ASSESSMENT OF THE IMPLICATIONS OF PETROL FILLING STATIONS DISTRIBUTION PATTERN IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA

BY

ABUBAKAR SAIBU ABDULKAREEM

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT,
FACULTY OF PHYSICAL SCIENCES,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

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BY

Saibu Abdulkareem ABUBAKAR
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DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT,
FACULTY OF PHYSICAL SCIENCES,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

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DECLARATION

I declare that the work in this dissertation entitled **"Assessment of the Implications of Petrol Filling Stations Distribution Pattern in Kaduna Metropolis, Kaduna State, Nigeria"** was carried out by me in the Department of Geography and Environmental Management. The information derived from the literature has been duly acknowledged in the text and list of references provided. No part of this dissertation was previously presented for another degree or diploma in any other Institution.

Saibu Abdulkareem ABUBAKAR _____ _____

Signature **Date**

CERTIFICATION

This dissertation entitled **"ASSESSMENT OF THE IMPLICATIONS OF PETROL FILLING STATIONS DISTRIBUTION PATTERN IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA"** by Saibu Abdulkareem ABUBAKAR meets the regulations governing the award of the degree of Master of Science Degree in Remote Sensing and Geographic Information System of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

Dr. B. Akpu Chairman, Supervisory Committee	_____ (Signature)	_____ Date
Dr. A.K. Usman Member, Supervisory Committee	_____ (Signature)	_____ Date
Dr. A.K. Usman Head of Department	_____ (Signature)	_____ Date
Prof. S. Abdullahi Dean, School of Postgraduate Studies	_____ (Signature)	_____ Date

DEDICATION

This dissertation is dedicated to the Almighty Allah; the all-knowing, who has given me the strength, wisdom and inspiration to carry out this work I say Alhamdulilah, and to my parents and my lovely family.

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ABSTRACT

The present location of petrol filling stations in towns and cities of Nigeria hardly reflects the approved criteria for their location, thereby posing environmental problems. This study therefore analyzed the locational pattern of petrol filling stations and its implications in Kaduna Metropolis using GIS technique. The list of petrol filling stations were collected from the Department Petroleum Resource [DPR]. Field survey was also carried out through which the geographic coordinates of petrol filling stations in the area were captured using hand held Global Positioning System receiver. Convenience sampling technique was used to administer 400 copies of questionnaire to the respondents eliciting information on the implications of the distribution pattern of petrol filling stations. Data were analyzed using Overlay and the Nearest Neighbour Ratio in ArcGIS 10.2 environment to determine the distribution and pattern of petrol filling stations. The Proximity (Buffering) Analysis in ArcGIS 10.2 environment was used to determine the petrol filling stations compliance to DPR standards while frequency tables, charts and mean scores were used to analyze the perceived implications of petrol filling stations distribution pattern. The findings revealed that out of 225 petrol filling stations, 69% were owned by independent marketers. About 76% of the filling stations were located along major roads in Kaduna metropolis. The nearest neighbour index of 0.399 with z-score of -19.129 indicated that the distribution of petrol filling stations in the area had a clustered pattern around each other. The study also revealed that only 16% of the petrol filling stations in the area satisfied the 400 metres distance apart from the nearest petrol filling station and only 3.6% met not more than four petrol filling stations within 2 kilometres radius. It was found that 53% of the petrol filling stations were sited 50 metres away in all angles of the built-up areas, none was within NNPC and PPMC

pipeline 15 metres right of way. Most of the petrol filling stations satisfied the minimum requirement of 15 metres from the PHCN transmission (99%) and rail lines (95%) right of way. The findings further revealed that high volume of vehicular traffic (23.8%) and siting of petrol stations at road intersection/junction (22.5%) were the main factors that influenced the clustered pattern of petrol filling stations in the study area. Traffic congestion due to queues at filling stations and air pollution with mean scores of 2.67 and 2.65 respectively were the most perceived socio-economic implications of petrol filling station's location in the area. The study therefore recommends that the government should enforce relocation of the petrol stations that did not satisfy the DPR standards and the DPR should make compulsory the submission of Environmental Impact Assessment (EIA) report to include the geographic location of the site to be used for construction of petrol filling station to check conformity before approval.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The expression petrol filling station is synonymously understood differently in different countries of the world. Among which are “petrol station”, “fueling station”, or “service station”. Nieminen (2005) defined petrol filling station as an area including fuel equipment and piping, storage tanks, forecourt and possible building premises for the sale of fuel (inflammable liquids) to customer’s vehicles (Hanekom, 2001; Genovese, 2004; Spencer, 2004). Similarly, Ayodele (2011) viewed filling station, petrol station, gas station or petroleum outlet as any land, building or equipment used for the sale or dispensing of petrol or oil for motor vehicles or incidental thereto and includes the whole of the land, building or equipment whether or not the use as a petrol station is the predominant use or is only a part thereof. Most filling stations sell petrol or diesel; some carry specialty fuels such as liquefied petroleum gas, natural gas, hydrogen, biodiesel or kerosene while the rest add shops to their primary business (Hamid, Iman, Suriatini and Martin, 2009). According to Odeh (2017) petrol station is a retail establishment where motor vehicles are refueled, lubricated, serviced, and sometimes repaired.

In Nigeria, the first petrol station was established in Lagos by Total in 1956 (Udoh, 2013). Thereafter the number multiplied to other regions of the country. However, their classification and standard slightly differ from that of the other parts of the world. According to the Department of Petroleum Resources [DPR] (2010), In Nigeria based on specification, purpose, capacity and location, petrol station could be classified into either category A or B.

Category “A” petrol stations refer to industrial petrol stations. It is the petrol stations located within the premises of institutions, establishments, companies and industries for their local consumptions. These petrol stations have few facilities and have small capacities. Category “B” petrol stations are commercial petrol stations located on sites along major highways and streets within towns, cities, outskirt of towns and cities as well as in the villages en route major highways to dispense fuel to the public at payment of regulatory price (DPR, 2010). This is the category that this study considered.

Oetomo and Sesulihatien (2012) discovered that some of the variables considered when selecting location for any utility are proximity to population centers, distance from neighbouring petrol filling stations, the easements of using existing utility, and the magnitudes of environmental pollution parameters. Mshelia, John and Emmanuel (2015) furthered that in locating petrol filling stations, it is important to take some precautionary measures like locating them at a required distance from buildings; places of public assembly such as markets, hospitals and schools and areas of high traffic congestions and residential buildings. Therefore the location of petrol filling station deserves adequate planning guidance and adherence to the locational guidelines because of its significance to the health and safety of the people and hence, the Directorate of Petroleum Resources is the agency saddled with the responsibility in Nigeria.

According to the DPR manual (2007) before operating petrol filling station one has to certify some physical planning standards. Foremost, land in which a petrol filling station must be sited should have been zoned for commercial and industrial uses or be designated specifically for the purpose of a filling station in a sub-division. The prospective land, which a petrol filling station is to be sited should not be less than 33 by 33 square metres or equivalent of two plots of

land. A petrol filling station should be sited 400 meters away from the next petrol station. A petrol station should be sited 50 meters away in all angles of the built-up areas in order to create a buffer zone for the residential house-the buffer zone can be devoted to any non-residential land use. In addition, the distance from the edge of the road to the nearest pump should not be less than 15 meters; and the total number of stations within 2 kilometres radius of the site should not be more than four (4) including the ones under construction. Filling stations should not be located less than 100 meters from school, hospital, theaters, clinics and other public and semi-public buildings. Lastly, the site for a filling station should not lie within Nigerian National Petroleum Corporation [NNPC] and Petroleum Products Marketing Company [PPMC] pipelines right of way or Power Holding Company of Nigeria [PHCN] transmission or railroad lines.

Public's perception on the location of petrol filling stations can be viewed with regard to the knowledge that the public has on standards and guidelines on filling stations locations. Filling stations were traditionally located in largely uninhabited areas (Isabel, Minarro, Ferradas, Caracena, and Rico, 2010). The situation obtaining on the ground proves to be different since many filling stations are being built within urban areas surrounded by residential and public buildings. This trend has been observed regardless of the dangers associated with filling stations. Filling stations come up in newly developed areas only when development reaches a point at which business potential of the areas can be assessed.

Geographic information systems (GIS) approach has been widely used in the people's daily life. GIS provides the appropriate tools for analyzing the effective factors on spatial data and non-spatial data (Keeble, 1968). It is a powerful computer-based tool for the capture, storage, management, retrieval, query, analysis and presentation of spatial data. GIS's ability as

spatial data processing and analysis tools available can be used to manage a wide range of Information (Keeble, 1968; Richards, Croner, Rushton, Brown and Fowler, 1999; Mc-Lafferty, 2003; Mohammed, Saad, Malick and Arif, 2005; Palestinian Central Bureau of Statistics, 2007). The petrol filling stations being spatially distributed necessitated the need to apply GIS in analyzing the implications of its distributional pattern in Kaduna Metropolis.

In Kaduna metropolis, there is high demand for land for socio-economic services that are in high demand. This high land demand often results to land scramble and illegal conversion of land uses, leading to haphazard development and the deliberate location of petrol filling stations in unsuitable areas that are highly vulnerable to hazard (Kaduna State Urban Planning and Development Agency [KASUPDA], 2009). Several problems have come to be associated with these poorly located filling stations. For instance, Samuel (2011) stated that petrol filling stations locations have contributed to traffic congestion, pollution, and fire. However, the dimension and extent of the problems depend on the criteria such as location, size and set back from the road. Today, this has become an important social issue requiring the attention of social critiques and researchers alike. Thus, it is imperative to study the distribution pattern of petrol filling stations in Kaduna metropolis in order to determine how they conform to the locational guidelines set by the regulatory body and their implications.

1.2 STATEMENT OF THE RESEARCH PROBLEM

The rapid population growth rate of most urban centers in Nigeria, Kaduna metropolis inclusive has increased the use of automobiles, generators and other petroleum demanding plants. The pathetic power situation in Nigeria has exacerbated the increasing demand for petroleum products, leading to the proliferation of petrol filling stations and consequently, with

less consideration of the minimum environmental safety requirements for their operations (Afolabi, Olajide and Omotayo, 2011). According to Samuel, Ogoro and Amanoritsewo (2015) the proliferation of petrol service stations is a trend in most of our urban areas. Since the petrol filling stations have spatial dimensions, it is expected that they are sited in an organized and sustainable manner (Olapeju, 2017). However it is noticeable that despite the availability of standards regulating the location of petrol filling stations in Kaduna metropolis, most petrol filling stations are still located in a manner that is chaotic and has the potentiality for socio-economic implications. The implications of this indiscriminate location of petrol filling stations in Kaduna metropolis often result to traffic congestion and even road traffic accidents among others especially during fuel scarcity.

There are quite a number of empirical studies that have been carried out on filling stations location around the world and in Nigerian urban centres. Mohammad (2015) analyzed the location of petrol filling stations in Kano metropolis. The result reveals that there were about two hundred and fourteen (214) petrol filling stations in Kano metropolis in 2012 of which the independent marketers owned 69% of the petrol stations, 26% were owned by major marketers and 5% by NNPC, most of the petrol stations satisfied the minimum set back of 15 meters distance from the road which represent about 96%. However, about 98% of the petrol stations have met the minimum distance of 100 metres away from health facilities. Similarly the petrol filling stations did not meet the minimum distance of 400 metres away from one petrol station to another on the same road.

Mohammad, Musa and Jeb (2014) analyzed the location of filling stations in Kano metropolis against the physical planning standards set by Department of Petroleum Resource,

[DPR] and Kano Urban Planning and Development Agency [KNUPDA] using GIS. The findings revealed of 214 filling stations located along the 43 roads in the study area, 69% were owned by independent marketers, 26% owned by major marketers and 5% owned by the NNPC. Most of the stations (96%) satisfied the minimum requirement of 15 metres distance from the road. Equally 98% of the filling stations met the minimum distance of 100 metres from the healthcare facilities.

