes greatly from the facility of the county to outlying areas using a smaller impedance coefficient leads to greater disparity among the villages. Hence, the spatial accessibility of health services is greater along highway in the county. The finding reveals that most of the villages are in underserved health services areas. An unequal distribution of health service resources and the reimbursement policies of the New Cooperative Medical Scheme have led to an edge effect regarding spatial accessibility to health services in Donghai County, whereby people living on the edge of the county have less access to health services. It was recommended that, comprehensivemeasures to alleviate the unequal spatial accessibility to health services in areas that are more remote and isolated should be considered.

Christopher and Fadare (2014) examined the accessibility of health facilitiesto the residents in Ibadan, Nigeria. The findings of the study revealed that majority (69.9%) of the residents patronized hospitals where general and specialized services are rendered. Also, more than 30% travelled 5km or less and others about 70% more than 5km for their medical needs. It took majority of the residents 2 hours and they paid an average of ₦356 ($2.23) per trip to health facilities. Furthermore, there was unequal distribution of the available 436 health facilities, with major ones situated in the modern areas of the city while the minor ones were concentrated in the older areas. This study concluded that residents have relatively low accessibility to health facilities.

2.4.2 Spatial pattern and accessibility of healthcare facilities

Michael, (2011) analysed the spatial pattern of health facilities in Lokoja, Kogi state of Nigeria. The study revealed that there were 24 health facilities in the study area, 20.8% of which were public health facilities owned by the government and the remaining 79.2% were privately owned. A cursory observation showed that most of the healthcare facilities were clustered within the north eastern and south western part of the city with non at the north western part of the town. The nearest neighbour analysis (NNA) determined the level of randomness and accessibility to these facilities, and an output of 0.99228 was found, an indication of weak randomness, because it exceeds the Z-score table value of -0.723417 which is an indicative of insignificant accessibility.

Ifeanyi*et al.*, (2012) used network analysis to measure accessibility of healthcare facilities in Enugu Urban Area. The result showed the spatial distribution of health institutions, closest facilities in case of emergency and route to those health institutions within Enugu urban Area. It was notice that most of the healthcare facilities were located within Enugu North LGA while Enugu East LGAs had fewer healthcare facilities. Areas deprived of healthcare facilities

were also identified as Emene andAmechi-Akwunanuw settlements where people had to travel several kilometres to access the facilities at the city facility. This is quite different from other settlements that had access within a distance of less than 500m. Various routes were also identified and the times taken to access some of these healthcare facilities were as well noted. The analysis generally showed the efficacy of GIS in determining accessibility of healthcare facilities.

Bindu and Janak (2013) used geospatial approach to assess and model the spatial accessibility of primary healthcare facilities in the tribal Talukas of the Vadodara District of Gujarat State of India. Findings show that, the locational pattern of the PHC in the study area is randomly dispersed as obtained by Average Nearest Neighbour analysis and all such PHCs are overburdened, serving large population as per the norms, where 8 PHCs were serving total population of more than 22,000 which goes up to 51,000. In terms of the time and distance, findings also convey that, the central and southern villages of the study area were relatively accessible as compared to the eastern and northern villages. The analysis suggest that the population of the study area can optimally be accommodated by allocating only a few new facility but emphasis has to be given to improving the connectivity especially in the inaccessible are which are rendered as dark zone on the basis of poor road connectivity.

Adetunji (2013) examined the spatial pattern and accessibility of urban population to health facilities in Ilesa south-western Nigeria. The findings revealed that health facilities in the area were unevenly distributed. Health trips in Ilesa were therefore skewed towards Zones with more health services. The result of the analysis of variance further showed the existence of significant variations in accessibility to health facility among the sampled population in the study area. It was recommended that, some of the public health facilities should be upgraded to the status of General hospitals given the growing nature of the town as the most important town in its region.

Furthermore, Umar (2016) employed both Network and neighbourhood GIS analyst tools to analyse the spatial distribution of PHC facilities in some selected LGAs of Kano south senatorial district, Kano state, Nigeria. OD (Origin Destination) matrix was created and the average nearest neighbourhood analysis was done. Results showed variation in the distribution of Primary Healthcare facilities visually and descriptively within the study area, with Sumaila having the highest percentage (36.03%), while Rano had the least (12.61%). However, the Neighborhood analysis revealed similar regularity in the spatial pattern of the facilities with less than 1% (0.01 significance level) likelihood that the pattern could be the result of random chance. Network analysis further showed that, most of the communities travels within the minimum of 4km WHO standard distance (Sumaila, (0.5-5.4km); Gaya, (1-3.8km); Ajingi, (0.5-5.1km); and Rano, (0.6-3.6km)) to access some of the nearest facilities. However, the distribution of the facilities with respect to population based on WHO criteria, shows a shortfall of 411 Health posts, 32 Health Clinics and 6 Primary Health Facilities), where the existing coverage offers one facility to 8,833 people. Therefore, it was recommended that, more facilities should be provided with respect to population sizes within the senatorial district.

Ayuba and Wash (2016) identified and mapped health facilities in Bukuru Town, Plateau State Nigeria. The result showed that there were 21 healthcare facilities of which only one (1) attained the tertiary level, one (1) comprehensive health facility, four (4) PHCs while others were at health facility level. This was further revealed that only two (2) of the healthcare facilities in the study area were owned by government while the remaining nineteen (19) were private healthcare facilities, both coverage distance of 5 to 200km in terms of patronage. The distribution of these healthcare facilities were not even with Bwandang and Bah wards at disadvantage in terms of accessibility.

With regards to health care service utilization, accessibility is generally influenced by the spatial structures of health care service supply and demand. On the demand side, cultural and educational factors may obscure the recognition of illness and the potential benefits from health care, while economic constraints may suppress utilization, even if benefits are recognized. It is estimated that deficient care seeking is a factor in 6-70% of child deaths (Donnel, 2014). In Bolivia, 60% of children who died during a study period were not taken for medical treatment during the fatal sickness. The median study finding is that 23% of fatally ill children are not taken for treatment. On the supply side, appropriate interventions may not be provided at all, perhaps due to a lack of resources. The substantial gaps that exist between the actual health spending of many poor countries and the spending required providing a package of essential health services suggest that lack of availability is the root of the problem in many instances. It is important to recognize, however, that many effective interventions are not prohibitively expensive, even for very poor countries. For example, one half of avoidable child deaths in sub-Saharan Africa could be realized through home-delivered interventions (Donnel, 2014).

In Nigeria, health planning started around 1946 with the launching of ten years development plans i.e. 1946-1956 (WHO/UNICEF, 1978). At the end of the plan period, much have not been achieved because common indicators of health revealed a deplorable situation. Furthermore, all levels of government, private sectors and development partners worked together to create a mixed health care economy of both public and private providers to ensure coverage of different socio-economic groups in Nigeria. The public system is structured with the Federal Ministry of Health (FMOH) responsible for policy formation, monitoring and evaluation, and operational responsibilities, states largely operates secondary health care while the local government manage primary health care (Adeyemo, 2005).

According to Universal Health Coverage (2013), the Nigerian health system is operating in a complex and rapid changing environment, and has made a great deal of progress but there are still substantial strides to be made. The World Health Organization (WHO) ranked Nigeria as the 187th of 191 member nations for its health system performance (WHO, 2000). This poor performance can be attributed to convoluted and poorly coordinated roles and responsibilities with regards to both governance structure and provider system. And often times, in planning for healthcare services, sectoral approachesare adopted without giving much thought to the spatial dimension of the facility provided (Lekan 2010). This consequently brings about uneven distribution of healthcare facilities over a space.

Erinosho (2003) believe that ideological practices have tremendous influence on the structural distribution of health care infrastructures. Navarro (1976) noted that the provision of health care infrastructures in underdeveloped countries like Nigeria serves the indigenous middle and upper classes more by providing them with medical equipment that is a replica of those in developed world, in that the forces of demand and supply are given free rein. Here the system often encourages division between the weak and the strong as well as the poor and the rich.

Developing countries rely on the imports of drugs, machinery, foreign medical personnel and technologists to man and maintain medical equipment imported from the developed countries (Adejoh& Martha 2006). This is not surprising other social amenities like water, electricity, roads etc. were allocated in this manner (Aluko-Arolowo, 2005). For instance, a breakdown of provision of portable water shows that 67% was allocated to urban facilities, especially state capitals (Elimelech, 2006). Apart from serving as an avenue for capital overflow, the maintenance of healthcare equipment may be obstructed or completely negated whenever there is economic downturn or political logjam between the manufacturing and the recipient country (Elimelech, 2006).

This was the exact situation in the 1980s, 1990s and even until the beginning of the new millennium (2000s) when medical equipment was remained unmaintained and obsolete due to Nigeria's precarious economic situation (Elimelech, 2006). A critical look at the National Programmes on Immunization (NPI) in 2005, for instance shows that there was more success recorded in urban areas than the sub urban and rural areas because there are more health infrastructures to sustain the programmes in the former than in the latter (Owumi, 2002). The success recorded was 25% for urban children and 7% for the rest (Elimelech, 2006). No wonder Nigeria has one of the highest death rates of children below the age of 5 in the world.

The health policy in Kaduna state is based on the Nigerian National Health Policy, which was put in place in 1986 and is based on theconcept and practice of Primary Health Care (PHC) Kaduna State Ministry of Health (KSMOH, 2017). The state has general or rural hospital in all the 23 Local Government Areas(KSMOH, 2017). There are about 1100 primary health care in Kaduna state. The state government partners with Path 2 and other NGO's to make them functional which yield a remarkable achievement in the primary health care delivery in the state. Apart from the primary health care facilities managed by the state and local authority under Primary Health Care Development Agency, state general and rural hospitals, the state has 3 tertiary health care facilities.

The demand for healthcare facilities has recently increased due to the growing population in Soba Local Government area of Kaduna state. Health care facilities that were provided initially for the original inhabitant of Soba has been over stretched as a results of increase in population which create a lot of problems like infants and maternal mortality especially in outskirts of the urban areas.

The application of GIS techniques in analysing the spatial provision and distribution of healthcare facilities in Soba will help the populace to understand the nature of services

rendered within the hierarchy of various healthcare facilities and as well give more insight to government and other concerned bodies to understand the community health needs and design effective intervention methods to improve the quality of services provided which will consequently manifest in the quality of life.The General Hospitals should be located in urban and some few rural areas, while tertiary healthcare had better be situated in main towns and often only in capital cities (WHO, 1997). Primary healthcare facilities on the other hand are essentially distributed to provide easy access to residents of various communities. Therefore, it's best to locate such categories of health facilities within the residential areas for their nature of service and demand to people. In due course, WHO (1997) recommended that PHC facility should not be located more than 4km accessible distance from any community.

The purpose of using GIS in health care facilities is that maps provide an added dimension to data analysis, which helps in visualizing the complex patterns and relationships. Relationships among neighbouring areas are explicit in a map which allows for the visualization of spatial patterns. The use of Geographical Information System (GIS) for the measurement of physical accessibility is well established and has been applied in many areas including retail site analysis, transport, emergency services and health care planning (Wilkinson, 1999; Albert *et al*., 2000; Cromley and McLafferty2002). In the context of health care planning ability of GIS to identify the geographical extend of health facility catchment area, which correspond to the area which contain the population utilizing this facility, is a particularly important analytical capability.

Patel, Waters and Ghali (2007) opined that the power of GIS lies in its ability to analyse, store and display large amounts of spatially referenced data. In a field where manual data analysis can become overwhelming, GIS is a valuable tool. The purpose of using GIS for healthcare research is as a result of the powerful tools and solutions that the technology brings to aid manipulation of geographic data in order to identify the distribution pattern of

healthcare facilities and generate maps. Moreover, it offers an added dimension to data analysis, and also helps in visualizing complex pattern of the healthcare facilities and relationships among neighbouring areas explicitly where physical accessibility can be determined from which inferences will be drawn.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 Introduction

This chapter is primarily concerned with the description of the study area and the methodology adopted for the study. The study area encompasses location and extent, climate,

relief, drainage, population as well as health. The chapter also includes all the required data collected and used to carry out the research and further explained how both the spatial and non-spatial data were processed. Ultimately, the techniques by which the processed data were analysed were also explained.

3.2 The Study Area

3.2.1 Location and extent

Soba local government areas are located within Latitude 11^0 04`00`` to $11^0$ 06`00``N and Longitudes $7^0$42`00`` to $7^0$7`00``E. It occupies an area of 4,793 km^2. Soba is bounded to the north by Ikara local government, to the east by Kubau local government to the south, by Igabi and Zaria local government to the west all in Kaduna state (Figure 3.1).

3.2.2 Geology, relief and drainage

The relief of the study area is predominantly undulating plain, and the area is drained by some minor rivers which mostly dry up in the dry season, these rivers are found in places like Kwasallo, Danwata, Matari, Garu, Maigana, Tofa etc. The bedrock geology is predominantly metamorphic rocks of the Nigerian Basement Complex consisting of biotite gneisses and older granites. Deep chemical weathering and fluvial erosion, influenced by the bioclimatic nature of the environment, have developed the characteristic high undulating plains with subdued interfluves. However, rocky granitic residuals form inselbergs of varying sizes and shapes, and constitute the main local relief (relative relief is less than 150m).

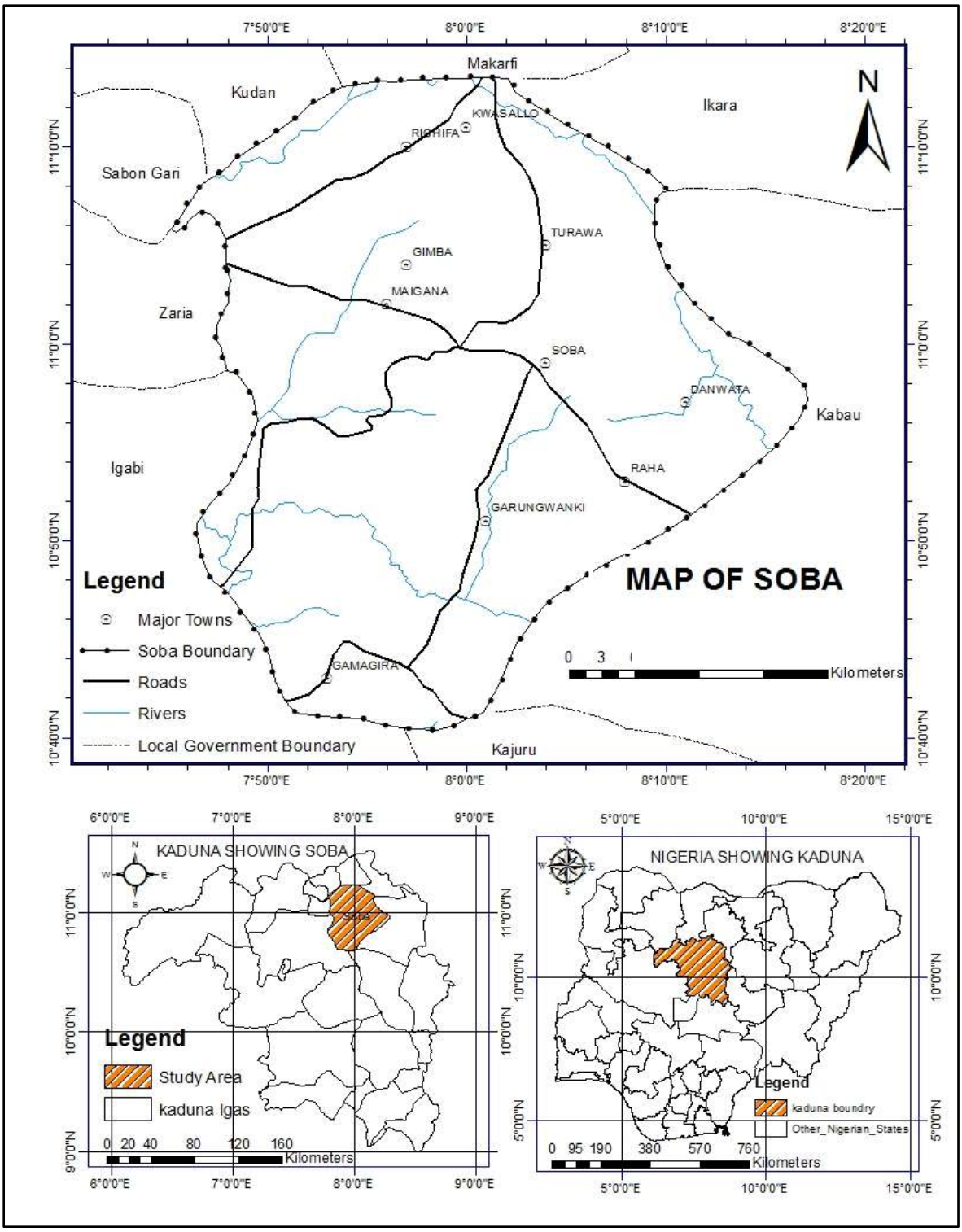

Figure 3.1: The Study Area
Source: adopted from Administrative Map Nigeria

3.2.3 Population

According to the 1991 population census, Soba had a population 176096 for both males and females in thelocal government area under study. It was further projected to 2018 using Mehta method 2004 using the formula. The projected population of Soba Local Government Area is 371561. The dominant ethnic group in the study area is Hausa, others includes Fulani, Yoruba, Mangu and others. It is therefore evident that the state's demand for healthcare is large and increasing over time due to increase in population.

3.2.4 Types of health facilities in the area

Soba local government has all the strata of primary and secondary healthcare facilities such as hospitals, maternities, clinics and dispensaries which offer both primary and secondary healthcare services to the peoples in the study area. The only secondary health facility in the area is Rural Hospital Maigana. Each Ward has at least one functional Primary Health Centre which also serves as the upward referral facility in the ward. Other levels of PHC facilities are the health clinic and health post, the latter being the lowest level health facility in the ward. The Primary Health Centre is to coordinate and supervise all the health services within the ward both at the facility and community levels. The Primary Health Centre is to be provided with appropriate number and mix of health personnel, equipment and drugs, and effectively linked with other health facilities in the ward. Managerial support for the WHS is to be provided by the Ward Development Committees/Village Development Committees. Under the Ward Health System, the Primary Health Centre is the referral facility for all the other PHC facilities in a political ward (NPHCDA, 2018).

3.3 Methodology

3.3.1 Reconnaissance survey

As a preparation for the study, a reconnaissance survey was carried out in order to acquaint the researcher with the study area. The objective was to obtain available relevant

information on healthcare facilities and establish a cordial working relationship with relevant stakeholders. The survey shows that Soba Local Government has one general (rural) hospital located at Maigana and 48 healthcare facilities across the area of which most of the facilities is just the buildings without supporting facilities.

3.3.2 Types and sources of data

1. Coordinates of the healthcare facilities were obtained using the handheld Global Positioning System (GPS) Garmin GPSmap 76S receiver.
2. Attribute data of the identified healthcare facility were sourced from the various healthcare facility management by inventory using checklist (Appendix I). The data include healthcare facility name, ward/location, category, ownership, hours of operation, staff capacities, equipment available (Appendix II).
3. Administrative map of the study area.
4. Relevant journals, textbooks, thesis and the internet materials were also utilized for literature review.

3.4 Data Analysis

Objective I: Identify and map the healthcare facilities in Soba

The healthcare facilities were identified and the coordinates of the healthcare facilities obtained from the field were structured into Microsoft excel. The required number of fields i.e. columns were then added to the table and the data for entire healthcare facilities were entered in their corresponding records i.e. rows. The coordinates then imported into the GIS environment and overlaid on the administrative map to show the distribution of the healthcare facilities in the study area.

Objective II: Examine the spatial pattern of healthcare facilities in Soba

To achieve this objective, the nearest neighbourhood analysis, inferential statistical tool in ArcGIS 10.3 were utilized to determine the pattern in terms of how dispersed,

clustered or randomly distributed the healthcare facilities are. The Z-score which usually returns a range of values between -2.58 to 2.58 was also obtained to understand the level of the healthcare facilities clustering, the nearest neighbourhood analysis is calculated as

Rn = Do/De

Do = Ex/n

Where Ex=summation of distance between all points, n=number of points in the study area.

De=0.5√a/n

a=area of the region under study; n=number of points in the study area

Objective III: Determine the spatial accessibility of healthcare facilities in Soba

To achieve this objective, random points were generated to represent the centroid of the wards within the wards boundary, and the average distance taken (travel time from each ward to each healthcare facility along the road network) were calculated using the network analyst functionality in ArcGIS 10.3. This involves the use of Origin Destination Matrix (OD) analyst tool. This tool is useful in representing a matrix of distances (travel time) going from a set of origin locations (wards) to a set of destination locations (healthcare facilities). The distance between every ward centroid and all the healthcare facilities were further structured into a geo-database to harness and determine the distance in kilometre from all the wards to the various healthcare facilities in Soba and determine the distances.

The World Health Organization (WHO, 1997) recommendation for locating primary healthcare facilities in developing countries was adopted as criterion for determining the shortest and farthest primary healthcare facilities to the respective wards within the study area. This criterion is that the maximum distance people should travel to access primary healthcare facilities should not be more than 4km along the existing roads.

Objective IV:Examine the availability of personnel and functionality of the equipment in the healthcare facilities

Based on the information derived from the inventory using a checklist, tables were created by dividing the collected data into subject based table to minimize redundant data. The table was created in Microsoft excel. The table have the following attributes; Name of the healthcare facility, year of establishment, category, types of facilities, ownership, carrying capacity (bed), hours of operation, staff capacity (Doctors and Nurses), availability of laboratory and pharmacy.

Some query operations (single and multiple queries) performed on the database includes:

- The number of healthcare facilities in Sobalocal government area
- The number of Doctors, Nurses and Midwives in each healthcare facilities in Soba LGA
- Number of healthcare facilities have laboratory and pharmacy
- Number of healthcare facilities with functional beds in the study area
- Number of healthcare facilities in the study area that provide 24 hours service
- The closest healthcare facilities located within the area
- The equipment available in the health care facilities

Finally, the results were discussed and summarized using descriptive statistics and maps.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is concerned with presentation of results and discussion. These were done under the following sub-titles: Identify and map the healthcare facilities in Soba; examine the spatial pattern of the healthcare facilities in Soba; determine the accessibility of the healthcare facilities to the people of Soba was also determined using the Origin-Destination (O-D) matrix ArcGIS network. Finally, the availability and functionality of the equipment in healthcare facilities in study area was also determined.

4.2. Distribution of Healthcare Facilities in Soba LGA.

4.2.1. Category of health facilities in Soba L.G.A.

There are basically three categories of health care facilities; these are primary, secondary and tertiary healthcare facilities. Two categories of health care facilities existed in the study area; these are the primary and the secondary Health Care Facilities Table 4.1

Table 4.1: Categories of Health Care Facilities

Category	Frequency	Percentage (%)
Primary	48	97.96
Secondary	1	2.04
Total	**49**	**100**

Source: Author's Analysis, 2019

The result shows that a total of 49 health care facilities were distributed across the study area. The primary health care (PHC) facilities which are mostly provided by Local Government authorities constitute the highest percentage of 97.96% while the secondary healthcare facility constitutes 2.04%.Thisimplies that primary health care facilities are

predominant in the study area, and this could be attributed to being the first point of contact to obtain health care services. From the result of the analysis, it is obvious that only one (1) secondary healthcare facility exist in the study area which is located at Maigana in Maigana ward. According to Abdurrahman and Nurunnisa (2013), secondary health care levelprovides specialised services to patients who are referred from the primary health care level. These services are provided through out-patient and in-patient hospital services, which include general medical, surgical, and paediatric cases and community health services. Adequate supportive services, such as laboratory, diagnostics, blood bank, rehabilitation and physiotherapy are also provided. This study is in conformity with the research of Oyewole (2017) that identified availability of more primary health facilities (88.1%) than secondary healthcare facilities (11.9%) in Funtua L.G.A.

4.1.1 Distribution of healthcare facilities and population by ward

This sub-section shows the spatial distribution of health care facilities and population ratio in Soba L.G.A. according to wards. Table 4.2 and Figure 4.1 present the distribution of the 49 healthcare facilities across the eleven (11) wards in the study area.