Sule, Shebe, Bichi and Atiyon (2006) studied the spatial distribution of filling stations in Kaduna metropolis using ArcView Geographic Information System software. The results of the study showed that there were 193 filling stations, and 68% were owned by the independent marketers. Although the study aimed at inventory and showing the location of the filling stations, but the spatial pattern of the stations was not considered. Similarly, Ayodele (2011) examined the spatial distribution of filling stations in Kaduna North Local Government Area of Kaduna state. The study identified the pattern and distribution problem in the area. The study found that there were 22 filling stations which were unevenly distributed along major roads. In addition, the study examined the setbacks and locational situation of the stations and concluded that 69.5% of the filling stations did not conform to the standard.

Tah (2017) carried out a GIS-Based locational analysis of petrol filling stations in Kaduna metropolis. The study analyzed the locations of filling stations in Kaduna metropolis against the physical planning standards set by Department of Petroleum Resource (DPR) and Kaduna State Urban Planning and Development Agency (KASUPDA). Names and addresses of the filling stations were obtained from DPR, Kaduna. Global Positioning System (GPS) Garmin 78s map was used to capture the locations of the filling stations. Frequency tables and spearman

correlation inferential statistics were used to analyze the data. The findings revealed that 74% of the petrol filling stations were owned by independent marketers, 18% owned by major marketers and 8% owned by the NNPC. There was significant correlation between the number of filling stations and the road hierarchy. The findings revealed that 86% of the filling stations did not meet the minimum distance of 100 metres from the healthcare facilities, 84% did not meet the criteria of 400 metres minimum distance to other stations where located on same road side. This study was limited to petrol filling stations compliance to minimum of 400 metres distance apart, distance from the road, distance to nearest healthcare facilities and school standards only but did not consider other DPR standards such as not more than four petrol filling stations sited within 2 kilometres radius, 50 metres away in all angles of the built-up areas to create a buffer for residential houses and a petrol station should not lie within 15 metres NNPC/PPMC pipeline right of way or PHCN transmission and railway lines. These are crucial DPR standards which compliance among petrol filling stations needs to be investigated. More so, the implications of petrol filling stations distribution pattern as perceived by the people living within the area.

Sule, Shebe, Bichi and Atiyon (2006); Ayodele (2011); Muhammad, Musa and Jeb (2014); Muhammad (2015); Tah (2017) studies focused on spatial distribution, geo-database creation, patterns of location of petrol filling stations in different parts of Nigeria and compliance to some DPR standards using one or more GIS techniques. Conversely, none of these studies to the researcher's knowledge attempted to assess the implications of petrol filling stations distribution pattern in Kaduna metropolis. This is the gap in knowledge that this study intends to fill It is therefore against this background that the study intends to analyze the locational pattern

and distribution of petrol filling stations in Kaduna metropolis, Nigeria. The research provided answers to the following questions:

1) Where are the petrol filling stations located in Kaduna metropolis?
2) What is the distribution pattern of the petrol filling stations in Kaduna metropolis?
3) To what extent do the petrol filling stations comply with DPR standards?
4) What are the implications of petrol filling stations distribution pattern?

1.3 AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to assess the implications of petrol filling stations distribution pattern in Kaduna metropolis, Nigeria. The specific objectives were to:

i. identify and map the petrol filling stations in Kaduna metropolis.
ii. determine the spatial distribution pattern of petrol filling stations in the study area.
iii. determine the extent to which petrol filling stations comply to DPR standards
iv. examine the perceived implications of petrol filling stations distribution pattern.

1.4 SCOPE OF THE STUDY

The spatial scope of this study covered all the petrol filling stations in Kaduna metropolis which comprises of Kaduna North, Kaduna South, parts of Chikun and Igabi LGAs of Kaduna State while the content scope of the study focused on spatial distribution of petrol filling stations, distribution pattern of petrol stations in Kaduna metropolis, and the perceived implications of the distribution pattern. This study considered the following DPR standards namely; that a petrol filling station should be sited 400 metres away from the next petrol station, that the total number of stations within 2 kilometres radius of the site should not be more than four petrol stations

including the one under construction, 50 metres away in all angles of the built-up areas, and a petrol station should not lie within 15 metres NNPC/PPMC pipeline right of way or PHCN transmission or railway lines. The temporal scope of the study covered all existing petrol filling stations registered with the regulating body operational as at year 2017.

1.5 JUSTIFICATION OF THE STUDY

Nigeria is blessed with abundant natural resources and at present, the ninth world producer and sixth world exporter of crude oil (Central Bank of Nigeria [CBN], 2010). Tah (2017) stated that the significant roles petroleum products play in any economy are well known. Chinambu (2011) acknowledged that, petroleum is a key driver of industrial activities. Besides the industrial development, the transportation sector is presumed to be the major consumer of fuel to facilitate mankind's movement patterns around the globe (Taylor, Sichinsambwe and Chansa, 2016). Oloko-oba et al. (2016) asserted that filling stations operations in Nigeria started prior to independence; the production and distribution of petroleum products which did not gain much popularity until independence in 1960 as a result of the fact that the mileage of motor able roads rarely increased and are few vehicles plying these roads. However, the authors further that the recent fast growing population and the high increase of cars and other fuel consuming machines makes demand for fuelling products high which has in turn trigger the numbers of petrol filling stations. This development have triggered the haphazard location of petrol filling station which must be stemmed hence the need for study on petrol filling location pattern.

The implications of distribution pattern of petrol filling stations are a major concern of urban centres particularly in Kaduna metropolis. This therefore, makes the findings of this research work to be useful to urban planners, city administrators, lawyers, engineers and other

professional bodies etc. Similarly, Government and private organizations such as Department of Petroleum Resources (DPR), Kaduna State Urban Planning and Development Authority (KASUPDA), Kaduna Geographic Information Systems (KADGIS) and KEPA. More so it will assist these agencies in carrying out day to day activities as it relates to distribution of petrol filling stations in Kaduna metropolis.

CHAPTER TWO

CONCEPTUAL AND THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

The chapter primarily focused on conceptual issues and review of relevant literature on spatial distribution of filling station facilities in Kaduna metropolis. The conceptual issues encompass the concepts of location and spatial pattern. Consideration was also given to the location theory. Relevant literature was reviewed under the following brief headings history of filling stations, filling stations regulations and compliance in Nigeria, determinants of locational pattern of filling station, locational pattern of filling station and implications of the locational pattern of filling station in Nigeria.

2.2 CONCEPTUAL FRAMEWORK

2.2.1 The Concept of Petrol Filling Station

The expression, petrol filling station (expression commonly used in Nigeria) is synonymously understood differently in different countries of the world. A fuel station is a facility where fuel and lubricants for automobiles are sold. Fuels sold include premium motor spirit (PMS) usually called petrol, liquefied natural gas (LNG), automated gas oil (AGO) commonly known as diesel and dual purpose kerosene (DPK) called kerosene. The retail outlet is also called filling station, gas station and petrol station. The fuels retailed are highly flammable as well as toxic; this implies that the risks of explosion, fire outbreak and environmental pollution are highly possible occurrences if the products are not properly handled (Afolabi, Olajide and Omotayo, 2011). Filling station otherwise known as petrol station, gas station,

refuelling station, or service station across the world is a facility which sells fuel and lubricants for motor vehicles, generators and other machine (Oloko-oba et al., 2016).

Filling stations are roadside facilities specially design to sell gasoline and other products that automobiles use. In addition many also offer other minor repair services such as motor tuning and tire alignment (Jackle, 1978 cited in Mohammed, 2015). According to Keeble (1968), petrol stations should be located not only where they are in fact accessible but where they can be easily located by strangers and that, in details they should be placed where they will little danger and congestion as, much possible. Petrol retailer or entrepreneur is any person who carries on a business which sells petrol for direct delivery into the fuel tanks of motor vehicles retailer or entrepreneur is any person who carried on motor vehicles (Sedgwick, 1969)

2.2.1.1 History of petrol filling stations in Nigeria

Energy adequacy is universally recognized as a crucial parameter for the sustainable development of a nation. The constant increase in oil and gas demand requires the exploration, development and distribution of new energy sources (Tavana, Pirdashti, Kennedy, Belaud and Behzadian, 2012). Ambituuni, Amezaga and Emeseh (2014) argued that petroleum consumption has been on the increase in Nigeria since the early 1980s. This upward trend is evident in the energy consumption data of 2006, 2007 and 2011 where petroleum products represents 53%, 67.3%, and 68.5% respectively of the total energy consumed in the Nigeria (Energy Information Administration [EIA], 2012).

Since the principal function of filling station is to supply the need for the automobile and truck owner, its history is related to that of the automobile. While the first passenger cars were sold in 1895, filling station begin operation in 1905 (Beckman, 1957). However Beckman

maintained that then specialized outlet for selling gasoline and lubricant were unknown. Rather motorist then purchase their product from number of kind retailing stores and service establishments that sell petroleum product together with other business activities. James 1953 argues that the first fuel dispensing stores with underground tank appeared in 1910. These stores specialized in selling motor fuel and lubricant and form large portion of their revenues, and often have physical space for motorist to derive in and receive service off the street.

Mohammed (2015) citing Pees (2004) stated that the first drive in station was opened in Chicago by Standard Oil Company of Indiana in 1913. It furthered that Standard of Indiana was the first specialized filling station. They argue that the company (Standard of Indiana) opened a pump station for automobiles in Minneapolis in 1911, however then the gasoline was pumped into cans and then poured into the vehicle's tank. Imperial Oil had a service station in Vancouver, Canada, in 1908. Standard also opened a curbside station having a rotary pump in Rockford, Illinois, in 1914.

Filling stations in Nigeria dated back to 1907 when the Socony Vacuum first brought the first cargo of sunflower kerosene to this country and since then up to the Nigeria independence in 1960, Oil companies had been in full control of arrangement for supplying petroleum products (Udoh, 2013). Even though the filling stations operations began prior to independence, the business is nothing to write home about till 1960s. This is because till close to independence the mileage of motor able roads hardly increased and the vehicles plying these roads were quite few. However with the independence in the year 1960, construction of more roads, schools, and factories started and consumption of petroleum products sky rocketed. Demands for all grades of petroleum products started to overtake the supply and this became more manifested after the civil

war (Udoh, 2013), hence leading to opening of many filling stations across the country. The filling stations operators are often referred to as oil marketing companies.

Nigeria has over 26,000 petroleum retail stations often called filling stations (PPPRA, 2006), owned by three operators that dominate the industries. These are the major marketers, the independent marketers and the NNPC. Six major marketers (Oando Nigeria Plc., Mobil Oil Nigeria Plc., Total Nigeria Plc., Forte Oil Nigeria Plc., MRS Nigeria Plc., and Conoil Plc.) controls 25.47% share of the fuels retail market; over 3800 independent marketers control 51% of the fuels retail market; while the NNPC controls only 23.43% of the retail market (Ambituuni, Amezaga and Emeseh, 2014).

Even though petroleum independent marketing was seen as a breakthrough in the process of retail and distribution of petroleum products, it is not free from limitations. Shikenan.com (2011) outlined the advantages and disadvantage of both independent and major marketing of Petroleum Company. The advantage of independent marketing is that one should get to choose any name for your filling station and brand it the way you like; not have worry about anything else in particular except the authorities; to choose a representative and an assistant representative to represent his company at the NNPC's Petroleum Products Marketing Company (PPMC) depot nearest him; can get high profit as per as nine naira profit per liter on each petrol product lift. The disadvantage of Independent marketing is one need lift a full tank any time you need to load up which most marketers cannot afford; to own tanker for transporting the product; a depot Representative that has to physically take his bank draft which is issued in the name of NNPC to the Depot and has to be physically present when picking the product up; to advertise his own brand; have insurance on these tankers, and this makes them incur heavy debts when accident

happens; be a member of Independent Petroleum Marketers Association of Nigeria [IPMAN], you will have to pay a sum of 5,000 Naira each time he load petroleum product; and have to employ a company's personnel (Shikenan, 2011).