Table 4.2: Distribution of Health Care Facilities by Ward

Ward	No. of HCs	(%)	1991 Pop	Projected Pop. 2018	Population – HCF Ratio
Danwata	1	7.65	13477	28436	1:28436
Gamagira	5	7.63	13436	28349	1:5669
Garu	4	9.08	15989	33737	1:8,434
Gimba	4	11.75	20697	43671	1:10917
Kinkiba	7	8.04	14155	29867	1:4,267
Kwasallo	4	9.28	16333	34463	1:8,616
Maigana	3	11.21	19744	41660	1:13,887
Rahama	2	3.33	5858	12360	1:6180
Richifa	6	12.10	21309	44962	1:7494
Soba	5	12.75	22459	47388	1:9478
Turawa	8	7.18	12639	26668	1:3334
Total	**49**	**100**	**176096**	**371561**	**1:7,583**

Source: Author's Compilation 2018; National Population Commission 1991

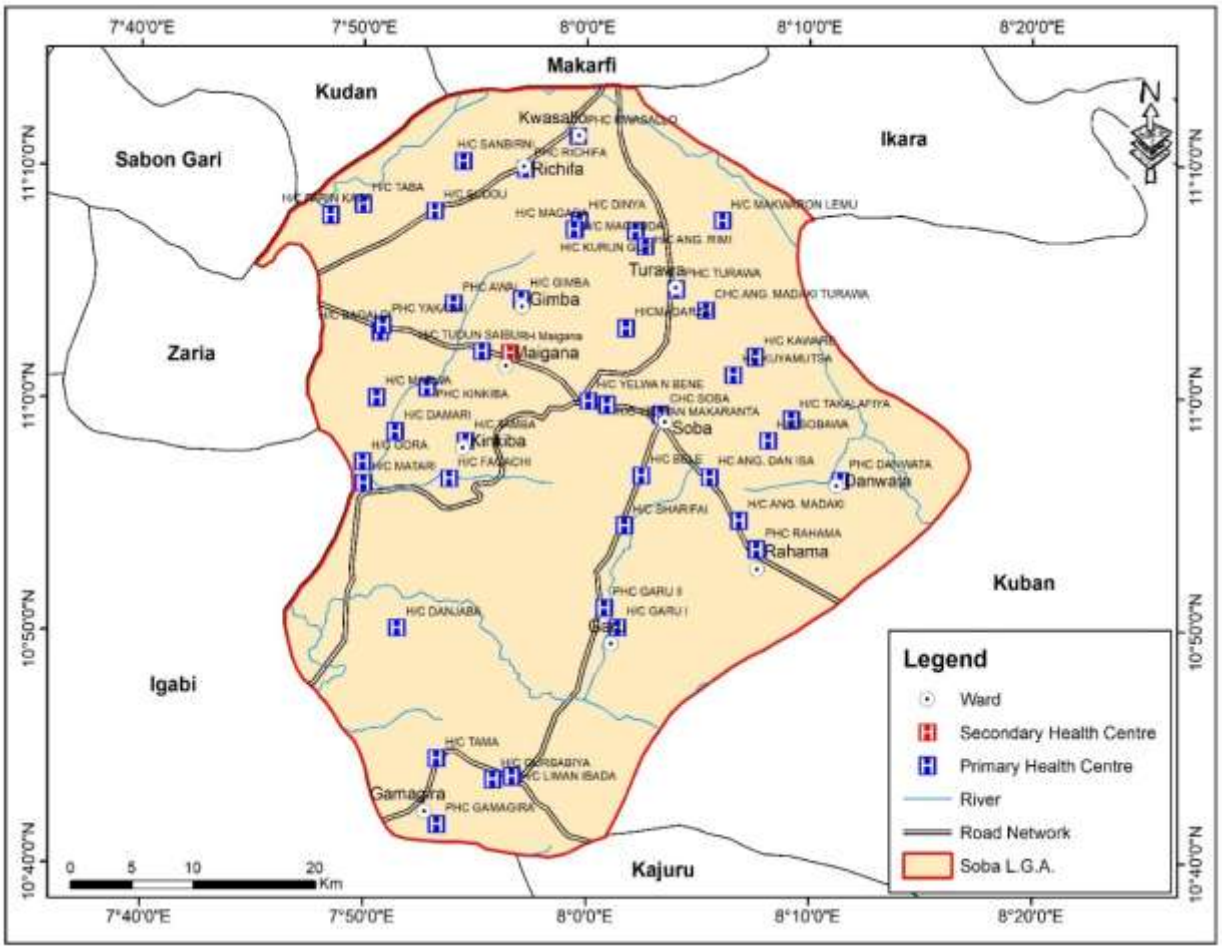

Figure 4.1: Distribution of primary and secondary health facilities in Soba L.G.A.
Source: Author's Analysis, 2019

The result shows that out of the forty nine (49) health care facilities, Turawa ward had the highest number with eight (8) HCF equivalent to 16.33% followed by Kinkiba with seven (7) 14.29%,while Danwata ward had least allocation with only one (1) healthcare facility. From this result, it is obvious that the distribution of the health care facilities is not based on population for example, Soba Ward have the highest population with 47388 people had 5 HCFs while Turawa with 26,688 people have 8 HCFs. Danwata ward with population of 28436 people which is higher than Turawa ward have only 2 HCF. From the result, it is clear that Turawa ward is well served with health facilities more than any other ward having facility per population ratio of 1:3334. This could be attributed to the fact that, Turawa is centrally located than the other wards and also have road connectivity with the neighbouring wards.

Generally, it is observed from the result that population was not the key issue in the allocation of the health facilities across the various wards. This study agrees with the work of Adetunji and Adeyinka (2013) which observed that population was never a criterion used in provision of health facility to the people in Ilesha, South – West Nigeria. The findings revealed that health facilities in the area were unevenly distributed. Health trips in Ilesha were therefore skewed towards zones with more health services. The result of the analysis of variance further showed the existence of significant variations in accessibility to health care facility among the sampled population in the study area. It was recommended that, some of the primary health care facilities should be upgraded to the status of General hospitals given the growing nature of the town as the most important town in its region.

4.3. Spatial Pattern of the Healthcare Facilities in Soba

The result presented in Table 4.3 and Figure 4.2 indicates that the nearest neighbour index for the spatial pattern of health care facilities in the area is0.983022 with critical value (z-score) of -0.225024at 0.821961level of significance (p-value).

Table 4.3: Summary of Nearest Neighbour Statistics

Observed Mean Distance:	3120.32 Meters
Expected Mean Distance:	3174.21 Meters
Nearest Neighbor Ratio:	0.983022
z-score:	-0.225024
p-value:	0.821961

Source: Author's Analysis, 2019

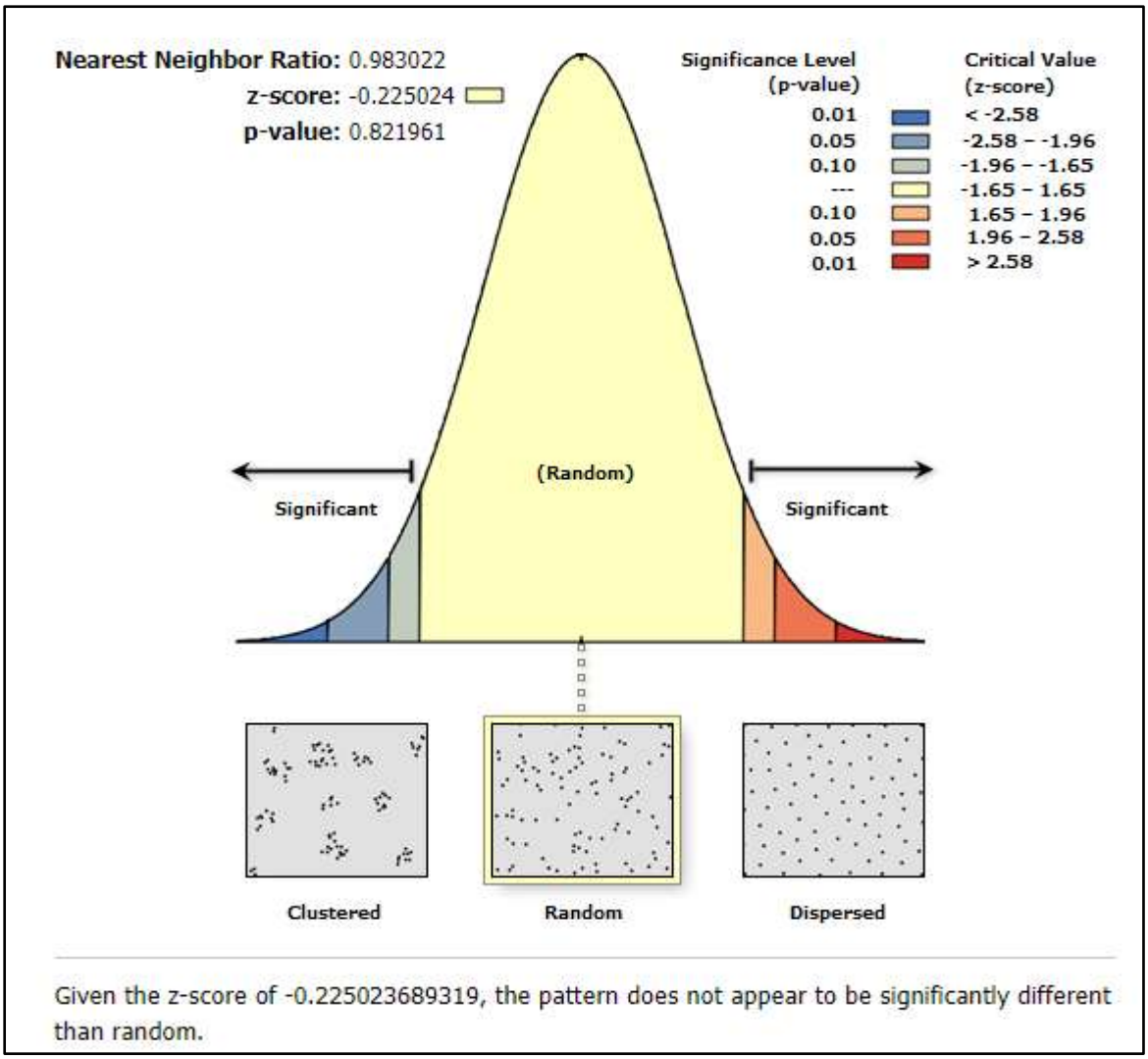

Figure 4.2: Distribution Pattern of Health Care Facilities in Soba LGA
Source: Author's Analysis, 2019

According to Getis and Ord (1998), the z-score usually returns a range of values between -2.58 to 2.58; therefore, a negative z-score less than -2.58 indicates a significant clustering at 0.01 probability level. A range of scores between both 2.58 to -1.96 at 0.05significant levels and -1.96 to -1.65 at 0.10 probability level shows that there is tendency towards a clustered pattern. A range of z-scores between -1.65 to 1.65 indicates a random distribution. Again, if the z-score lies between both 1.65 to 1.95 at 0.10 significance level and 1.96 to 2.58 at 0.05 probabilities level then it is obvious that there is tendency towards a regular pattern. Therefore, since the z-score is approximately -0.23 which is less than the standard critical value of 2.58 as measured by Getis and Ord (1998), then the pattern is

significantly even with greater than 1% (0.01 level of significance), from the emerging result this affirms that the locational pattern of Health Care facilities in the study area is statistically random. This result is in line with the study of Oyewole (2017) that conducted a similar research and observed a random distribution pattern of health facilities in Funtua L.G.A. of Katsina State. Another study by Adewoyin, Ogunyemi, Muibi, Fasote, Halilu, and Alaga, (2016) that compare the pattern of distribution of health care facilities between urban and rural settlement in Ife East L.G.A. of Osun State, observed a clustered distribution in urban areas and dispersed in rural areas.

4.4 Accessibility of the Healthcare Facilities to the Peoples of Soba LGA.

The Figure 4.3 depicts that the Origin (O) represents the Ward centroid and the Destination (D) depicts the health facilities as displayed by a series of connectivity of lines from where distances were measured. This means that, each ward has access to all the available health care facilities along the existing road network within this area when the need arises, although this depends on individual choices to patronize those closes by or far away from their residence and the affordability of transport fare. The results obtained helped in identifying the areas that are easily accessible in terms of health care facility within thestandard distance recommended by WHO which is 4km distance from the facility to the target community.

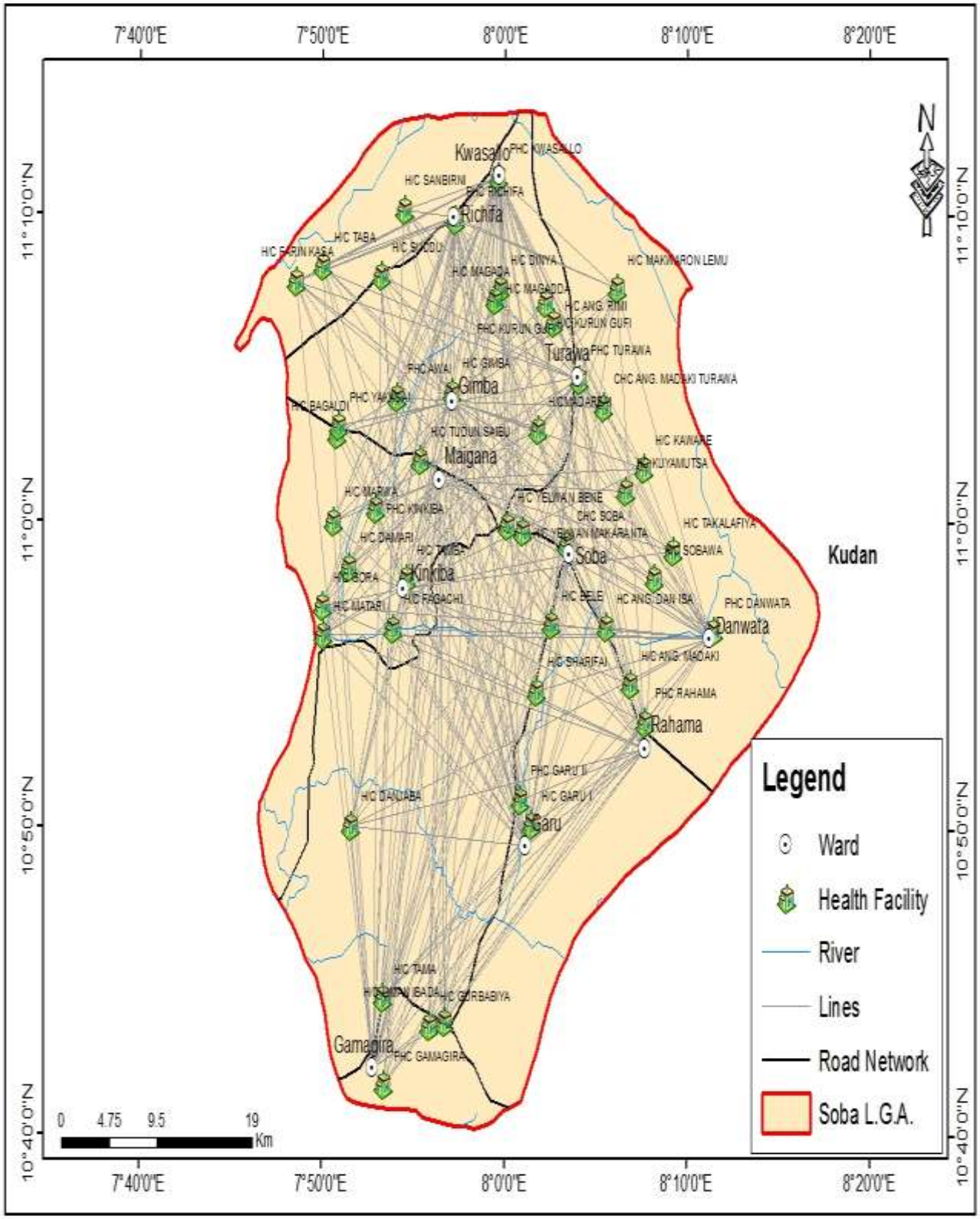

Figure 4.3: Accessibility of Wards to Health Facilities in Soba LGA

Source: Author's analysis, 2019

The results in Table 4.4 shows the wards, theminimum, the maximum and the average distances covered along the road network to access the nearest health care facilities among the facilities in each of the electoral ward

Table 4.4: Accessibility of the People of Soba L.G.A. to Health Facility Distance in Km

Ward	Min	Max	Average
Danwata	0.5	47	23.5
Gamagira	1.4	55	27.5
Garu	1.4	40.3	20.15
Gimba	0.5	42	21
Kinkiba	0.6	31	15.5
Kwasallo	0.1	56	28
Maigana	2.2	37	19.5
Rahama	1.7	45	23
Richifa	0.3	53	26.5
Soba	0.6	37	18.5
Turawa	0.2	47	23.5

Source: Author's Analysis, 2019

The result of the O-D cost matrix as shown in the Table 4.4 above indicates that theminimum distance from the ward centroid to the nearest facility is 0.136 Km and themaximum distance is 55.823Km. The result revealed that people in Kwasallo ward had the highestaccess to the nearest health care facilities with a minimum distance of 0.136Km; whileMaigana ward had the least access to the nearest facility with a minimum distance of2.238Km. While, Kinkiba ward had the lowest distance from the ward centroid within the ward tothe farthest health care facility with a maximum distance of 30.983Km, Kwasallo ward hadthe longest distance from the ward to the farthest Health Care facility with a maximumdistance of 55.823Km. The result shows that Kinkiba ward was more centrally located to all Health Care facilities within the study area with an average distance of 15.799Km from its closest facility to the farthest. This implies that households within

Kinkiba is wellserved and have access to different types of health care facilities with Gamagira ward is the least served with an average distance between the closest facility to the farthest facility of 28.196Km. This means that residents within the ward had to travel farther to access a particular type of facility that was not available within the ward. Hence, all thesevariations in terms of spatial accessibility to health care facility in those locations might have restricted movement in the deprived areas due to the frictional effect of distance.

Table 4.5: Closest Facility to Residents of Each Ward

Ward	Health Facility	Distance in KM
Danwata	PHC Danwata	0.5
Gamagira	PHC Gamagira	1.4
Garu	H/C Garu I	1.4
Gimba	H/C Gimba	0.5
Kinkiba	H/C Tamba	0.6
Kwasallo	PHC Kwasallo	0.1
Maigana	RH Maigana	2.2
Rahama	PHC Rahama	1.7
Richifa	PHC Richifa	0.3
Soba	CHC Soba	0.6
Turawa	PHC Turawa	0.2

Source: Authors Analysis, 2019

From the Table, the ward within the study area closest to a facility was that of Kwasallo to PHCKwasallowhich is 0.136 Km, followed by Turawa to PHC while Maigana had the least accessibility with 2.238 Km. This could be attributed to fact that Maigana is a large ward and some villages within the ward are far from ward headquarters.

From the result wards like Kwasallo, Turawa and Garu have easy physical access to health facility but the field observation embarked on shows that these facilities lack man power and other social amenities such as water, light, beds etc. And Maigana that have least accessibility

has the only secondary health facility in the area and is better equipped and have a reasonable number of staff and it also serve as referral hospital in the area.

4.5 Availability of Personnel and Functionality of Equipment in Healthcare Facilities in Soba LGA.

4.5.1 Availability of health care personnel in Soba L.G.A.

Table 4.6 shows that the secondary health facility at Maigana, Maigana ward had the highest medical staff capacity with 98 workers followed by Soba and Turawa with 33 workers while Rahama ward has the least with3 personnel. The health facilities in Rahama ward were 2 with only 3 health workers and this could be attributed to the fact that the HCFs in these wards are dilapidated and are without facilities such as light and water.

Table 4.6: Distribution of Health Personnel in the Study Area

Ward	Bed Cap	Staff Cap	Doctors	Pharmacist	Nurses /Midwives	Com Health Workers	Lab. Tech
Danwata	23	10	0	1	1	4	0
Gamagira	43	18	0	1	2	10	0
Garu	27	13	0	0	1	7	0
Gimba	19	9	0	0	1	5	0
Kinkiba	59	29	0	1	1	14	1
Kwasallo	9	15	0	0	1	8	1
Maigana	59	98	3	4	15	42	3
Rahama	13	8	0	0	1	3	0
Richifa	65	28	0	0	1	12	1
Soba	43	33	0	2	1	13	1
Turawa	36	33	0	0	1	12	0
Total	387	287	3	9	22	128	7

Source: Author's Analysis, 2019

Table 4.7 Human Resource for Primary Health Care facilities according to NPHCDA

Personnel	Primary Health Care	HealthCenter	Health Post
1. Medical officer (If available)	1	0	0
2. Community Health Officers (CHOs)	1	0	0
3. Nurse/Midwifes	4	1	0
4. Community Health Extension Workers (CHEWs)	3	2	0
5. Pharmacy Technician1	1	0	0
6. Health Records Technician1	1	0	0
7. Medical Laboratory Technician	1	0	0
8. Junior Community HealthExtension Workers (JCHEWs)	6	1	1

Source: Primary Health Care Development Agency 2018

4.8Availability and Functionality of the Equipment in the Health Care Facilities in Soba LGA

Ward	Auto Clave Tape	Audio Meter	Blood pressure Monitor	TM, Body weight Scale	Stor Fac	Clocks	Protect Equip	Sharp Contain.	W Chair	Lab equip
Danwata	2	0	1	1	2	1	2	1	0	UC
Gamagira	3	0	5	6	2	2	5	6	0	1
Garu	4	0	3	3	0	2	1	2	0	UC
Gimba	4	0	4	4	1	5	3	3	0	1
Kinkiba	2	0	3	4	2	3	2	3	0	UC
Kwasallo	3	0	4	4	2	3	2	2	0	1
Maigana	8	1	7	10	5	6	6	9	3	2
Rahama	2	0	2	1	1	1	1	1	0	1
Richifa	7	0	3	6	2	5	5	3	0	1
Soba	5	0	5	6	3	4	4	4	1	2
Turawa	8	0	6	6	2	4	3	4	0	1, UC
Total	**48**	**1**	**41**	**51**	**22**	**36**	**34**	**38**	**4**	**11**

Table 4.9 Essential Equipment List for Primary Health Care Facilities

	Item description	Primary health Facilities Quantity	Health centre	Health Post
1.	Hospital bed with mattress	10	6	2
2.	Examination couch	3	2	1
3.	Artery forceps (medium)	6	3	2
4.	Bed pan (stainless steel)	4	3	1
5.	Urinal (F) stainless steel	4	2	1
6.	Bowls (stainless) with stand	4	2	1
7.	New clime standing fan	6	4	2
8.	Plastic chairs	12	10	4
9.	Stainless bowl for cotton	6	4	1
10.	Graduated medicine cup	10	10	2
11.	Dissecting forceps	6	4	2
12.	Dressing scissors	4	3	2
13.	Sponge holding forceps	2	2	1
14.	Sponge holding forceps	2	2	1
15.	Dust bin (pedal)	6	6	1
16.	Gloves disposal packs of 50	4	4	1
17.	Syringes and needles, pack of 100	4	4	1
18.	Stainless instrument tray	3	2	1
19.	Length measures for babies	4	2	2
20.	Long benches	12	8	2
21.	Medicine cupboard	1	1	1
22.	Refrigerator medium	2	1	1
23.	Writing table and chairs	6	2	1
24.	Incision and drainage kit	6	2	2
25.	Weighing scale (Adult)	2	1	1
26.	Weighing scale (Child)	3	1	1
27.	Filing cabinet	3	1	1
28.	Bed sheets & pillow case	24	12	4
29.	Sterilizer (medium) 15 Litre	2	1	1
30.	Drip stand	4	2	0
31.	Baby dressing table for maternity	1	1	0
32.	Malaria RDT kits	2	2	0
33.	Vagina speculum (Sims, set of 3)	1	1	0
34.	Test tube rack	1	0	0
35.	Autoclave	1	0	0
36.	Set of aluminium pot &	1	0	0
37.	Utensils	1	0	0

Source: National Primary Health Care Development Agency, 2018

4.5.2 Distribution of health facilities with Doctors

Spatial database queries were carried out to retrieve information on the doctors across thewards in Soba L.G.A. The results of number of doctors obtained from available health care in the study area are presented in Figure 4.4.

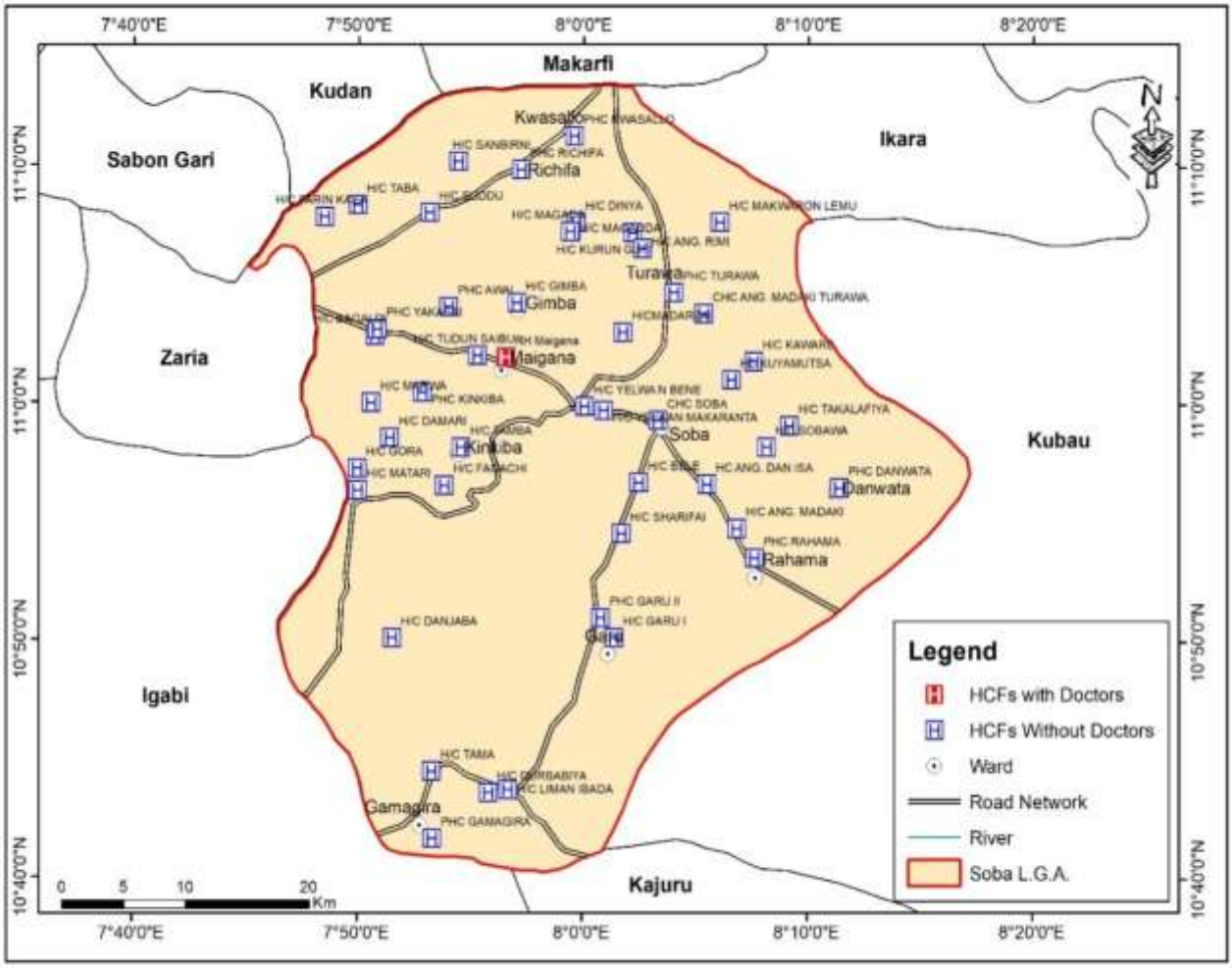

Figure 4.4: Distribution of Doctors in Soba L.G.A.
Source: Author's Analysis, 2019