2.2.1.2 Petrol filling station regulations in Nigeria

The petroleum sector is divided into two which are the upstream and downstream sectors. The upstream petroleum sector involves the search for and production of crude oil and gas. It comprises such activities as; exploration, evaluation and appraisals, development, production and decommissioning (Charles, 1999). On the other hand, the downstream sector involves refining, product storage, transportation, distribution, and retailing. Filling station concerned with distribution and retailing of petroleum products with or without other businesses attach to it. The location and the sitting of filling stations however need careful examination in regard to the control that requires to be exercised, the legal tools that may be required to enforce such control and the optimum conditions that should be created from the point of view of service to the general public.

Filling station has been identified as one of the major generator of traffic hazards, aestheticism reducing and potential fire causal agents (Ujjwal and Sokhi, 2006). It is on this basis that laws and regulations were made by government on sitting and location of filling station so as to minimize and reduce the risk associated. In Nigeria the DPR is responsible for registering and regulating the downstream petroleum sector including the filling station business. Other agencies involve are the state ministries for town planning. Indeed one time the DPR blame the town planning ministries for foul play and lamented that Indiscriminate citing of filling stations in odd

places across Nigerian cities would continue unless the town planning authorities are called to order (Business Day, November 2013).

In the bid to strengthen its control over the industry, the Nigerian National Oil Corporation (NNOC) was established and given responsibility for both up-stream and downstream activities in the sector. The NNOC also looked after Government's participation in the activities of the oil companies. In 1977, the Ministry of Petroleum Resources (which also had regulatory functions) and operates side-by-side with the NNOC, were merged to form the Nigerian National Petroleum Corporation (NNPC). The NNPC combined the commercial functions of the defunct NNOC (that is, exploration, production, transportation, processing of oil, refining and marketing of crude oil and its refined products) with the regulatory functions formerly exercised by the Ministry of Petroleum Resources. In the Ministry of Petroleum Resources, there is a Department of Petroleum Resources (DPR) which has four divisions: Resources Management Division, Inspections Division, Technical Control Division, and Service Division, which has three branches including Economics, Planning and Statistics. The DPR issues the certificates and regulates the activities of filling station (Proshare, 2013).

According to the DPR (2007) procedure guide for grant of approvals to construct and operate a petrol products retail outlet, before one begin petroleum retail outlet or filling station business one has to submit three (3) copies of approved plan. The plan should show the building existing or proposed on the site and the relation to the roadways and adjoining properties. A certificate signed by the Chief Federal/State Fire Officer that the arrangements proposed for the prevention of fire at the site are satisfactory. A certification signed by the town planning authority for the construction of a petrol filling station on the proposed site. Also, a certificate

signed by the divisional police officer or a superior police officer in-charge of the police motor traffic stating satisfaction that the site and layout of the proposed filling station do not constitute an unnecessary traffic hazard. One must show evidence of registration with Corporate Affairs Commission to deal in petroleum products and tax receipt and/or tax clearance certificate for the preceding three years.

According to the DPR manual before operating filling station one has to certify some physical planning standards. These standards are that;

i. Land should be zoned for commercial/industrial use or be designated specifically for the purpose in a subdivision,
ii. The parcel of land should not be less than 33 by 33 square metres or equivalent of two plots of land to allow for the free flow of traffic,
iii. A petrol filling station should be sited 400 metres away from the next petrol station,
iv. A petrol station should be sited 50 metres away in all angles of the build-up areas to create a buffer zone for the residential house and even the non-residential land use,
v. The distance from the edge of the road to the nearest pump will not be less than 15meters,
vi. The total number of stations within 2 kilometres radius of the site should not be more than four (4) including the one under construction,
vii. Filling station should not be located less than 100 metres from school, hospital, theaters, clinics and other public and semi-public buildings,
viii. Finally, the site (for filling station) should not lie within NNPC/PPMC pipeline right of way or PHCN transmission or railway lines (DPR, 2007).

2.2.2 The Concept of Location

Whynne-Hammond (1979) was of the view that, in spatial analysis three elements are very important in any study namely; locations, interactions and regions. Therefore, it is appropriate to review some of the conceptual basis behind the location of phenomena on earth surface. Location is seen as a point or an area in which human activities takes place (Morril, 1970). Generally it could be a room, factory, house, school, filling station, a town or a city, hospital etc., but because of their service and demand to people as well as their hazardous nature, it is best to locate filling stations in distant proximity to the population they are meant to serve. Besides, Mohammed, Musa and Jeb (2014) opined that the demand for petrol services increases with increasing distance from a petrol station.

Service providers in whatever field have been concerned with spatial aspects of service delivery, as such, various theoretical models for optimal spatial distribution of service facilities have been proposed. The various models have included variables such as distance and time travelled the size and shape of catchment areas, and the degree of dispersion of facilities which attempts to explain the spatial distribution and patterns of geographic phenomena in space (Berghmans, Schoovaerts and Teghem, 1984; Massam, Akhtar and Askew, 1986; Rushton, 1991). 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 in the year 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 of space. In the light of the latter, the analysis of spatial patterns becomes particularly intricate if one look not only at spatial patterns created by

the location that entities have in space, but at the combination of spatial and attribute values. From a quantitative perspective, this theoretical construct is most famously summarized by Tobler's (1970) first law of geography (TFL): "everything is related to everything else, but near things are more related than distant things".

Miller (2004) noted that the concept of Testing the First Law [TFL] is implicit in the practice of spatial analysis. In similarly strong terms O'Sullivan and Unwin (2003) parroted that "if spatial autocorrelation (as a way to formalize TFL) were not commonplace, geographic analysis would be of little interest, and geography would be irrelevant. However, if geography is worth studying at all, it must be because phenomena do not vary randomly through space," because the relationship between distance and similarity has additionally been extended into the realm of using space (distance) to represent semantic similarity, a concept also referred to as spatialization (Montello, Fabrikant, Ruocco and Middleton, 2003; Skupin and Fabrikant 2007). Montello and colleagues named their studies "the first law of cognitive geography", stressing the fact that distance ubiquitously is associated with similarity (or dissimilarity). It has to be noted though that several factors, such as connectedness contribute to distance estimations in map-like displays (Fabrikant, Montello and Mark, 2006).

2.2.3 Distribution Pattern

In an effort to understand better how distribution form a pattern, it brings to attention the question, how things are arranged or distributed. Hence, distribution is the arrangement of objects viewed at a variety of scales; these may be at or near the earth, or beyond. Distribution may vary from ordered patterns to apparent randomness. For example, each house in a street or road has its own location but together the houses form a pattern (Rushton, 1991).

In geography, “spatial patterns” refers to the organization and placement of people and objects in the human world. It may refer to the distances between them or the regularity of distribution among them. In other words, refers to how resources, activities, demographics or other features of the landscape are arranged over the surface of the earth (Golledge, 1995). Spatial patterns are everywhere. They include naturally occurring patterns, such as the concentration of plant life in a certain area as well as man-made patterns, such as those found in towns, cities and communities. In fact, everything that has a location in geographic space inevitably creates or contributes to a spatial pattern (Skupin and Fabrikant, 2007).

For example, on a community-wide scale, the study of spatial pattern would include where filing stations are located, how many of a particular types are present, and where the facilities are located in relation to each other and to residential areas. Spatial pattern in this case could include how far apart facilities are or how densely populated they are in a particular residential area using the facilities is. This can be helpful for learning the distribution strategies of filling stations and for understanding the characteristics of the existing ones and how people respond to them. Since a spatial pattern is also seen as perceptual structure, placement, or arrangement of objects on earth and the space in between them, therefore pattern may be recognized because of their arrangement; may be in a line or by a clustering of points (Skupin and Fabrikant, 2007).

However, it does not come as a surprise that geography devotes a large amount of attention to analyzing, identifying and explaining spatial patterns, both in qualitative and quantitative terms (Abler, Adams and Gould, 1971). It also does not come as a surprise that geography education teaches to understand and analyze patterns and to establish connections

between spatial patterns and processes potentially responsible for causing patterns. It is, indeed, worthwhile to understand the role of spatial patterns from the perspective of spatially primitive concepts (Golledge 1995; Marsh, Golledge and Battersby, 2007).

2.2.4 Geographic Information System (GIS)

According to Earth Science Research Institute (ESRI), Geographic Information System (GIS) is a computer system for capturing, storing, querying, analyzing and displaying geographic data. GIS represents a new paradigm for the organization of the information and the design of information system, the essential aspect of which is the use of concept of location as the basis of structuring of information systems. Moreover query can be easily performed, enhanced by graphical representation. A Geographic Information System (GIS) is an automated information system for capturing, storing, analyzing, displaying and managing data and associated attributes that are spatially referenced to the earth. GIS is a tool that allows users to create interactive queries (user created searches), analyze the spatial information, edit data, maps, and present results of all these operations [USDA, 2008]. According to Liang, Masoem, and Hua (2005), GIS provide a common link between two or more previously unrelated databases. The most useful aspect of GIS as a management tool is its ability to associate spatial objects (street names, milepost, route number, etc.) with attribute information. The use of a GIS database provides a stored ‘intelligent’ record of the derived observations and accurately depicting their spatial location on a map (Emakoji and Otah, 2018).

GIS application to spatial analysis has gained traction in recent years, due to the availability of low cost GIS soft wares with user-friendly interfaces. Since the petrol filling stations have spatial dimensions and attributes, the manner in which they are sited can be

understood using GIS techniques. Studies are abundantly available with respect to the locational analysis of petrol filling stations in urban spaces with GIS (Adsavakulchai and Huntula, 2010; Camelli, 2010; Ayodele, 2011; Emwandongo, 2013).

Essentially, the application of GIS in this research encompasses the spatial pattern of filling stations and the physical dimensions of compliance to DPR standards. Therefore, mapping and visualization of filling stations and their relationship to the geographical location of petrol filling stations can allow for better service provision to the underserved populations. Despite widespread recognition that the analysis of patterns and relationships in geographical data should be a central function of GIS, the sophistication of certain areas of analytical functionality in many existing GIS continues to leave much to be desired (Goodchild, 1987). Thus, 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). The same theme has constantly recurred in the GIS literature, among such include: (Goodchild, 1987; Burrough, 1990; Openshaw, 1990).

The GIS software packages such as ArcGIS which constitutes ArcMap, ArcCatalog ArcInfo and ArcView has many functions and tools designed for service provision studies such as filling station. These functions can be used for the visualization of data, spatial analysis and modeling. They are crucially important in any study as they enable better decision-making by providing services status and needs for an area or region from a spatial point of view (Burrough, 1990). Among the other numerous tools include; neighbourhood statistics functions and the network analyst tool.

The neighbourhood statistics functions, for instance, can be used as point data for the location of filling stations, for spatial demonstration of point-pattern. These methods 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 and Fingleton, 1985). The output of this function is more useful for pattern recognition than for the location of individual. Petrol filling stations data such as location of the facilities can be analyzed by this function to identify their spatial pattern in any area. Locational studies can use several GIS based neighbourhood statistics functions such as the focal mean, the focal sum or the focal range, which computes the required statistics for either rectangular or circular neighbourhood shapes (Black, 2003).

2.2.5 Concept of Metropolis

Metropolis is also called metropolitan area. In common parlance, the concept of metropolis has no precise and static meaning. It is often used to mention the global cities of international importance and cosmopolitan characteristics. At the lower level, metropolis is the city that has more importance in a region. Metropolis is a Greek word actually consisting of two words namely meter (mother) and polis (city) hence can be translated as mother city. According Lewis Mumford classification of cities on the basis of technological development levels in Europe there are eopolis, polis, metropolis, megalopolis, tyrannopolis and necropolis. However in ancient times, the term metropolis was reserved for a specific type of a city: the capital of an empire, state, kingdom and places from which the rest of the world (or at least some major territory) was ruled. Thus, a metropolis would rank considerably higher than a provincial city.

Mieg (2010) stated that the metropolis originally defines the relationship between various settlements and a certain city. Bronger (2004) introduced three parameters for the metropolis which include a minimum size of one million inhabitants, a minimum population density of 2,000 inhabitants sq. km and a mono-centric structure. However, in this study metropolis will be conceptualizes as the main city of a state or province which has its suburbs over which the main city exercises a commanding economic and social influence.

2.3 THEORETICAL FRAMEWORK

2.3.1 The Location Theory

In location theory, the spatial pattern of economic activities is explained mainly in terms of transport cost. Therefore, Hoover (1948) 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. However, it has been noted that because of the nature of their activities, public services like filling stations, generally locate primarily with market in mind, and are therefore oriented towards consumer (Market) depending on the transport situation (Hoover, 1948). Thus, the location that is more likely to minimize travel costs for the user populations are those at strategic points in the transport network. In other words, the cost of 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 our case, motorist to filling stations.

In the location of filling station facilities, therefore the main objective is the maximization of social utility or the minimization of social costs for a given users. At the same time, all motorists should have access to filling station. For this reason, the basic issue to note is that a non-monetary criterion is very important in the location of such public facilities. Efficient locations from the owner's point of view are 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

This section discussed the empirical studies conducted on spatial pattern of petrol filling stations according the set objectives of this study.

2.4.1 Spatial Distribution Pattern of Petrol Filling Stations

Samuel (2011) examined the spatial distribution of filling stations in Kaduna North. The study used GIS in mapping the filling stations while descriptive statistics was used in measuring the compliance to standards. The study found that there are 22 filling stations operational in the area and the distribution is uneven as the stations are mostly concentrated along major roads. Most (80.3%) were located within the CBD either on a road junction or at a roundabout constituting traffic problem. Also, 69.5% of the petrol filling stations did not conform to the minimum 400m distances apart, setback and their location in relation to roundabout standards.

Ogundahunsi (2014) analyzed the locational of fuel stations, in Ilesa, Osun State, Nigeria. The study used the Institutional Analysis and Development (IAD) framework to analyze the locational pattern of fuel stations and the underlying implications. The study focused to determining the level of compliance of fuel stations with planning standards and regulations and

examining the physical, social and economic congruence between fuel stations and other land uses in the study area. Fifty (50) fuel stations were sampled for data collection. This was coupled with interview and direct observation. Findings revealed that 60% of the fuel stations were established between years 2000 to 2012. Regarding compliance to standard, only 6% complied with setback regulation from the road; none complied with setback to adjoining residential buildings while 56% complied with landmass regulation. The study also indicated that the distribution pattern of the fuel stations was tending towards clustering. Also, about 82% of the respondents felt that the stations were too close to each other and 94% agreed to the stations being close to residential buildings.

Njoku and Alagbe (2015) studied site suitability assessment of petrol filling stations (PFSs) in Oyo Town, Oyo State, Nigeria. The standard criteria set for PFS siting by Oyo State Urban and Regional Planning Board (OSURPB) and the Nigerian Department of Petroleum Resources (DPR) were considered. The DPR criteria were incorporated to assess possible lapses in the local standards. The study was multi-dimensional, incorporating suitability, proximity and spatial statistical techniques. The results showed that, out of the 113 petrol filling stations [PFSs] in the area, only 2.6% were in high suitability zone, 5.3% in medium as well low and 86.7% in very low suitability zone. Also, assessing the size of PFSs, only 39% had the standard land area while 61% were deficient. Furthermore, only 5% of PFSs in the area had their dispensing pumps at least 15m off the road. More so, the assessment of the spatial pattern of PFSs in the area showed that the distribution of petrol stations are very clustered with less than 1% likelihood that the clustered pattern could be a result of random chance.

Oloko-oba et al. (2016) assessed filling station in Ilorin, Kwara State, Nigeria. The study used geospatial techniques to determine the distribution pattern and assess the level of conformity of the filling stations against the physical planning standards by the regulating bodies. Primary and secondary data were used as data sources. Roads were digitized and a handheld Global Positioning System (GPS) receiver was used to capture the coordinates of filling stations. Frequency tables, nearest neighbourhood ratio and proximity (buffering) were used to analyze the data collected. The finding shows that there were 225 filling stations in the study area with a clustered pattern of distribution. About 71.6% of the filling station met the 15 metres distance standard from the edge of the road while 28.4% violated it. Also, 97.3% of the filling stations violated the 400 metres distance apart between filling stations apart. About 98.7% of the petrol filling stations did not comply with the 2 kilometres radius of four stations.

Ogunyemi et al. (2017) carried out a study on the distribution pattern of petrol service station in Sango-Ota Metropolis in Ado-Odo Ota Local Government Area of Ogun State, Nigeria. The data used included the geographic coordinates of both the petrol service stations and fire service stations using Global Positioning System [GPS] receiver, land use map of the study area, Administrative Map of Ado-Odo Ota and the list of petrol service station. Nearest neighbourhood ratio was used to analyze the data. The result of the analysis showed that Ado-Odo Ota had one hundred and thirty-four (134) petrol service stations and most of these petrol service stations were located along the major road that passes through the centre of Atan Ota, Iyana Ota, Onipanu Ota, Ojuore Junction, Lagos-Abeokuta highway. The findings indicated that the spatial pattern of petrol filling stations in Iju to Iyana road and Iyana to Ojuore road showed a dispersed pattern with nearest neighbour ratio of 1.928377 and 0.957973 respectively. Also in

Abeokuta highway the petrol filling stations showed a random pattern with a nearest neighbour ratio of 0.670344 while Sango Ota road showed clustered pattern.

Dutsenwai, Abdullah, Jamak and Noor (2015) examined the factors influencing customer loyalty in Malaysian petrol stations. Using convenience non-probability sampling, data was collected from 223 customers of petrol stations using self-administered questionnaire. Descriptive statistics, correlation and regression analysis were used to analyze data. It was found that all predictors were positively and significantly correlated with customer loyalty with product assortment (0.568) and sales promotion (0.451) contributing more to customer loyalty in petrol station among other predictors. The main effect of the predictors (product assortment, service quality and sales promotion) accounted for 39.8% of the variance in customer loyalty which was found to be significant. Also, the location of petrol station was found to have influenced the customer loyalty.

Mwenda and Oloko (2016) examined the determinants of motorists' choice of a petrol station in Thika Sub County, Kenya. A total of 260 copies of questionnaire were administered randomly to the sampled respondents from each of the 12 petrol stations in Thika town and the data collected was analyzed using descriptive and inferential statistics using the Statistical Package for Social Sciences. The findings revealed that friendliness of petrol station staff was the most critical factor in service station selection by motorists with a mean value of 2.13. The motorists agreed that they considered accessibility preferences (entering the petrol station, speed limits, turn restrictions and other service factors) with 2.13 mean values. Also, the brand and reputation of a petrol station as well as petrol station's image and reputation were the most important factors in building motorist loyalty towards the station with mean value of 2.06 each.

2.4.2 Extent of Petrol Filling Stations Compliance to DPR Standards

Several authors have through their findings shown the failure in compliance to standards of siting filling stations in many parts of the world and also in Nigeria particularly. For instance, Ujjwal and Sokhi (2006) applied GIS for petrol station vulnerability assessment in New Delhi, India. In their study land uses within the 200 metres radius from each filling station were identified using high resolution Ikonos image and coordinate of the station were obtained using GPS. Stations were categorized into vulnerability classes on the bases of the use, density and population with 200 metres buffers. The study revealed that many of the petrol stations in that area fail to comply with the standard of distance from residential areas, adequate firefighting equipment and distance from the road.

Ioj and Tudor (2011) examined the temporal changes in proximity of residential land use to filling stations in Bucharest suburban, Romania. Geographic coordinates of the filling stations were obtained using GPS, aerial photographs and Google earth maps were used to digitize the residential areas. Frequency tables and buffering were used to analyze the data. Buffer zones were created to see the encroachments of the residential areas. The findings revealed that 35% gas stations were located in the residential areas and 65% gas stations were located in non-residential area. About 16.7% of gas stations located in residential areas which were against the standard. Also, the number of residential areas located in 15 metres buffer zone increased by 55.6% between the years 2005 and 2008 and in the second buffer zone of 50m the number increased by 24.1% within the same period.

Ahmed et al. (2014) studied the health risk and safety of petrol stations in Minna town, Niger State Nigeria. The study determined the level of awareness of hazards and safety measures

among petrol filling stations and assessed the prevailing safety practices in petrol filling stations in the area. Data was collected using an interview, questionnaire survey and field observation. Frequency table was used to analyze the data. The findings revealed that about 90% of the petrol filling stations were owned by the independent petroleum marketers and 65% of the station's attendants were not properly trained on safety. Also, only 34% complied with the 30 metres distance away from residential buildings and 66% did not comply with the 30 metres distance from the edges of the road.

Samuel, Ogoro and Amanoritsewo (2015) studied petrol filling stations location and minimum environmental safety requirements in Obio Akpor LGA, River State Nigeria. The study examined the proliferation of petrol filling stations in relation to the minimum environmental safety requirements by the Department of Petroleum Resources (DPR) that 'distance from the edge of the road to the nearest pump and from the next petrol filling station should not be less than 15 metres and 400 metres respectively. The Global Positioning System (GPS) was used to acquire the coordinates of each filling station in the study area. Distances between filling stations from the road and from each other were determined using the ArcGIS 9.3 measurement tool alongside buffering analysis in respect to their coordinates. Buffering analysis was used to examine the conformity of petrol filling stations to the DPR standards. The findings revealed that conformity to 400 metres required distance from one another was met by only 23% whereas 33% conformed to the required 15 metres distance from the road.

Olapeju (2017) examined the potential chaos associated with spatial distribution of gas filling stations in Ilaro town, Ogun state. Buffering and proximity analysis were in ArcGIS as well as frequency tables were used to analyze the data. The findings showed that with respect to

threshold land size of 1188m^2, 41.2% of the filling stations complied while only 17.7% were in conformity with 9 metres setback from the road. About 50% of the petrol filling stations have their nearest neighbour filling station on either side of the road locating outside the radius of 300 metres and 32.4% of the petrol filling stations comply with the minimum setback of 100 metres from places of worship. Also, concerning minimum setback of 100 metres from school 47.1% complied and 85.3% to hospitals. The nearest neighbour analysis with value of 0.33 indicated that the locational pattern of petrol filling stations tend towards clustering.

Yunusa (2017) appraised the compliance level to Environmental Management Plan by petrol filling stations in Kaduna metropolis. For this study, data was obtained from published documents, questionnaire was administered to the managers of the filling stations and observation using checklist. Three categories of filling stations sampled include, major marketers, independent marketers and NNPC managed stations. Multi-stage sampling was used in selecting the 290 filling stations for this study. Both descriptive statistics and Kruskal-wallis test were used to analyze the data. Findings revealed that 80% of the filling stations do not have an EMP. The level of compliance to EMP was higher among the major marketers than in NNPC and independent marketers. The Kruskal-wallis test shows a significant difference in the level of compliance between the three categories of filling stations. It was found that 90% of the filling stations agreed that the EMP followed by a successful implementation and monitoring will improve filling stations level of compliance with environmental laws and regulations relating to operation of filling stations level of compliance reaching almost 100%, and can reduce the identified impacts to an insignificant level. Furthermore, the study also revealed that, only 17% of the filling station kept record of reports, injuries, accidents, diseases and dangerous

occurrences, 60% lack certification and 47% lack adequate training for workers which serves as constraints to EMP implementation.

2.4.3 Implications of Petrol Filling Stations Distribution Pattern

In the fuel retailing business, location is very important because it determines the turnover (Uba, 2013). Associated with the location decision are consequences which may not be intended or desirable. Several reports have shown the negative consequences of locating fuel stations in residential areas (Adewumi, 2013; Adedeji, 2013; Bello, 2013). Evident are the countless incidences of PFS fires lately in Nigeria, such as that of Mobil petrol station on Oba Akran Avenue, Ikeja, Lagos state (Kazeem, 2014), Jobayo filling station on Nwaniba Road, Uyo, Akwa Ibom State (Effiong, 2014), Okozak Petrol Station, Uzuakoli in Bende Local Government Area of Abia State (Anayo, 2014), all in 2014 and the Conoil filling station, opposite Nigerian National Petroleum Corporation (NNPC) headquarters in the Federal Capital Territory, Abuja incidence in 2013 which often have affected the people living the immediate environs of the PFS.