The result shows that only the health care facility situated in Maigana had doctors while the other healthfacilities are without Doctors. The result of this study clearly indicates that only 3 doctors are serving the population of over 371561 in the study area. Comparing the World Health Organization recommended doctor/population ratio in Nigeria which is 1:10,000 by the year 2000 (World Development Report, 2005), and the situation of Soba L.G.A. with doctor/population ratio of 1:123854, it could be seen that the number of doctor in the study

area is not enough to serve the population. This resultconforms to the study ofBalogun and Alaegor (2006) that observed inadequacy in the distribution of doctors in some parts of Edo South senatorial district and also Oyewole (2017) that carried similar study in Funtua L.G.A., Katsina State. The study observed that there is shortage of health personal especially the doctors in the study area and the implication is that the cases supposed to be handling by doctors will end up being handled by other categories of health workers.

4.5.3 Distribution of health facilities with pharmacist

The results on number of pharmacist available in health care facilities in the study area is presented in Figure 4.5 and Table 4.7.The result shows that pharmacist were available in only five (5) of the HCFs. Two (2) pharmacists were in Soba ward and four (4) in Maigana, one each in Gamagira, Kinkiba and Kwasallo wards respectively. The availability of pharmacists in these health care facilities could be attributed to the fact that Soba and Maigana ward were more densely populated comparedto other wards and also having the only secondary health facility (Rural Hospital Maigana). Also, it could be as a result of the easy road connectivity with other healthcare facilities within the study area. However, it is interesting to note that most of these health care facilities are with pharmacies but no pharmacist.The nurses in most cases perform the duties of the pharmacists. This is because primary health care facilities are predominant in the study area controlled by the local government authority will find it difficult to employ a qualified pharmacist due to the financial requirements of their salaries and other allowances.

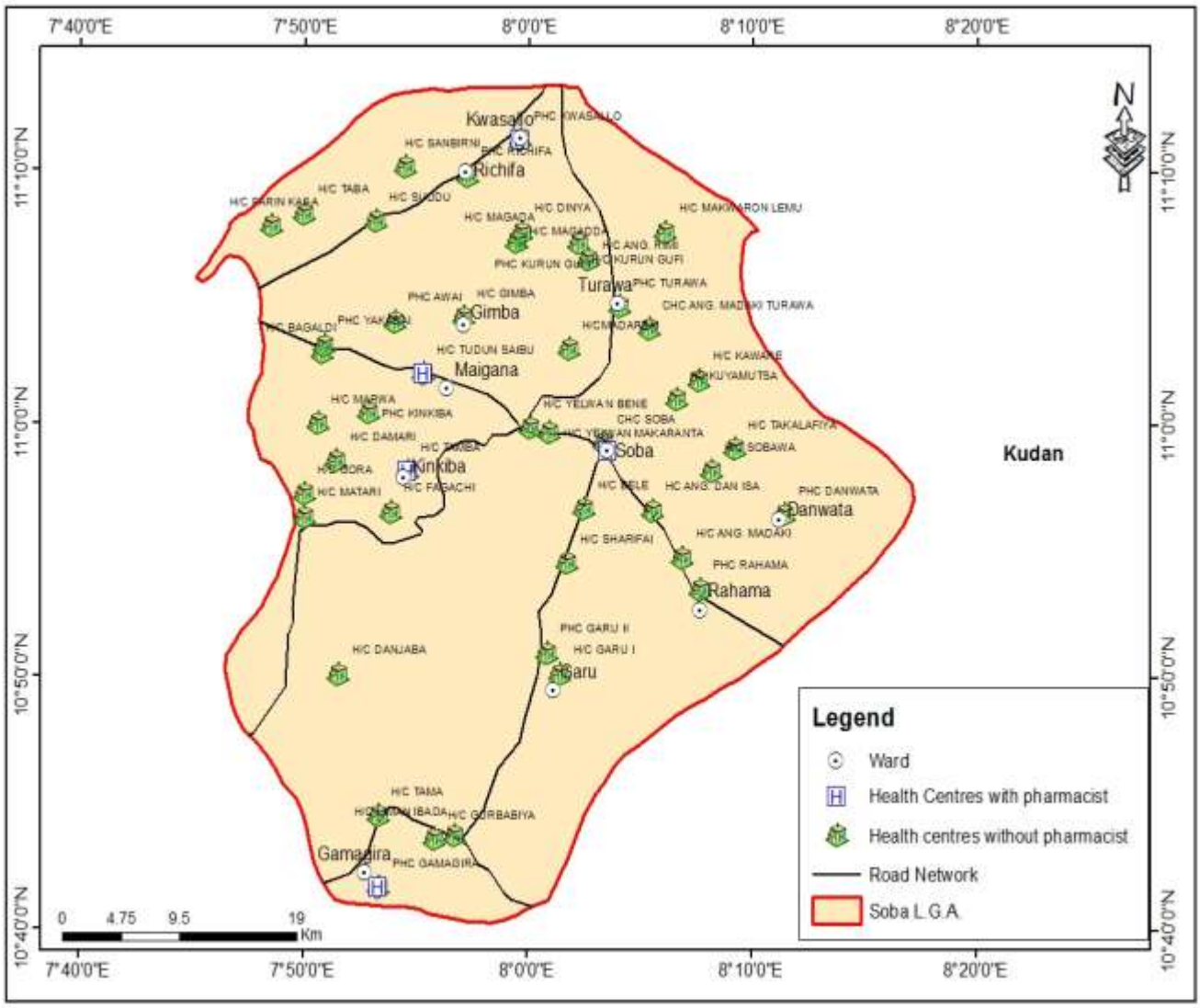

Figure 4.5: Distribution of Pharmacist in Soba L.G.A.
Source: Author's Analysis, 2019

4.5.4 Distribution of health facilities with Nurses/Midwives

The result on number of nurses and midwives obtained from available health care facilities in the study area is presented in the Figure 4.6.

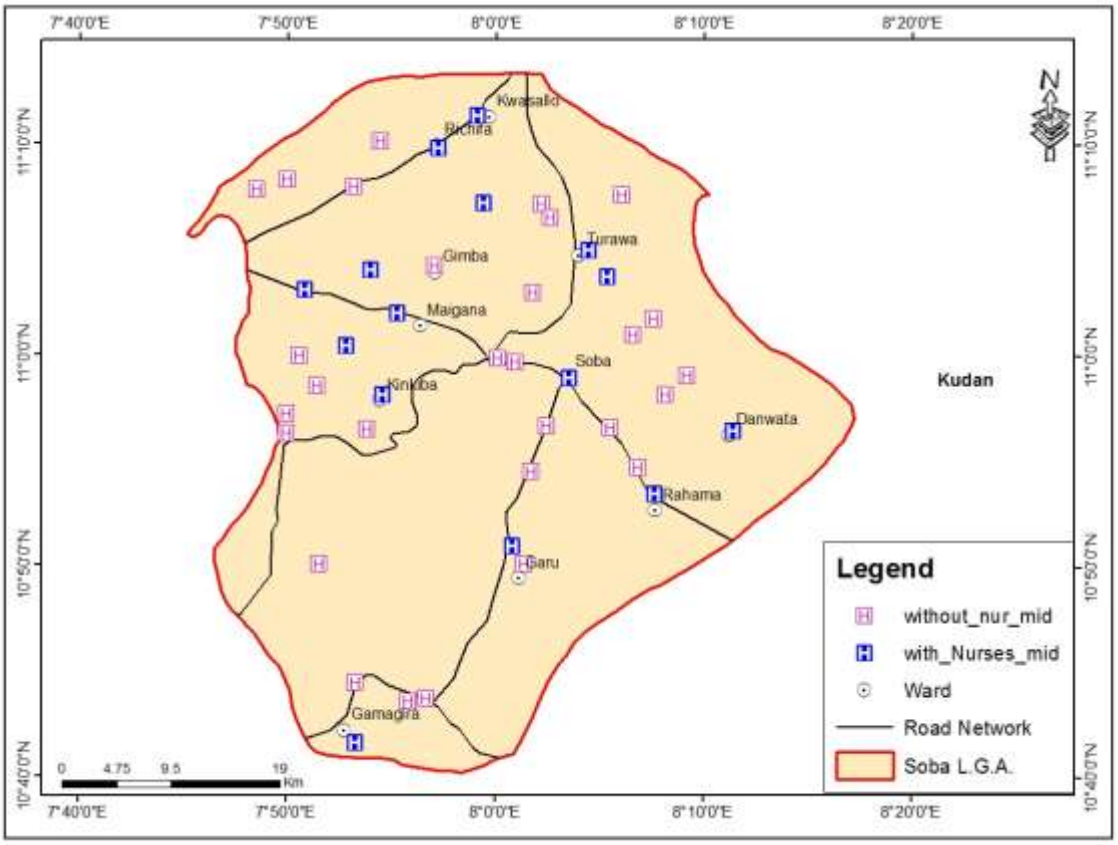

Figure 4.6: Distribution of Nurses/Midwives in Soba L.G.A.
Source: Author's Analysis, 2019

The result shows that only fifteen (15) of the facilitiesout the forty nine (49) facilities had nurses and midwives. It can be seen from Table 4.6 that there are twenty two (26) nurses and midwives in the study area of which Maigana had the highest with 15 nurses/midwives followed by Gamagira with 2, Danwata, Garu, kwasallo, Soba,Kinkiba, Richifa, Gimba, Rahama and Turawa had 1 nurses/midwives each. This result indicates that provision of nurses/midwives across the wards is inadequate.

4.5.5 Distribution of health facilities with Community Health Workers

The number of community health workers in the health care facilities across the various wards in Soba L.G.A. is presented in Figure 4.7The result in the Figure indicates that all the health facilities had community health workers whileTable 4.6 reveals that 128 community health workers were distributed across the 11 wards within the study area of which Maigana ward had the highest with 42 community health workers followed by Kinkiba

ward with 14 community health workers. While Richifa and Turawa had 12 workers each. The result indicates community health workers for wards such as Maigana, Kinkiba, Gamagira and Turawa were sufficient enough to serve the population while for Danwata, Gimba and Soba ward were not adequately sufficient to the people of the ward.