Nwanjo and Ojiako (2007) investigated the potential health hazards of petrol stations on attendants in Owerri, Nigeria. Attendants from twenty filling stations were assessed in the area and another twenty that were not exposed to its vapour were used as control. The findings showed a significant increase in the ($p<0.05$) activities of alkaline phosphatase, alanine and aspartate aminotransferases for those exposed to petrol vapour from 6-10 years while the plasma bilirubin concentrations showed no significant change ($p<0.05$). The concentrations of serum urea, creatinine and urinary protein for those exposed to petrol vapour from 6-10 years were found also to be significantly higher ($p<0.05$) when compared with the control. Also, findings

indicated that exposure to petrol vapour increases the activities of some serum diagnostic liver enzymes and may also affect renal function indices. The study concluded that these effects are directly related to the duration of the exposure due to incompliance with the required outfit kits for petrol attendants by most of the petrol stations.

Afolabi, Olajide and Omotayo (2011) assessed the safety practices of filling station in Ile-Ife, South Western Nigeria. Data was collected using a self-administered questionnaire and an observational checklist. Data was analyzed using tables, charts and Fisher's exact test. It was found that out of the 27 filling stations in the area, 52% were owned or run by conglomerates and only 11.1% of the petrol filling stations had a minimum required distance of 30 metres between the edge of the road and the dispenser nearest to the road. About half (52%) were located less than 30 metres from residential areas and 37% had pumps close to the road that permits refueling while still parked on the road. The findings showed that 94% were aware of safety measures and fire extinguisher (54%) was most common safety measure known. Fire hazard (94%) was the most common hazard known and only 10.5% reported of fire incident in the past.

Mshelia, Abdullahi and Dawha (2015) evaluated the environmental effects of the petrol stations in their neighbourhoods in Maiduguri and Jere. Data for the study were obtained through field survey where the functional statuses of those petrol stations were recorded and GPS (Garmin 76 CSX) devise was equally used to determine their co-ordinates. Three household heads around each of the 35 sampled petrol stations were randomly sampled to provide information on the activities of the petrol stations that are either improving on the well-being of the residents or detrimental to their lives. Data sourced were then analyzed using simple descriptive statistics and GIS Software and the results presented in charts and tables. It was

found that 50.7% of the sampled residential houses were located at unfriendly distances (less than 50m) to petrol stations. The findings indicated that air pollution (74%) and traffic accidents (45%) were the highest perceived danger in relation to the distance between the petrol stations and the residential settlements. Besides, respiratory disease (30.1%) was found to be suffered most by the workers in the petrol stations and the residents living nearby these petrol stations.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the study area in terms of the location, size, climate, population, people, land use pattern and economic activities. It also described the data types, data sources, sampling technique and the techniques used for data analysis.

3.2 STUDY AREA

3.2.1 Location and Size

Kaduna metropolis is located between Latitudes 10°26'0" and 10°38'0"N of the Equator and Longitudes 7°22'0" and 7°32'0"E of the Greenwich Meridian (Figure 3.1). The study area comprises of Kaduna North, Kaduna South, part of Igabi, and Chikun Local Government Areas. Kaduna metropolis covers roughly 50km² from the city centre.

3.2.2 Climate

Based on Ayoade (1988) classification, Kaduna metropolis has a tropical continental climate type characterized by wet and dry season. The tropical continental is more pronounced in the dry season particularly in December and January. The dry season is dominated by the north-east trade wind called Harmattan which prevails between November-February.

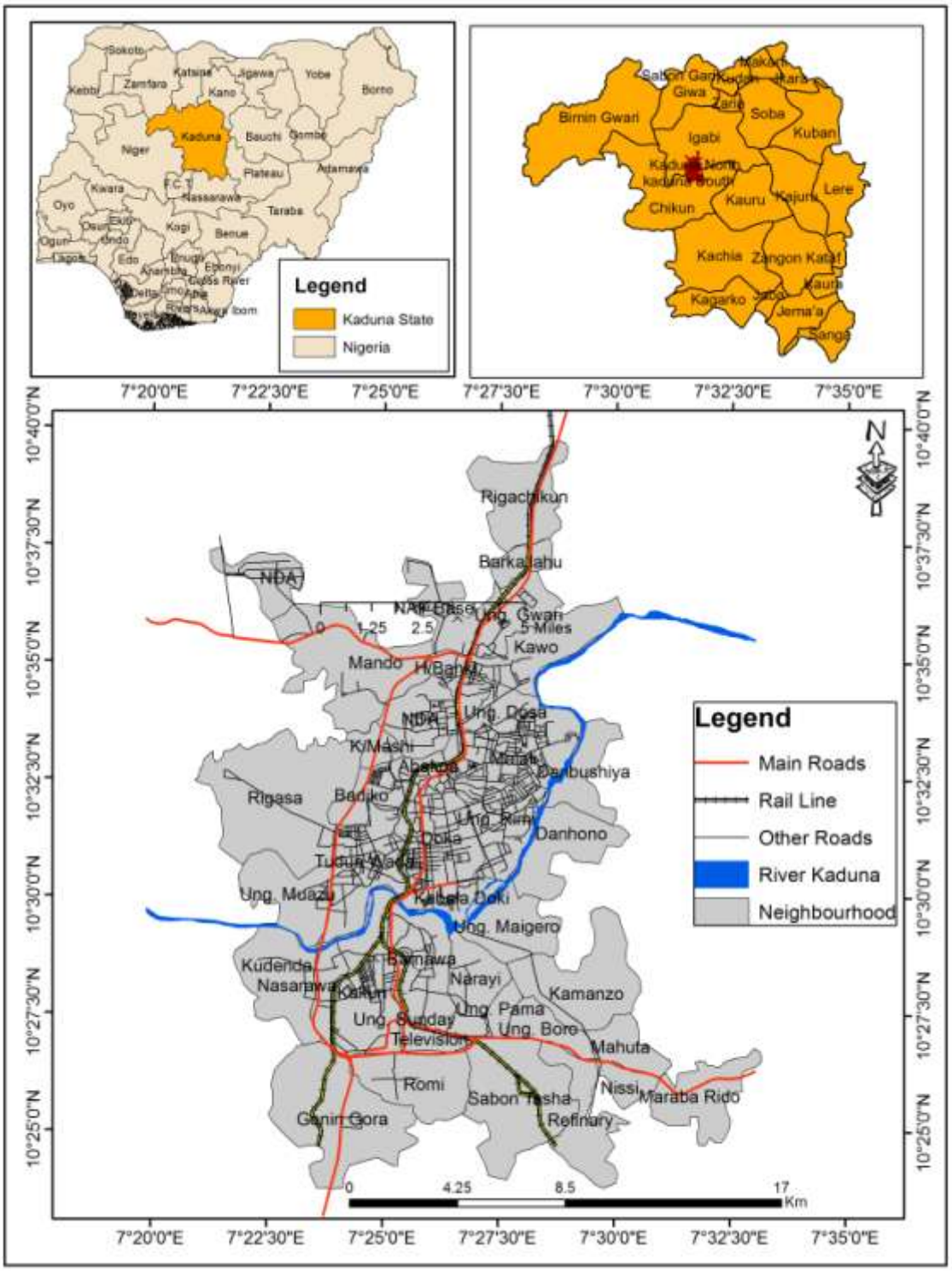

Figure 3. 1: Kaduna Metropolis (The Study Area)
Source: Google Map, 2017.

The dry season is also rainless from October to April. The wet season is dominated by the tropical maritime trade wind which starts around May to October. The area has a mean daily temperature showing a major peak in April. As such, temperatures are hot all year round except for the dry cool and dusty months of harmattan in November to February. The maximum temperature seldom falls from about 36°C as in April to about 27°C in the heart of rain season (August-October). The annual rainfall is about 1000mm (Ayoade, 1988).

3.2.3 Population and People

Kaduna metropolis is a trade centre and a major transportation hub for the surrounding agricultural areas with its rail and road junction. The population of the four LGAs that make up Kaduna metropolis stood at 1,570,331 based on 2006 Nigerian census (National Population Commission [NPC], 2009). Some of the major ethnic groups in the state includes: Hausa, Fulani, Baju, Ham, Gbagyi, Koro Kaninko, Gure, Kurama, Atyap, Ikulu, Aegorok Adara, Atakad, Chawai, Kagoma, Kahugu Nimzo and Numana (Tourist Guide, 2009). There are other ethnic minorities such as Yoruba and Igbo among others, who have come as immigrants from western, eastern and other parts of the country. Islam and Christianity are the major religion with other traditional forming the minority group.

3.2.4 Land Use Pattern

Residential land uses occupy the largest area in Kaduna metropolis. This consists of low, medium and high residential neighbourhoods. The major residential areas include; Kawo, Unguwar Dosa, Hayin Banki, Badiko, Rigasa, Tudunwa, Tudun Nupawa, Malali, Unguwar Rimi, Kabala West, Kabala Costain, Kabala Doki, Narayi, Makera, Barnawa, Sabon Tasha, Television, Romi, Gonin Gora, among others. These neighbourhoods are a combination of

modern and traditional categories. Most of the high rise building are found around the central business district, and are characterized by impervious surfaces (Ali, 2004). With this land use pattern, situation of petrol filling stations within residential areas will be common practice.

3.2.5 Economy

The activities in Kaduna metropolis reflect the commercial, services, administrative, industrial, transport and professional needs of the state and northern Nigeria. The 1956 capital territory law created the limits of the present day Kaduna metropolis and set in motion, the rapid and dynamic physical, economic and social transformation of the town. This resulted to the establishment of modern infrastructural facilities such as electric power supply, pipe borne water, good roads, banks, telephone services and international airport (Ayoade, 1988). These modern infrastructures were the backbone of the establishment of industries like; textile mills, breweries, bottling companies, flour mills, motor assembly plants, to mention a few. These have attracted many, especially the youths, to seek for employment and share in the economic development of the town. These industrial growth and high rate of urbanization has attracted both national and international business men, and has make Kaduna metropolis one of the strongest commercial center in northern Nigeria and the country at large (Ali, 2004).

3.3 METHODOLOGY

3.3.1 Reconnaissance Survey

A reconnaissance survey of the study area was undertaken in order to have adequate knowledge of the study area. It also helped the researcher to gain good knowledge on problems posed by petrol filling stations in the study area.

3.3.2 Type and Sources of Data

The type of data and source used for the research is as shown in Table 3.1.

Table 3. 1: Types and Sources of Data Used

Type of Data	Source	Purpose
Road network shape file	Open Street Map (2018)	This was used to extract the features such as road network, settlement
List of petrol filling stations	Department of Petroleum Resources, Kaduna State	To ascertain the number of petrol filling stations
Geographic coordinates of petrol stations locations	Hand Held GPS	Map the distribution of petrol filling stations
Environmental standards for siting petrol filling stations	Department of Petroleum Resources, Kaduna State	Measure compliance to planning standard requirements
Residents perception on implications of petrol filling stations locations	Questionnaire	To establish the perceived implications of petrol filling stations

Source: Author's Compilation, 2017.

3.3.3 Data Processing

The downloaded road network shape file from Open Street Map was imported into ArcGIS 10.2. Also, the x and y coordinates of the petrol filling stations and their attributes were entered in Microsoft excel and then saved as Comma Separated Values CSV (comma delimited) format and imported into the ArcGIS 10.2 environment. The x and y coordinates define the position of a petrol filling station on the map as a point feature with each point having its own attributes.

3.3.4 Sample Size and Sampling Technique

In order to obtain the sample size, 2006 population of each of the neighbourhoods that make up Kaduna metropolis was projected to 2017 using exponential formula with inter-census growth rate 3.18% for Kaduna State, which gave a total population size of 1,833,427.