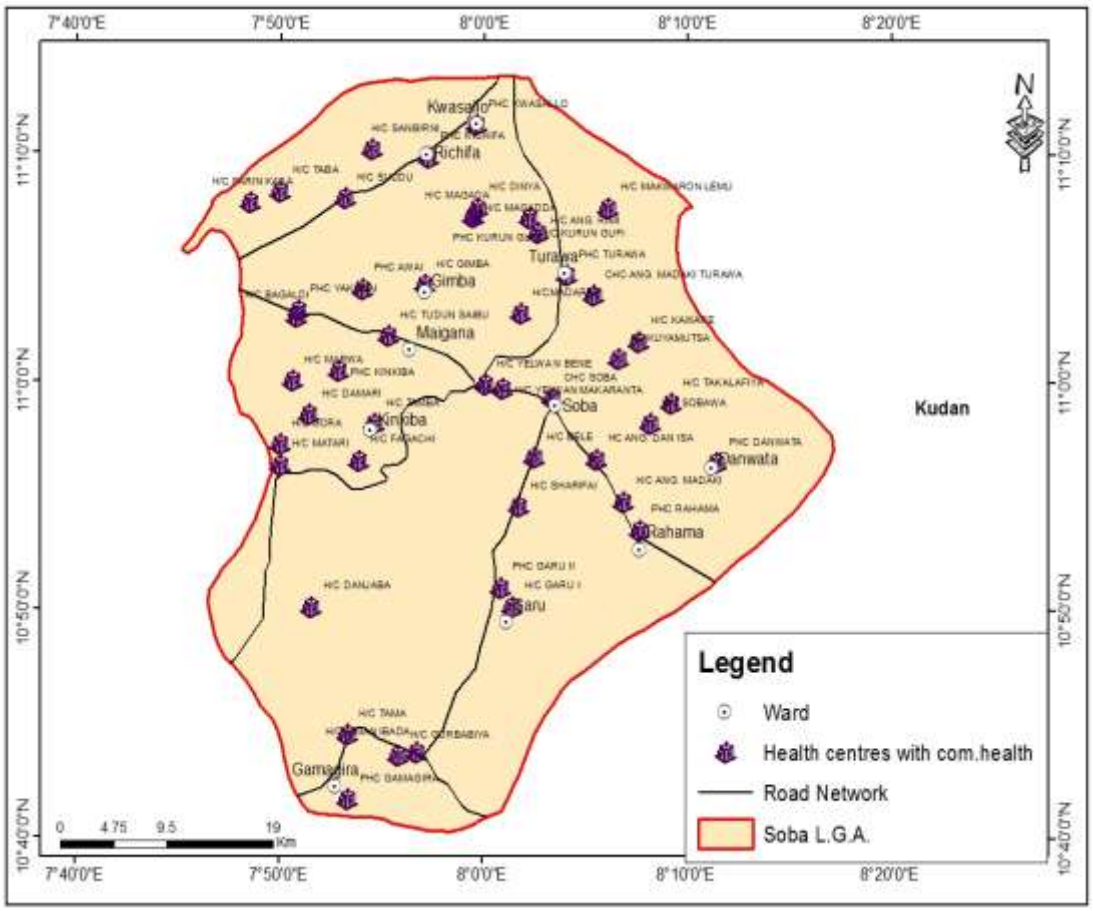

Figure 4.7: Distribution of Community Health Workers in Soba L.G.A.
Source: Author's Analysis, 2019

4.5.5 Distribution of health facilities with Laboratory Technician

The number of laboratory technicianin the health care facilities across the various wards in Soba L.G.A. is shown in Table 4.6 and further presented in Figure 4.8. Health care facilities with Laboratory Technicians are depicted in red and HCFs without laboratory technicians were depicted using green.

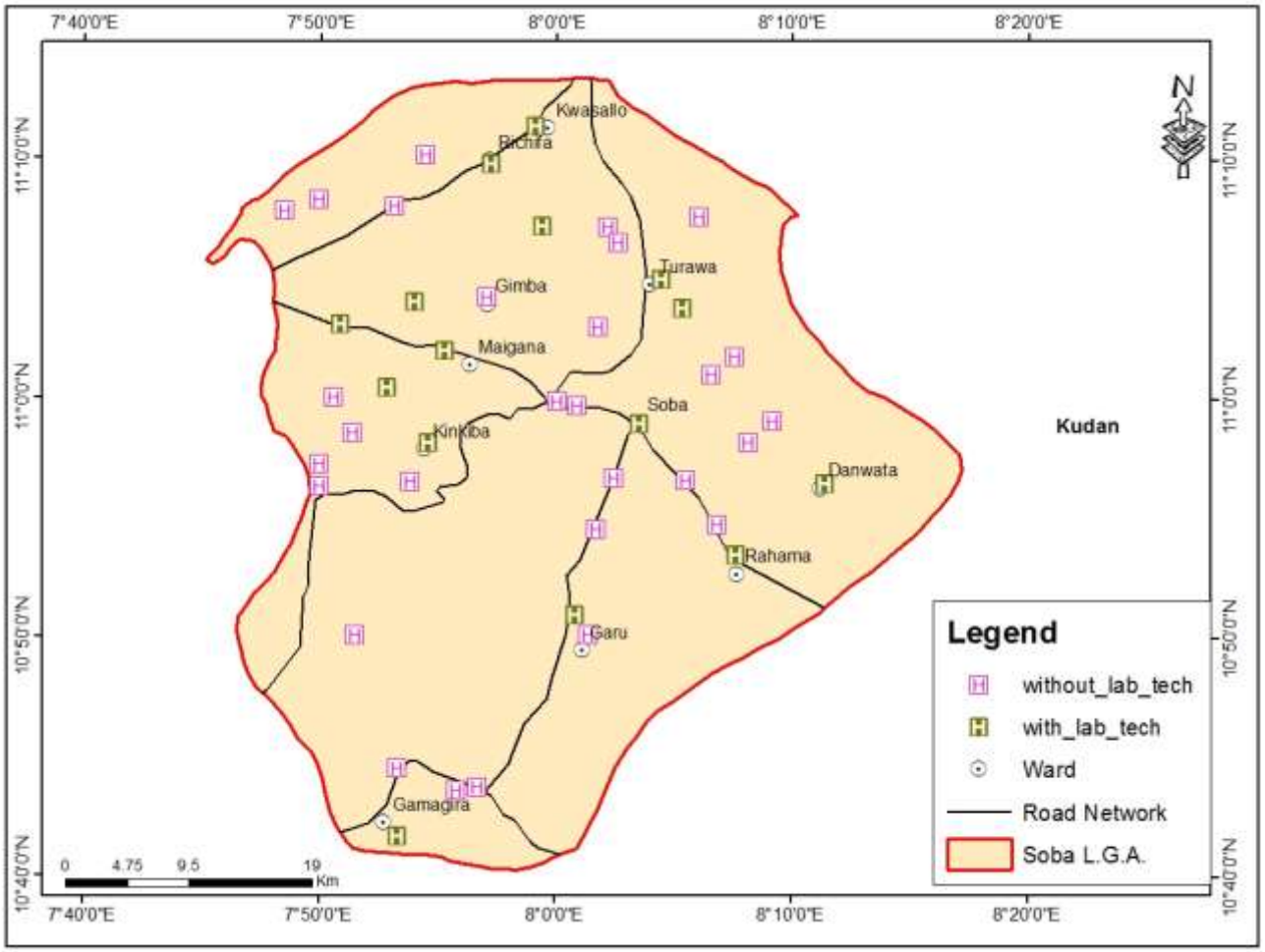

Figure 4.8: Distribution of Laboratory Techniciansin Soba L.G.A.
Source: Author's Analysis, 2019

From Figure 4.8, 11 wards had health facilities with laboratory technician. Also, Table 4.6 shows Maigana had highest number of laboratory technicians with 3 butGimba, Kinkiba, Richifa, Danwata, Gamagira, Gimba, Rahama and Turawa, Soba had 1 each. This result indicates poor performance of State and Local Government authorities in provision of human resources and amenities to health care facilities in the study area. And this can lead to over utilization of the facilities that are better equipped.Population is an important criterion used to determine which areas should benefit from a particular facility. There are instances where some communities are not only remote but are also scattered such that those communities may not have the population threshold of 3500 to 5000 to establish a lower level facility like a healthcare facility. Other remote communities may have the required population threshold but are denied any form of health facility. While communities close to

urban areas and better served with infrastructure like roads, schools, electricity and without the required population threshold may have a health facility established there.

Inadequate infrastructure such as roads, electricity, potable water and schools in some communities in the region makes it difficult for them to be provided with health facilities. Typical example is communities likeGoburawa in Gamagira ward, Fagachi in Kinkiba ward and Sobawa in Danwata ward.People in these communities have to resort to walking for long distances before they can reach a health facility. Even where they can have the access to roads, those roads are in bad condition and only a few stretches. They are mostly accessible by foot bicycles and motorbike. They are without electricity, portable water and some are without schools. As a result siting a health facility in any of these villages would be very difficult.

Inadequate personnel are also a challenge in the distribution of health care facilities in the study area. Some of the health facilities in the area do not have adequate health personnel such as doctors, nurses and laboratory technicians. A typical example is the Rural Hospital Maigana where there is only 3 medical doctors.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1Summary

The study employed the use of Remote Sensing (RS) and Geographic Information Systems (GIS) techniques in mapping the distribution and analysing Health Care Facilities (HCs) in Soba L.G.A. of Kaduna State-Nigeria. This was done byidentifying and mapping the healthcare centers, examining the spatial pattern, determining the accessibility of the healthcare facilities to the peoples of Soba. And finally availability and functionality of the equipment in healthcare facilities was also examined.

The finding showsthat a total of 49 health care facilities are distributed across the study area. The primary health care (PHC) facilities which are mostly provided by local government constitute the highest percentage (97.96%), while the secondary healthcare facility constitutes 2.04%.

The result further shows that out of the fortynine (49) health care facilities, Turawaward had the highest number of health facilities (8) equivalent 16.33% followed by Kinkiba with seven (7) 14.29%. Richifa ward is the third highest with six (6) HCs 12.24% while Soba and Gamagira ward had five (5) 10.20% each. Four (4) 8.16% each of the health facilities was allocated to Garu, Gimba and Kwasallo ward respectively. Danwata ward had least allocation with only one (1) healthcare facility. Also, the nearest neighbour analysis on the spatial pattern of health facilities in the study area indicates that locational pattern of Health Care facilities in the study area is statistically random.

The result of the O-D cost matrix indicates that theminimum distance from the ward centroid to the nearest facility is 0.136 Km and themaximum distance is 55.823Km. The

result revealed that Kwasallo ward had the highestaccess to the nearest Health Care facility with a minimum distance of 0.136Km, whileMaigana ward had the least access to the nearest facility with a minimum distance of2.238Km. While, Kinkiba ward had the lowest distance from the ward centroid within the ward tothe farthest health care facility with a maximum distance of 30.983Km, Kwasallo ward hadthe longest distance from the ward to the farthest Health Care facility with a maximumdistance of 55.823Km. The result shows that Kinkiba ward was more centrally locatedto all health care facilities within the study area with an average distance of 15.799Km fromits closest facility to the farthest.The ward within the study area closest to a facility was that of Kwasallo to PHCKwasallowhich is 0.136 Km, followed by Turawa to PHCTurawa (0.248 Km), Garu to H/C Danwata(0.442 Km),Danwata to Danwata (0.494Km).Maigana had the least accessibility with 2.238 Km.

The findings also indicates that the secondary health facility at Maigana, Maigana ward had the highest medical staff capacity with 98 workers followed by Soba and Turawa with 33 workers while Kinkiba have 29 and Richifa had 28 health workers. The least is Rahama ward with only one personnel. The health facilities in Rahama ward were 2 with few health workers.The result showed that only the health care facility situated in Maigana had Doctors while the other health facilities are without Doctors. It also observed that Pharmacist were available only in PHCsand Rural Hospital Maiganawhile nurses/midwives and laboratory technicians were found in 7 and 5 HCFs respectively. Finally, it discovered that all the HCFs had at least one community health worker.

5.2 Conclusion

Healthcare mapping for explicit understanding of relationships between communities (demand) and healthcare facilities (supply) may result into sustainable healthcare management. The integrated approach of Remote Sensing and GIS techniques provide the major tools in the elevation of all attributes (healthcare, capacity, pattern,

settlements and access) to provide the necessary information in the detection of problems faced by inhabitants in their quest for seeking health and proffering solutions to the medical challenges.

The study concluded that, there are 48 primary healthcare facilities and only one secondary healthcare facility that is Rural Hospital located atMaigana ward. The facilities are randomly distributed across the area, clustering in areas like Kinkiba, Turawa and dispersed in Danwata and Rahama.It is also concluded that in most of the facilities it is only the building without supporting facilities. Most of the facilities are not accessible by cars and can only be access via other means of transportation like donkeys, bicycles, motorcycles and so on. The equipment available in the facilities are more of handling minor cases. Such equipment include body weight scale, blood pressure monitor, freezers, protective equipment, sharp containers, stainless steel equipment, auto clave tape etc. Therefore,the need of the peoples can only be met if the facilities is well equipped.

5.4 Recommendations

Based on the outcome of this research on spatial analysis of health care facilities inSoba L.G.A. Kaduna State, the following are recommended:

i. Expansion of Health Infrastructure especially to areas with minimum distance longer than the WHO recommendation. Kaduna state and Soba Local Government should speed up efforts in renovating, building and equipping more health facilities especially in rural areas where the availability of these facilities is either low or non-existence like Danwata ward,Danjaba, Bagaldi andGurbabiya. In the short-term where the facilities are available but in poor condition, government can mobilize funds to renovate and equip these facilities such areas include Gora, Tamba, Madarzai and HayinNa'iya. As a long term measure, the Government through the Ministry of

Health should build more health facilities especially in areas where there are difficulties with access to health care.

ii. Location of primary health facilities should be based on demographic and spatial accessibility. It is the responsibility of the every government to ensure that all citizens in the country have access to health care .Therefore; government should allow the mandated institutions the free hand to select communities that genuinely need health facilities like Danwata with a population 33069 with only one functional health facility, Rahama with only 2 facilities to serve the 23748 inhabitants and so on.

iii. Human resource development in the health sector should be given the needed attention. This can be achieved by retaining existing staff and attracting new ones. Here, government can commit more resources to provide incentives which could be in the form of staff housing and motor bikes to health personnel who accept postings to inaccessible parts of the area. Special allowances should be paid to health personnel accepting postings to rural communities. This would enhance the capacity of lower level facilities such as health outpost and health facilities to treat minor cases that are sometimes referred to hospitals that are located at considerable distances.

iv. Improvement in the provision of functional and serviceable health equipment

Stakeholders such as Government should put in effort in providing health facilitiesespecially those in the rural communities with essential equipmentfor a functional health care facility such as hospital beds, mattress, examination couch, baby dressing table for maternity stainless instrument tray.