$P_{t+n} = P_t\, e^{r*n}$

P_{t+n} = Population at the future date (2006)

P_t = Base year population (2017)

e = exponential sign

r = growth rate (3.18%)

n = interval between the base year and future year (11)

Using the projected population size as the study population, Yamane (1967) formula was used to calculate the sample size at 95% confidence level and 5% sampling error assumption thus;

$$n = \frac{N}{1 + N(e)^2}$$

Where,

n= Sample size
N= Population size
e= Margin of error (0.05)

Based on the formula, 400 respondents were sampled for this study (Table 3.2). The proportionate distribution of the sample size by sampled neighbourhoods in the study area is as shown in using

$$\text{Sample Size per neighbourhood} = \frac{\text{Neighbour population x Sample size}}{\text{Total neighbour population}}$$

Table 3. 2: Distribution of Sample Size

S/No	Neighbourhood	1991 Population	2017 Projected Population	Sample Size
1	Abakpa	13539	30709	7
2	Badiko	16265	36891	8
3	Badarawa	32737	74252	16
4	Barnawa	32684	74132	16
5	Doka	53911	122278	27
6	Gonin Gora	3806	8633	2
7	Hayin Banki	16538	37511	8
8	Kabala Doki	22694	51473	11
9	Kakuri	77374	175496	38
10	Kawo	37107	84164	18
11	Kurmin Mashi	20026	45422	10
12	Malali	22677	51435	11
13	Narayi	40164	91098	20
14	Nassarawa	30781	69816	15
15	Rigachukun	7812	17719	4
16	Rigasa	72483	164402	36
17	Romi	8182	18558	4
18	Sabon Tasha	41121	93269	20
19	Television	28344	64288	14
20	Tudu Wada	60299	136767	30
21	Unguwar Gwari	10781	24453	5
22	Unguwar Sarki	6509	14763	3
23	Unguwar Dosa	19658	44587	10
24	Unguwar Muazu	37713	85539	19
25	Unguwar Shanu	18442	41829	9
26	Unguwar Rimi	52717	119570	26
27	Unguwar Sanusi	23971	54370	12
	Total	**808335**	**1833427**	**400**

Source: Author's Computation, 2017.

Convenience sampling technique was used to administer questionnaire to the adult members of the neighbourhood where petrol filling stations were located at household level in the study area. Only adults (above 20 years) were administered questionnaire. This ensured that only respondents with adequate knowledge on environmental issues like situation of petrol filling stations and its implications in the study area were administered questionnaire hence the reliability of the responses from them.

3.3.5 Data Analysis

Both descriptive and non-parametric inferential statistical test were used in analyzing the data for this study while the petrol filling station geographic coordinates for the spatial pattern was analyzed in ArcGIS 10.2 environment.

Objective 1: **To identify and map petrol filling stations in Kaduna metropolis**

This was achieved through importing the geographic coordinates of the petrol filling stations from the excel file into ArcGIS 10.2 environment which was overlaid on the road network shape file obtained from the Open Street Map of Kaduna metropolis. The result was presented in map and simple frequency percentage tables.

Objective 2: To determine the pattern of distribution of petrol filling stations in the study area

The spatial pattern of distribution of petrol filling stations was determined using Average Nearest Neighbour statistical tool in ArcGIS 10.2. Data on geographic coordinates of petrol filling stations was used for this analysis. The average neighbour in ArcGIS calculates the Z-score and the nearest neighbour index. The Average Nearest Neighbour Ratio is given by (Clark and Evans, 1954 cited in Lawal, 2017);

$$\frac{Observed\ Mean\ distance}{Expected\ Mean\ distance} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

The Average Nearest Neighbour tool measures the distance between each feature centroid and its nearest neighbour's centroid location. It then averages all these nearest neighbour distances. According to Bob and Andy (2009) the average nearest neighbour ratio is calculated as the observed average distance divided by the expected average distance (expected average distance being based on a hypothetical random distribution with the same number of features covering the

same total area). If the average distance is less than the average for a hypothetical random distribution, the distribution of the features being analyzed is considered clustered. If the average distance is greater than a hypothetical random distribution, the features are considered dispersed.

Objective 3: To determine the extent to which the location of petrol filling stations comply with DPR standards

This was achieved through the use of Proximity Analysis (Buffering) in ArcMap environment to determine the level of conformity of petrol filling stations in Kaduna Metropolis with respect to the minimum 400 metres distance between petrol filling stations and that the total number of stations within 2 kilometres radius of the site should not be more than four petrol stations including the one under construction, 50 metres away in all angles of the built-up areas, and petrol filling stations not lying within 15 metres NNPC/PPMC pipelines right of way or PHCN transmission or railway lines DPR guidelines. Also frequency tables were used to show the extent of compliance to DPR standards.

Objective 4: To examine the perceived implications of the distribution pattern of petrol filling stations

This was achieved using the data collected on the perceived implications of petrol filling stations in Three-Likert rating scale of Agree (A) = 3, Not Sure (NS) = 2 and Disagree (D) = 1 was analyzed using weighted mean score and ranked in descending order. To obtain the mean score, respondents rating was added together 1 + 2 + 3 = 6, and later divided by 3. Table was used to present the result.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter summarized the socio-demographic characteristics of the respondents and analyzed the spatial distribution of petrol filling stations and petrol filling compliance level to DPR standards based on the data collected during the field survey. Similarly, the implications of petrol filling stations distribution pattern as perceived by the residents in the study area were examined and discussed.

4.2 IDENTIFICATION AND MAPPING OF PETROL FILLING STATIONS IN KADUNA METROPOLIS

The spatial distribution of petrol filling stations varies across the roads in Kaduna metropolis, operators/ownership, road type (major or minor) and the various neighbourhoods in the study area. The geographic coordinates obtained of the petrol filling stations obtained from the field survey with the aid of Global Positioning System (GPS) receiver was used to determine the spatial distribution.

4.2.1 Distribution of Petrol Filling Station along the Roads in Kaduna Metropolis

Table 4.1 shows the spatial distribution of petrol filling stations along the roads in Kaduna metropolis. Table 4.1 indicates that there were two hundred and twenty-five petrol filling stations existing in Kaduna Metropolis and they were located along twenty four (24) roads in the study area. Figure 4.1 gives a graphical representation of the distribution of petrol filling station in Kaduna Metropolis.

Table 4. 2: Distribution of Petrol Filling Stations in Kaduna Metropolis

Location	Number of PFS	Percentage
Abuja-Kaduna Road	14	6.2
Ahmadu Bello Way	5	2.2
Ali Akilu Road	8	3.6
Aliyu Makama Road	6	2.7
Constitution Road	2	0.9
Dutsima-Ribadu Road	2	0.9
Golf Course Road	1	0.4
Junction Road	4	1.8
Kachia Road	7	3.1
Karaye Road	1	0.4
Kano Road	2	0.9
Lagos-Mando Road	7	3.1
Link Road	6	2.7
Mohamadu Buhari Way	2	0.9
Murtala Mohammed Road	3	1.3
Nnamdi Azikiwe Road	83	36.9
Nuhu Aliya Crescent	2	0.9
Polytechnic Road	2	0.9
Rigasa Road	4	1.8
Sabo Tasha-Kachia Road	32	14.2
Shagari Road	1	0.4
Television Garage Road	5	2.2
Television Bye-pass Road	11	4.9
Kaduna-Zaria Road	15	6.7
Total	**225**	**100**

Source: Field Survey, 2017

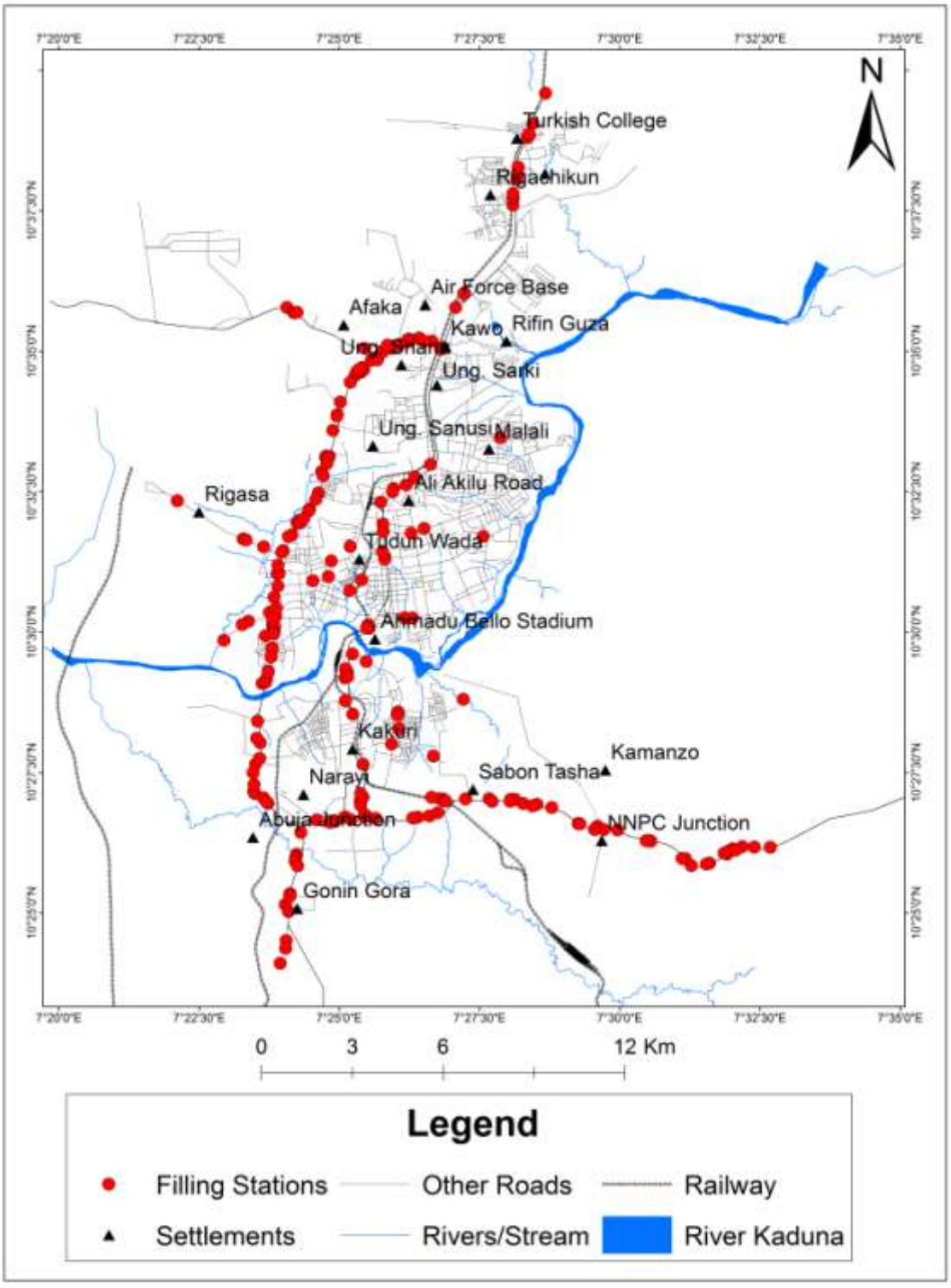

Figure 4. 1: Distribution of Petrol Filling Stations in Kaduna Metropolis
Source: Field Survey, 2017

Also observed is the uneven spatial distribution of petrol filling station along the roads in the study area, as Nnamdi Azikiwe Road (36.9%) had the highest proportion of petrol filling stations, followed by Sabo Tasha-Kachia Road (14.2%), Zaria Road (6.7%) and Abuja-Kaduna Road (6.2%) as shown in Table 4.1. These four roads accounted for 64% of the entire petrol filling stations in Kaduna Metropolis. This result is not surprising because these are the major roads linking the study area with other major cities in Nigeria hence serve as exit roads. This finding corroborate with the assertion of Baichie and Wallimsi (2000) that filling stations are not built in town centres but rather on exit roads.

This result agrees with Samuel (2011)'s findings that petrol filling stations in Kaduna North LGA were unevenly distributed and mostly concentrated along major roads. Also, roads like Television Bye-pass, Ali Akilu, Kachia, Lagos-Mando, Aliyu Makama and Link do have a significant number of petrol filling stations (Table 4.1). The least number of petrol filling stations in the study area was along Golf Course, Karaye and Shagari roads with each having one petrol filling station. These roads being of minor road classification type might be the possible explanation of the relatively low number of petrol filling stations situated in them.

4.2.2 Distribution of Petrol Filling Station by the Operators

In Nigeria, petrol filling stations are usually owned and operated by the independent marketers, major marketers and NNPC. Table 4.2 indicates the distribution of petrol filling stations in Kaduna metropolis by their operators.

Table 4. 3: Distribution of Petrol Filling Stations by Operators

Operator	Number of PFS	Percentage
Independent Marketers	156	69.4
Major Marketers	56	24.9
NNPC	13	5.7
Total	**225**	**100**

Source: Field Survey, 2017

Table 4.2 reveals that about 69% of the petrol filling stations were owned and operated by independent marketers, while 24.9% were owned and operated by major marketers. This result agrees with Mohammed, Musa and Jeb (2014)'s findings which revealed that 69% of petrol filling stations were owned by independent marketers, while 26% owned by major marketers in Kano metropolis. Also, Oloko-oba et al. (2016) discovered in Ilorin, Kwara State, that 16% of the petrol filling stations were owned by major marketers, 81.8% by independent marketers while 2.2% owned by NNPC.

The high proportion of independent marketers who owned and operated petrol filling stations in Kaduna Metropolis might be attributed to the assertion of Isah (1999) that the promulgation of indigenization decree of 1972 encouraged the participation in strategic oil and other business through independent marketers' involvement in lifting and distribution of petroleum products. This is expected to improve distribution efficiency of petroleum products. Although, it is claimed that the problem facing effective distribution of petroleum products stem from unpatriotic behaviour of some independent marketers through diversion of the product as a result not making the product readily available. Figure 4.2 illustrates the distribution of petrol

filling stations by the operators while Plates I and II that shows the petrol station owned by major and independent marketers respectively (Appendix B).

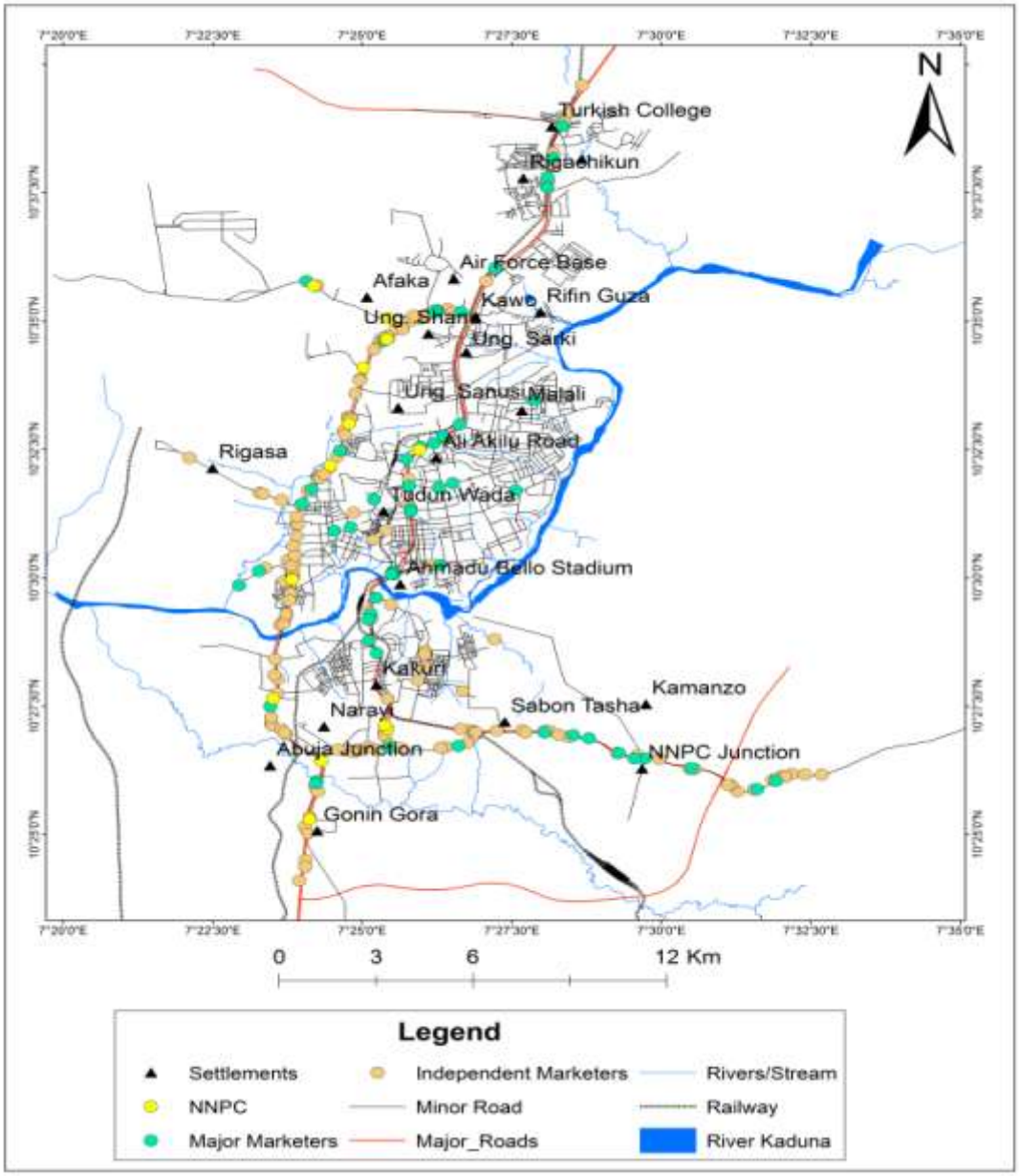

Figure 4. 2: Distribution of Petrol Filling Stations based on Operators in Kaduna Metropolis
Source: Field Survey, 2017

On the other hand, NNPC representing the least accounted for only 5.7% of the total ownership of petrol filling stations in Kaduna metropolis. Undoubtedly, this result indicates the

participation of NNPC, a state-owned oil company with a marketing arm that engage in oil retail sales management. This has ensured thorough re-distribution of petroleum products via its Mega or Micro petrol filling stations nationwide which has made them a major player in both the upstream and downstream sectors of the Nigerian oil and gas industry.

4.2.3 Distribution of Petrol Filling Station by Road Type

Table 4.3 indicates the distribution of petrol filling stations in Kaduna metropolis according to road classification type.

Table 4. 4: Distribution of the Petrol Filling Stations by Road Class

Road Class	Number of PFS	Percentage
Minor Road	55	24.5
Major Road	170	75.5
Total	**225**	**100**

Source: Field Survey, 2017

Table 4.3 reveals that about 76% of the petrol filling stations in the study area were located along the major roads whereas the minor road accounted for only 24.5% of the petrol filling stations. This finding corroborates Uba (2015)'s finding in Kano metropolis which revealed that 78% of the filling stations were along major roads. Also Ogunyemi et al. (2017) found that most of the petrol service stations in Ado-Odo Ota LGA of Ogun State were located along the major road that passes through the centre of Atan Ota, Iyana Ota, Onipanu Ota, Ojuore Junction, Lagos-Abeokuta highway. Easy access that these major roads provide and handling of higher vehicle traffic might be the possible explanation to most petrol filling stations situated along major roads. This is an indication that road classification is a crucial determinant in the location of petrol filling station in the study area.

4.2.4 Distribution of Petrol Filling Stations by Neighbourhoods

Table 4.4 shows the distribution of petrol filling stations in Kaduna metropolis according to the neighbourhood where they are situated.

Table 4. 5: Distribution of Petrol Filling Stations According to the Neighbourhoods

Neighbourhood	No. of PFS	Percentage
Abakpa	3	1.3
Badiko	11	4.9
Barnawa	9	4.0
Doka	15	6.7
Gonin Gora	13	5.8
Hayin Banki	6	2.7
Kabala Doki	1	0.4
Kakuri	10	4.4
Kawo	2	0.9
Kudenda	5	2.2
Kurmin Mashi	8	3.6
Mahuta	2	0.9
Malali	1	0.4
Mando	24	10.7
Maraba Rido	13	5.8
NAF Base	5	2.2
Narayi	2	0.9
Nassarawa	6	2.7
Nissi	3	1.3
Refinery	1	0.4
Rigachukun	12	5.3
Rigasa	7	3.1
Romi	4	1.8
Sabon Tasha	4	1.8
Television	10	4.4
Tudu Wada	26	11.6
Unguwar Boro	8	3.6
Unguwar Gwari	1	0.4
Unguwar Muazu	8	3.6
Unguwar Rimi	1	0.4
Unguwar Sunday	4	1.8
Total	**225**	**100**

Source: Field Survey, 2017

As shown in Table 4.4, Tudu Wada (11.6%), followed by Mando (10.7%), Doka (6.7%), Gonin Gora (5.8%) and Maraba Rido (5.8%) were among the neighbourhoods with a high spatial distribution of the petrol filling station in Kaduna Metropolis. The graphical representation is as shown in Figure 4.3.

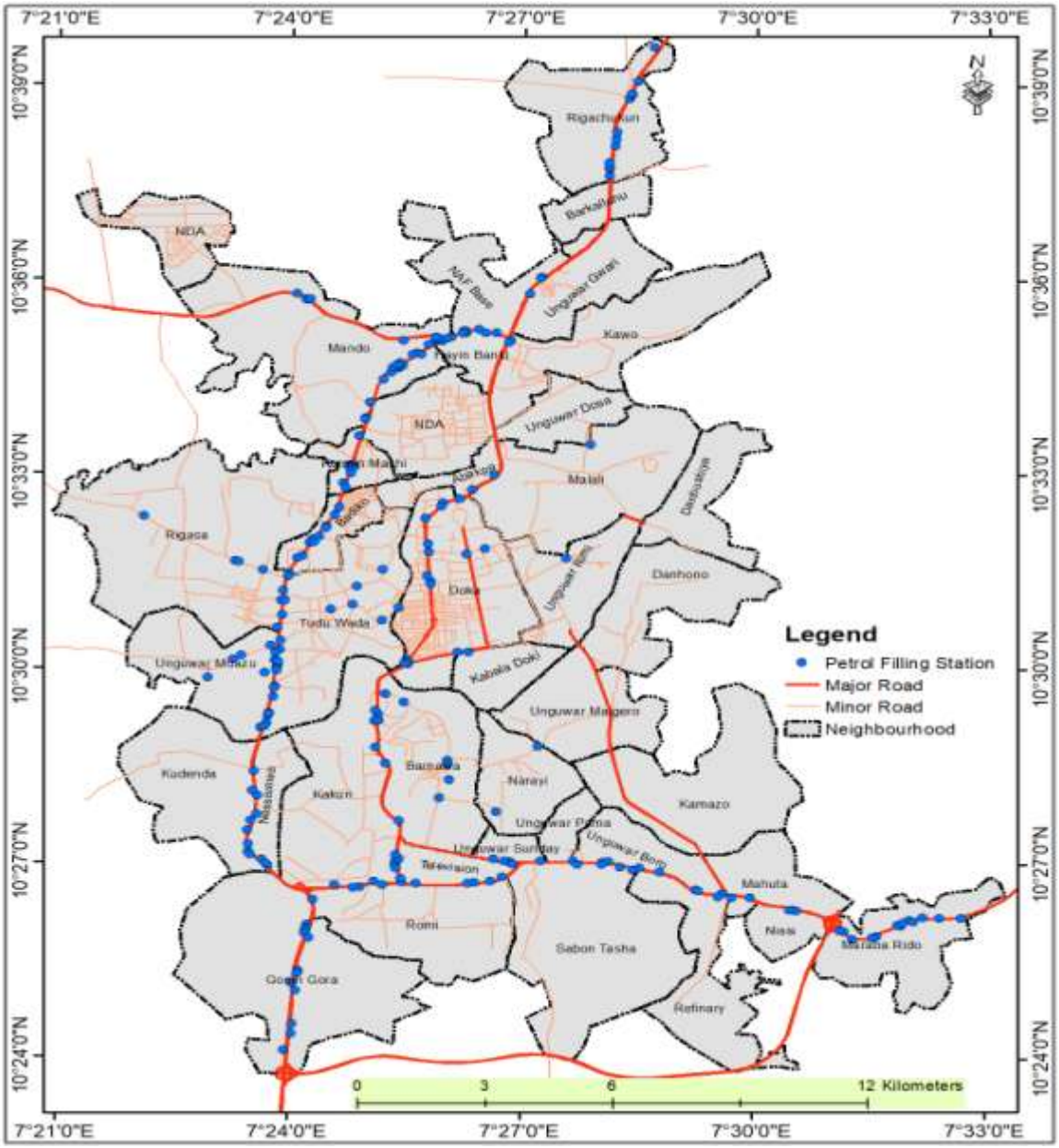

Figure 4. 3: Distribution of Petrol Filling Stations by Neighbourhoods
Source: Field Survey, 2017