Recommendation for Further Study

This study recommends the spatial accessibility of primary health care facilities in Soba LGA based on distance function of minimum, maximum and average distance.

REFERENCES

Abbas, I.I, Auta, S.Z., & Muhammad, R. (2012). Healthcare Facilities Mapping and Database Creation Using GIS in Chikun local government area of Kaduna state, Nigeria. *Global journal of human, social science, geography and environmental geoscience. Vol 12, issue 10 No 1.*

Abdulkader A. Murad (2011) *Creating a Geographical Information Systems-based Spatial Profile for Exploring Health Services Supply and Demand* Department of Urban and Regional Planning, Faculty of Environmental Design, King AbdulazizUniversity, Jeddah-21589, Saudi Arabia.

Abdurrahman B.I. &Nurünnisa U. (2013)*A GIS-based Spatial Analysis of Health care Facilities in Yola, Nigeria*Department of Geodetic & Geographic Information Technologies. The Fifth International Conference on Advanced Geographic Information Systems, Applications, and Services.

Abler, R. (1987). The National Science Foundation, National Center for Geographic Informationand Analysis, *International Journal of Geographical Information System. Pp. 303-26.*

Abubakar, M., Dalhatu U, S., &Adamu, M.Y. (2008) Creating a GIS application for planning in Nassarawa State: *Indian journal of Multidisciplinary Research Vol. 4: pp. 557-592.*

Adamu, Y. M. (2001). *Causes and determinant of maternal mortality in Kano state.* Being a Ph.D Thesis Department of Geography, ObafemiAwolowo University Ile Ife Nigeria.

Adebayo, A.A. (2004). *Mubi Region; Geographical Synthesis. Paracelete Publishers; Yolapp. 17-76*

Adejoh, I., & Martha, O. U. (2006).*Poverty, Health and Well-being of Nigerian Workers*. Theme, 106.

Adejuyigbe, O. 1973. *Location of Social Science Centre in Western Nigeria*, the case of Medical Facilities. Man and Society, 1, 115-142.

Adetunji, M. A. (2010). *Spatial Analysis of Urban Mobility Pattern in Ilesa, Osun state, Nigeria*. Unpublished Ph.D. thesis Department of Geography, ObafemiAwolowo University, Ile-Ife, Nigeria.

Adetunji, M.A. &Adeyinka, M. (2013). Spatial Distribution Pattern and Accessibility of Urban Population to Health Facilities in Southwestern Nigeria. A Case study of Ilesa, Department of Geography, Faculty of Arts and Social Sciences, Federal University Lokoja, Kogi state, Nigeria. *Mediterranean Journal of Social Sciences. Vol. 4 No 2*.

Adewoyin, J.E., Ogunyemi, S.A., Muibi, K.H., Fasote, O., Halilu, S.A. &Alaga, T.A. (2016) Spatial Distribution and Accessibility of Primary Health Facility in Ife East Local Government of Osun State, Nigeria.*Journal of Scientific Research & Reports* 9(7): 1-9.

Adeyemo, D. O. (2005). Local government and health care delivery in Nigeria: a case study. *Journal of Human Ecology*, *18*(2), 149-160.

Agnew, J. (2011). Space and place. *Handbook of geographical knowledge*, 2011, 316-331.

Ahmed, M., 2010. *Creating a GIS application for local health care planning in Kano metropolis.An Unpublished PGD GIS/Remote Sensing* Thesis, Submitted to the Department of Geography Ahmadu Bello University, Zaria.

Ajala, O.A.,Lekan, S &Adeyinka, S. A. (2005). Accessibility of Healthcare facilities; a panacea for Sustainable Rural Development in Osun state.*Journal of Human Ecology. 18(2).*

Akingbola, E. O. (2009). Exploring Accessibility of to public healthcare services in Abuja using GIS.*Journal of Human Ecology*. 18(2): 121-128.

Alabi, M. O. (2011). Towards sustainable distribution of health facilities using GIS; a case study from Nigeria. *American journal for tropical medicine and public health.*Pp. 130

Aluko-Arolowo S. O. (2005). Equity in Health and Federal Character Policy: a study in Rural-Urban Dichotomy, *Babcock Journal of Social Management Science,*Vol 4(1): pp. 38-47.

Amer, S. (2007). *Towards Spatial Justice in Urban Health Services Planning*: a space analytic GIS-based approach using Dar es Salam, Tanzania as case study pp. 299, Utretcht University.

Aref, W. &Samet, H. (1991). *Extending a DBMS with Spatial Operation* Proceedings 2nd International Symposium on Large Spatial Database pp. 299-318.

Atser, J., &Akpan, P. A. (2009). Spatial Distribution and Accessibility of Health Facilities in AkwaIbom State, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, *2*(2).

Ayuba, I.G. & Wash P.M. (2016). Identification and mapping of health facilities in Bukuru town,Plateau state, Nigeria.

Balogun, T.F., &Alaegor, A. G. (2006). An Evaluation of the Spatial Distribution of Healthcare Facilities in Edo state. *Knowledge Review, 12(1), 71-78.*

Becker, L. &Guting, R. H. (1992). *Ruled-Based Optimization and Query Processing in an Extensible Geometric Database System.* ACM Transactions on Database System 17 pp. 247-303.

Benachi, J. &Yasui, Y. 1999. Geographical pattern of excess morality in Spain explained by two indices of deprivation. *Journal of Epidemiology and Community Health, 53:423-431*.

Berman, E. M. & West J. P. (1998). Responsible risk-taking. Public Administration Review, 346-352.

Bindu, B. &Janak, P. J. (2013). A geospatial spatial approach for assessing and modelling spatial accessibility of the primary health centers in the tribal Talukas of the Vadodara district of Gujarat state of India. *International Journal of Geomatics and Geosciences. Volume 3, No 3. Pp.582-591*.

Brabyn, L. & Skelly, C. (2002). Modelling Population Access to New Zealand Public Hospitals. *International Journal of Health Geographics.*

Brinkhoff, T., Kriegel, H. P., &Scheider, R. (1993). *Comparison of Approximate of Complex Objects used for Approximation-Based Query Processing in Database Systems.* Proceeding 9th International Conference on Data Engineering, Vienna, pp. 40-49.

Brunet, M.,,Pichon, M.F., Pallud, C., &Milgrom, E. (1980). *Relationship of presence of progesterone receptors to prognosis in early breast cancer.*Cancer research, 40(9), 3357- 3360.

Brush, J.E. & Gauthier, H.L. (1968). Service centers and consumer trips. Department of Geography, university of Chicago.

Burough, P. (2001). *Principles of Geographical Information System. Spatial Information systems and Geostatistics.* New York: Oxford University Press. 20p

Burrough, P.A. & McDonnell, R.A. (1998). *Creating continuous surface from point data.* Principle of Geographic Information Systems. Oxford university press, Oxford UK.

Census, 1991. National Population Commission. Retrieved from: www.population.gov.ng.

Chang, K. T. (2004). *Introduction to geographic information systems.* 2nd edition, New York McGraw-Hill. Pp. 22.

Chesson, P. (2000). *Mechanisms of Maintenance of Species Diversity*. Annual RevolutionEcological System pp. 343-366.

Christaller, W. (1966). *Central places in southern Germany*. Prentice Hall.

Christopher, A. W. &Fadare, S. O. (2014). *Accessibility of Health Facilities to Residents inIbadan, Nigeria*. Research on Humanities and Social Science.

Clark, P.J. & Evans, F. C. (1954). *Distance to Nearest Neighbour as a Measure of SpatialRelationship in Population. Ecology,* 35. 445-453.

Connolly, T. M. &Begg, C.E. (2005). *Database Systems (4th Ed.)*. London: Pearson Education Limited.

Cribb, A. & Dines, A. (1993). *Health Promotion: concepts and practice*. Oxford Blackwell Science.

Cromely E.K. &Mclafferty S.L (2002) *Analyzing Access to health Services*. GIS and Public Health. Guilford press, New York.

Cromley, E. & Sarah, L. (2005). *GIS and Public Health*. Mc. Lafferty 2nd Edition, the Guilford. Pp. 20.

Darlgren, C.N. (2008). Access to Health Services in Zambia, Health Policy and Planning. Vol10. No. 1. 51-57.

Dictionary, M.W. (1993). Sprinfield: Merian-Webster.

Elimelech, M. (2006). The global challenge for inadequate and safe water. *Journal for watersupply: Research and Technology*-AQUA, 55(1), 3-10.

Erinosho O. A. (1998). Health Sociology for Universities, College and Health-related Institutions. Bookman Social Science Series, Ibadan.

Erinosho, O. A. (2006) Health Sociology for Universities, Colleges and Health Related Institutions, Bulwark Consult, Abuja.

Fiebig, T. &Moerkotte, G. (2000). Evaluating queries on structure of the extended access support relations in International workshop on the World Wide Web and Databases (pp 125-136). Springer, Berlin, Heidelberg.

FMoH (2004). Revised National Health Policy, Abuja: Federal Ministry of Health Nigeria. Pp. 5-10.

Gatrell, J. &Loytonen, M. (1998). GIS and Health. London: Taylor and Frances in Southern Germany, (Prentic Hall Inglewood Cliffs, N.J.)

Getis, A. &Ord, J. K. (1996) *Local Spatial Statistics:* an overview in spatial analysis and modelling in a GIS environment, edited by Longley, P. and Batty, M. John Wiley and sons: New York.

Golledge, R. G. (1995). Primitive of spatial knowledge. In Cognitive aspects of human-computer interaction for geographic information systems (pp. 29-44). Springer, Dordrecht.

Guagliardo, M. F. (2004). Spatial Accessibility of primary healthcare; Concepts, Methods and Challenges. *International journal of health*Geographic, 3:3.

Guagliardo, M.F., C.R. Ronico, I. Cheung, E. Chacko & J.G. Josef, (2004). Physician accessibility: An urban case study of pediatric providers. Health Place, 10: 273-283. PMID: 15177201

Ifeanyi, E.R., Ojiako, J.C. &Eze, C.G. (2012). Accessibility analysis of healthcare delivery system within Enugu urban area using Geographic Information System.

Igoh Martins Gad (2013) *Gog Ecology and Assessment of Rabies Awareness in Ahmadu Bello University Residential areas, Samaru,Zaria.* An unpublished UG GIS Thesis, submitted tothe Department of Veterinary Medicine Ahmadu Bello University Zaria.

Inyang, I. B. (1994). Provision of healthcare facilities in Nigeria; the problem of equity and accessibility. Ibom journal of social issues vol. (2) pp.78-91.

Kim, Y., Byon, Y. J., & Yeo, H. (2018). *Enhancing healthcare accessibility measurement using GIS:* a case study of Seoul, Korea plos one, 13(2)

Klauss, G., L. Staub, M. Widmer& A. Busato, 2005. Hospital service areas-a new tool for health care planning in Switzerland. BMC Health Serv. Res., 5: 33-33. PMID: 15882463

Kwaku, K. K. (2008). Spatial accessibility to healthcare facilities in Ajumako-Enyam-Essiam and Denkyira district in Central Ghana.*Norwegian Journal of geography 62(3), 203-209.*

Lekan, S. (2010). Distribution Pattern of Healthcare Facilities in Osun state, Nigeria.*Ethiopian Journal of Environmental Studies and Management Vol.3 No.2*

Leon Wingler, Ahmadu Bello University Zaria &MuyassarSamaha, Bayero University Kano, (2009) *Distribution of Primary Health Care Facilities in metropolitan Kano Using GIS*.

Mabogunje, A. L., (1971). *Growth Pole and Growth centres in the regional development of Nigeria.* Geneva; United Nations Institute for Social Development Report No 71.

Makanjuola, R.O. (2002). Health Care in Nigeria. The National Scholar. A Publication Academic Staff Union of Universities, September pp 27-29.

Masser, D.W. (1988). Linear relation on algebraic groups. New Advances in Transcendence theory, 248-262

Moril, R. C. (1970). The Natural landscape metaphor in information visualization: the role of common sense geomorphology. *Journal of the American society for information science andtechnology,*Vol 61, No 2: 253-270.

Nieuwlaat, R., Wilczynski, N., Navarro, T., Hobson, N., Jeffery, R., Keepanasseril, A.,&Sivaramalingam, B. (2014). *Interventions for enhancing medication adherence.*Cochrane database of systematic reviews, (11).

Novartis Institute for Tropical Diseases (2015). Nature Review Drug Discovery, 14(6), 442-444.

Nuhu, H.T. &Ezikiel, A.V. (2014). Geospatial Distribution of Healthcare Facilities in Mubi North Local Government Area of Adamawa state.*Advanced Journal of Medical Reports and Reviews, Vol.2 (001), pp.008-018.*

O'Sullivan, D. & David, J. (2003). Geographic Information Analysis pp. 356-380, JHON WIIEYand SONS.

Obionu, C.N. (2007). Primary healthcare for developing countries. Publishes by Institute of Development Studies, university of Nigeria Enugu campus, 183-284.

Odimegwu, C., &Okemgbo, C. N. (2003). *Gender role ideologies and prevalence of violence against women in Imo State, Nigeria*. The Anthropologist, 5(4), 225-236.

O'Donnell, O. (2014). *Access to health care in developing countries: breaking down demand side barriers.*Cadernos de saudepublica, 23(12), 2820-2834.

Ogunbodede, E.F. (2007). Assessment of traffic congestion in Akure Nigeria using GIS approach: lesson and challenges for urban sustenance: Department of Geography and planning Science, AdekunleAjasin university, Ondo, Nigeria.

Okarfor, F. C. &Onokerhoraye, A. G. C. (1977).*Rural System Planning Geography and Planning Series.*University of Benin, Benin, Nigeria.

Olajuyin, L.O., Olayiwola, L.M. and Adeyinka, S.A. (1997). *Location Analysis of Health Facilities:* A Case Study of Irewole Local Government Area.

Onokerhoraye, A. G. (1999). *Health and Family Planning Services in Nigeria: A Spatial perspective.* University of Benin publishers. ISBN 9783282417.

Onyemelukwe, G.C. (1996). Herbal Medicine as Potential Source for Anti diabetic Drugs.

Oppong J. R. (2007).*Data Problems in GIS and Health* department of Geography University of North Texas Denton, TX 76203 OPPONG@UNT.EDU

Osotimehin, B. (2009). An address delivered at the Nigerian Academy of science forum on evidence-based health policy making with the theme ''Reducing Maternal and Infant Mortality in Nigeria held in Reiz Continental Hotel.

Parker, E. B. & Campbell, J. L. (1998). Measuring access to primary medical care: some examples of the use of geographical information systems. *Health and place journal, 4(2), pp. 183-193.*

Patel, A.B., Waters, N.M., &Ghali, W. A (2007). *Determining Geographic Areas and Populations with Timely Access to Cardiac Catheterization Facilities for Acute Myocardial Infarction Care in Alberta, Canada*. International journal of Health geographics.

Pavignani, E. (2007). "Module 9. *Studying the Network*" World Health Organization, Geneva.

Penchansky, R. & Thomas, J.W. (1981). The concepts of access. Definition and relationship to consumer satisfaction. Medical Care, 127-140.

Rodrigue, J. P., Comtois, C., & Slack, B. (2016). *The geography of transport systems*. Routledge.

Ronald j. Vogel; *Financing Health care in sub-Saharan Africa* Greenwood press, 1993 pp 18

Rossi-Espagnet, A., Tabibzadeh, I. & Maxwell, R. (1989). Spotlight on the cities: improving urban health in developing countries. World Health Organization.

Rushton, G. (1991). Use of location-allocation models for improving the geographical accessibility of rural services in developing countries in Akhtar R (Eds). *Health care patterns and planning in developing countries*. Westport, Connecticut: Greenwood Press.

Ryan, M., Roland, E. R., Scott, D.A. & Reeves, C. (2001).eliciting public preferences for healthcare. A systematic review of techniques. Health Technology Assessment (Winchester, England) 5(5), 1-186.

Rytkonen, M., E. Moltchanova, J. Ranta, O. Taskinen& J. Tuomilehto et al., 2003. *The incidence of type 1 diabetes among children in Finland--rural- urban difference*. Health Place, 9: 315-325. PMID: 14499216.

Stedman, T.L. (Ed). (1995). Stedman's medical dictionary for the health profession and nursing. Lippincott Williams.

Swain, P.H., Davies, S.M., Landgrebe, D.A., Hopper, R.M., Lindelaub, J.C. & Silva, L.F. (1978). Remote Sensing: the quantitative approach. Mhi.

Tilley-Gyado, R., Filani, O., Morhason-Bello, I., &Adewole, I. F. (2016). Strengthening the Primary Care Delivery System: A Catalytic Investment towards Achieving Universal Health Coverage in Nigeria. *Health Systems & Reform*, *2*(4), 277-284.

Ujoh, F., &Kwaghsende, F. (2014). *Analysis of the spatial distribution of health facilities in Benue State, Nigeria*.Midwives, 68036(65.5), 1527.

Umar, N.K., Musa, I.J., Hassan, M., &Obeka, S.S. (2016). Spatial distribution of primary healthcare facilities in Kano south senatorial districts, Kano state.

United Nation Population Fund (2010). Projeksipunduduk Indonesia, 2035.

Upton, G. J. &Fingleton, B. (1985). *Spatial statistics by example: point pattern and QuantitativeData*, Vol. 1 New York: John Wiley & sons.

Wang, F &Luo W. (2005). Assessing spatial and non-spatial factors for health care access: towards an integrated approach to defining health professional shortage areas. *Health and Place. 11(2): 131-146.*

WHO (1997): *Weekly Epidemiological Record*. Geneva World Health Organization report.Pp. 281-288.

WHO (2010): Anniversary of smallpox eradication. Geneva, *World Health Organization Journal, vol 65(01), pp. 1-4.*

Wilkinson, P., C. Grundy, M. Landon & S. Stevenson, (1998) *GIS in Public Health. In: GIS and Health.*Gatrell, A. and M. Loytonen, (Eds.). Taylor and Francis, London, UK, pp: 179- 189.

Wojuade, C. A. Fadare, S. O. (2014). Accessibility of health facilities to residents in Ibadan, Nigeria. Health, 4(6).

World Development Report (1993). Investing in Health. New York, Oxford University Press, 134-6.

World Development Report (2005). A better investment climate for everyone. The World Bank.

World Health Organisation, (1998): A Vision for All. Life in the 21st Century. Geneva World Health Organisation Report.

World Health Organisation, (2000); Health Systems- Improving performance. *Geneva World Health Reports. Pp. 1-10*

World Health Organisation, (2001). The Declaration of Alma Ata. *The International Conference on Primary Health Care,* Alma Ata. September 1978 pp. 6-12.

World Health Organization (1978). International Classification of Procedures in Medicine (vol. 2).

World Health Organization (1997). Strategies for the prevention of blindness in national programs: a primary healthcare approach.

World Health Organization (2004). Substance Abuse Department. Global status report on alcohol 2004.

World health Organization. (2006). the world health report: working together for health. World Health Organization.

World Health Organization. (2015). *tracking universal health coverage: first global monitoring report*. World Health Organization.

Appendix I: Checklist

Department of Geography

Faculty of Science

Ahmadu Bello University, Zaria.

This checklist is designed to obtain information for a research study titled: **Spatial Analysis of Healthcare Facilities in Soba local government area, Kaduna state, Nigeria using Remote Sensing and GIS.** The study is an academic research leading to the award of Master of Science in GIS and Remote Sensing. I solicit for your support to provide adequate and

accurate information as all information provided will be used for academic purpose and treated as confidential.

Thank you.

SHEHU Zailani

1. Healthcare Facility Coordinates: Northing…….. Easting…….
2. Healthcare Facility Name……...
3. Address of Healthcare Facility……...……...
4. Year of Establishment……...
5. Healthcare Facility Type……
6. Healthcare Facility Category…….
7. Types of Ownership……..
8. Opening Hours……...
9. Hours of Operation……
10. Number of Wards……..
11. Bed Capacity…….
12. Staff Capacity……
13. Number of Doctors……
14. Number of Nurses and Midwives……..
15. Number of Pharmacists…….
16. Number of Lab. Technicians/Scientists……
17. Number of Community Health Extension Workers…….
18. Number of Ambulances……
19. Source of Water……
20. Water Supply: Adequate [ ] Inadequate [ ]
21. Availability of Pharmacy: Yes [ ] No [ ]
22. Availability of Laboratory: Yes [ ] No [ ]
23. Drugs: Adequate [ ] Inadequate [ ]
24. Laboratory Equipment: Adequate [ ] Inadequate [ ]
25. Toilet Facilities: Adequate [ ] Inadequate [ ]

APPENDIX II: presents the names and locations of the existing healthcare facilities found in the study area.

Names and Locations of the existing health care facilities in the study area

SN	NAME OF HEALTH FACILITY	LONGITUDE	LATITUDE
1	PRIMARY HEALTHCARE FACILITY DANWATA	8.18995027	10.94140101
2	HEALTH CARE FACILITY TAKALAFIYA	8.15297374	10.98479867
3	HEALTHCARE FACILITY SOBAWA	8.13595173	10.96997003
4	PRIMARY HEALTHCARE FACILITY GAMAGIRA	7.88898669	10.69457846
5	HEALTHCARE FACILITY DANJABA	7.8588679	10.83518225
6	HEALTHCARE FACILITY GURBABIYA	7.93062648	10.72682981
7	HEALTHCARE FACILITY TAMA	7.88856303	10.74170117
8	HEALTHCARE FACILITY LIMAN IBADA	7.94498201	10.72908286
9	PRIMARY HEALTHCARE FACILITY GARU II	8.0135582	10.84980393
10	HEALTHCARE FACILITY GARU I	8.02360906	10.83591186
11	HEALTHCARE FACILITY BELE	8.04137424	10.94479317
12	HEALTHCARE FACILITY SHARIFAI	8.02861787	10.90885675
13	HEALTHCARE FACILITY FARIN KASA	7.80814393	11.13089785
14	PRIMARY HEALTHCARE FACILITY AWAI	7.90030299	11.06776869
15	HEALTHCARE FACILITY GIMBA	7.95087918	11.07085322
16	HEALTHCARE FACILITY MAGADA	7.9908505	11.12095843
17	HEALTHCARE FACILITY BAGALDI	7.84581408	11.04753289
18	PRIMARY HEALTHCARE FACILITY KINKIBA	7.88078211	11.00767769
19	HEALTHCARE FACILITY DAMARI	7.85679941	10.97582811
20	HEALTHCARE FACILITY TAMBA	7.90967743	10.96922997
21	HEALTHCARE FACILITY FAGACHI	7.89739036	10.94240236
22	HEALTHCARE FACILITY MARWA	7.84302048	11.00040139
23	PRIMARY HEALTHCARE FACILITY KWASALLO	7.99323961	11.18779484
24	HEALTHCARE FACILITY DINYA	7.99450735	11.12714824
25	HEALTHCARE FACILITY TABA	7.83280363	11.13899174
26	HEALTHCARE FACILITY SUDDU	7.88615176	11.13402978
27	HEALTHCARE FACILITY SANBIRNI	7.90731026	11.16988360
28	PRIMARY HEALTHCARE FACILITY KURUN GUFI	8.03634397	11.11993592
29	RURAL HOSPITAL MAIGANA	7.93976804	11.02877774
30	PRIMARY HEALTHCARE FACILITY YAKASAI	7.84742751	11.05223376
31	HEALTHCARE FACILITY TUDUN SAIBU	7.92164180	11.03359754
32	HEALTHCARE FACILITY MATARI	7.83317145	10.93891976
33	HEALTHCARE FACILITY GORA	7.83278012	10.95431776
34	PRIMARY HEALTHCARE FACILITY RAHAMA	8.12735387	10.89187022
35	HEALTHCARE FACILITY ANG. MADAKI	8.11421951	10.91277981
36	PRIMARY HEALTHCARE FACILITY RICHIFA	7.95391302	11.16423303
37	HEALTHCARE FACILITY MAGADDA	7.99028505	11.12095843
38	COMPREHENSIVE PRIMARY HEALTHCARE FACILITY SOBA	8.05556695	10.98827550

39	HEALTHCARE FACILITY KAWARE	8.12630579	11.02989516
40	HEALTHCARE FACILITY KUYAMUTSA	8.10989873	11.01709096
41	HEALTHCARE FACILITY ANG. DAN ISA	8.09204382	10.94367532
42	HEALTHCARE FACILITYYELWA N BENE	8.00121509	10.99817538
43	HEALTHCARE FACILITY YELWAN MAKARANTA	8.01531703	10.99524813
44	PRIMARY HEALTHCARE FACILITY TURAWA	8.06709357	11.07822172
45	HEALTHCARE FACILITY MADARZAI	8.02946642	11.05026347
46	HEALTHCARE FACILITY MAKWARON LEMU	8.10122361	11.12754744
47	HEALTHCARE FACILITY KURUN GUFI	8.03634397	11.11993592
48	HEALTHCARE FACILITY ANG. RIMI	8.04368223	11.10921322
49	CHC ANG. MADAKI TURAWA	8.08922375	11.06327182