This result is expected because these neighbourhoods serve as entry and exit into the Kaduna Metropolis and most petrol filling stations are situated along exit road. That most car drivers fuel their vehicle when moving out of the city could be the possible explanation for the location of most petrol filling along exit roads in the study area. Also, the fast growing population and the high number of cars as well as other fuel consuming machines like generators due to unreliable power supply have made demand for petrol product high which has in turn triggered the numbers of petrol filling stations. The least number of petrol filling stations were located in Kabala Doki, Malali, Refinery, Unguwar Gwari, Unguwar Rimi with 0.4% each (Table 4.4). This implies that motorists and residents within these wards is expected to be least served with petroleum products in the study area.

4.3 PATTERN OF DISTRIBUTION OF PETROL FILLING STATIONS

The pattern of the distribution of petrol filling stations was determined using the Average Nearest Neighbour Analysis in spatial statistic toolbox of ArcGIS version 10.2 environment. The average nearest neighbour analyses calculates the nearest neighbour index (which is a measure of the distance between each accident centroid and its nearest neighbour's centroid location. It then averages all these nearest neighbour distances). These parameters were used as the basis for the determining whether the distribution is clustered, dispersed or random (Clark and Evans cited in Lawal, 2017). Table 4.5 shows the R values ranges from 0.361 to 0.612. According to Clark and Evans (1954) cited in Lawal (2017), the index (average nearest neighbor ratio) is interpreted as follows;

R = 0: the distribution is clustered

R = 1: the distribution is random

R = Greater than 1: the distribution is dispersed.

Table 4. 6: Spatial Pattern of Petrol Filling Stations in Kaduna Metropolis

Statistics	Kaduna Metropolis	Remark
Observed Mean Distance	230.405 Meters	
Expected Mean Distance	679.159 Meters	
Nearest Neighbor Ratio	0.339	Clustered
Z-score	-19.129	
p-value	0.001	

Source: Field Survey, 2017

Table 4.5 shows the nearest neighbour index of 0.399 with z-score of -19.129 for the petrol filling stations in Kaduna metropolis hence, the distribution of petrol filling stations in the area tends towards clustered pattern. Figure 4.4 further shows the graphical representation of the average nearest neighbour index of petrol filling stations.

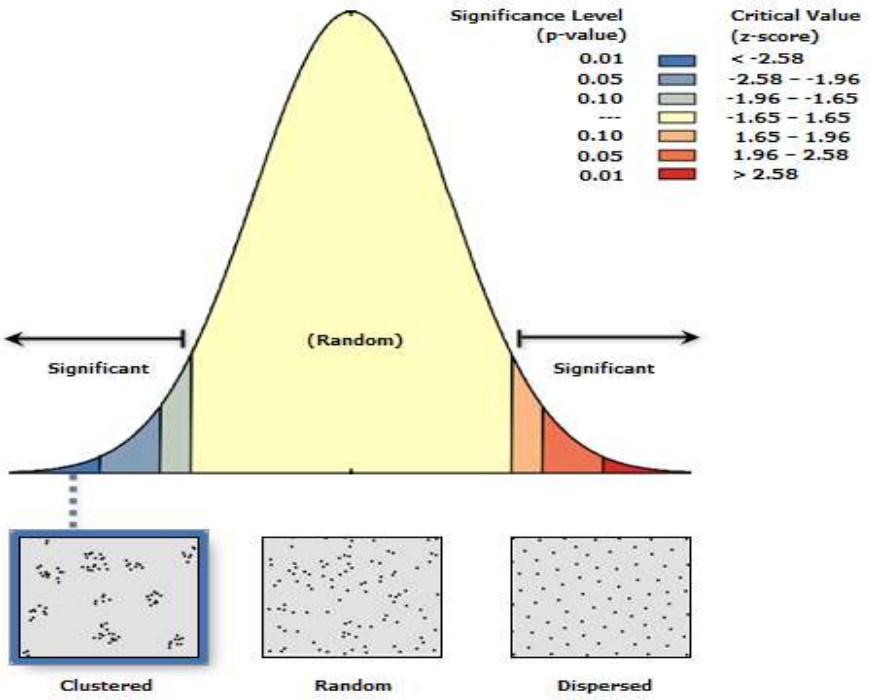

Figure 4. 4: Pattern of Distribution of Petrol Filling Stations in Kaduna Metropolis
Source; Field Survey, 2017

This result is an indication that most of the petrol filling stations were located close to each other rather than been uniformly distributed in the study area. The clustering pattern of petrol filling station might hinder the free flow of traffic along the roads. This is so because queues of vehicles at the petrol filling stations often result into serious traffic hold-up on adjoining road. This corroborates the finding of Oloko-oba et al. (2016) that shows a clustered pattern of petrol filling stations distribution in Ilorin, Kwara State. However, it disagrees with Abdullahi (2012)'s finding which revealed that petrol filling stations were randomly distributed in Agege Local government Area of Lagos State.

4.4 EXTENT OF PETROL FILLING STATIONS COMPLIANCE TO DPR STANDARDS

This study considered the compliance of petrol filling stations in the study area to the DPR standards namely; that a petrol filling station should be sited 400 metres away from the next petrol station, the total number of stations within 2 kilometres radius of the site should not be more than four petrol stations including the one under construction, 50 metres away in all angles of the built-up areas, and petrol filling stations should not lie within NNPC/PPMC pipelines right of way or PHCN transmission or railway lines.

4.4.1 Distance between the Petrol Filling Stations

Table 4.6 shows the level of compliance of petrol filling stations in the minimum 400 metres distance between petrol filling stations in the study area.

Table 4.7: Compliance to 400 metres Distance between Petrol Filling Stations

Distance	Number of PFS	Percentage
Less than 400 metres	188	83.6
Greater than 400 metres	37	16.4
Total	225	100

Source: Field Survey, 2017

Table 4.6 revealed that about 84% of the petrol filling stations in Kaduna metropolis did not satisfy the 400 metres distance apart from the nearest petrol filling stations standard while only 16% met the standard. This implies that distance apart standard for sitting petrol stations has not been complied with by the petrol stations operators in Kaduna metropolis. This violates the fundamental objective of planning which provides the right site for right use at the right time for right purpose in order to achieve spatial functionality, efficiency and aesthetics. This result is similar with Samuel, Ogoro and Amanoritsewo (2015) findings which revealed that conformity to 400 metres required distance from one petrol filling station to another was only met by 23% of the petrol filling stations in Obio Akpor Local Government Area of River State. Also Oloko-oba et al. (2016) discovered that 97.3% of the filling stations did not satisfy the 400 metres distance apart from the nearest station criterion in Ilorin, Kwara state. Figure 4.5 indicated the graphical representation of distribution of petrol stations compliance to 400 metres distance standard.

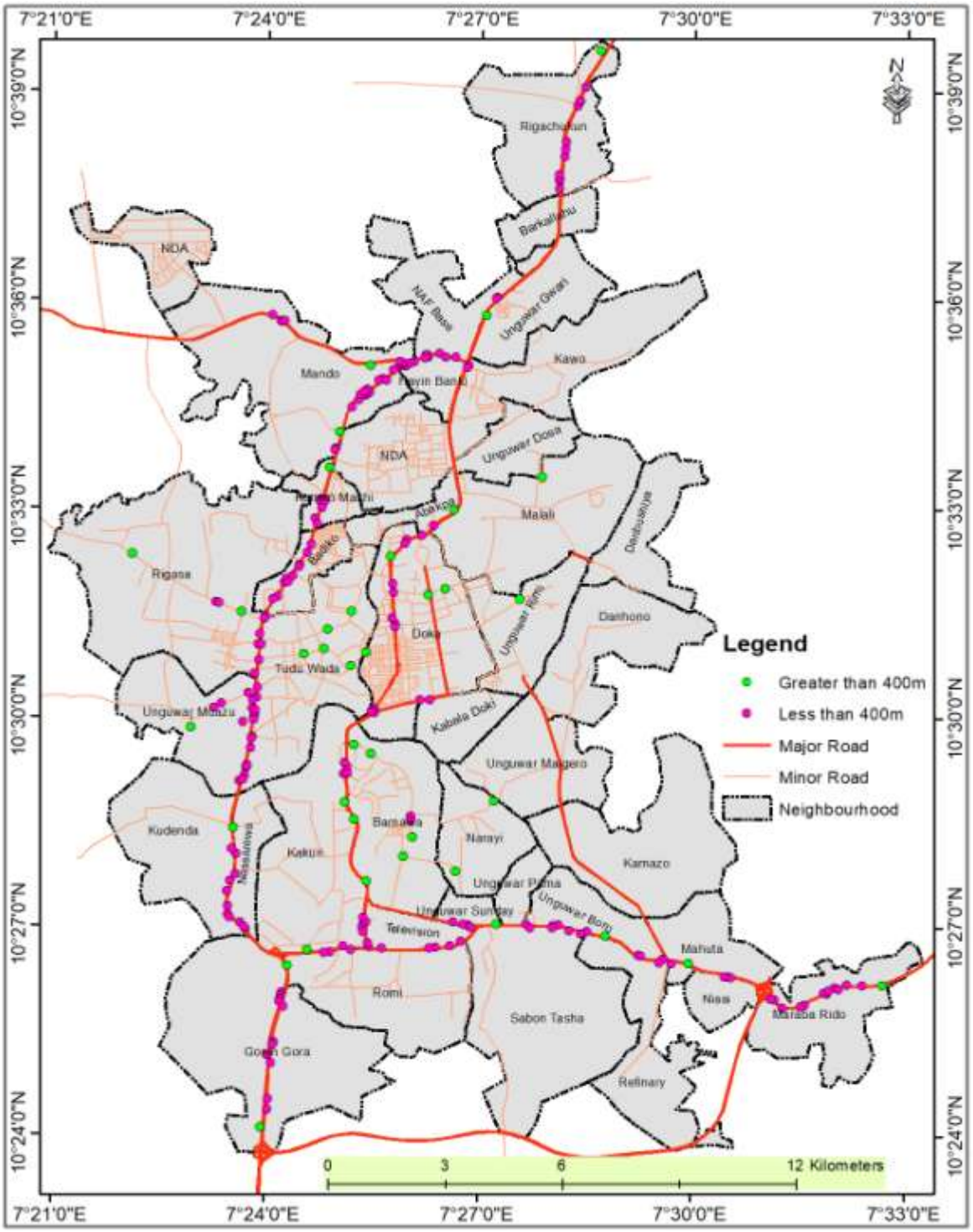

Figure 4. 5: Distribution of Petrol Filling Stations Compliance with 400 metres Distance to Nearest Station

Source: Field Survey, 2017

4.4.2 Petrol Filling Stations within 2 kilometres Radius

Figure 4.6 shows the petrol filling stations compliance to not more than four petrol stations within 2 kilometres buffer radius of the site including the one under construction.

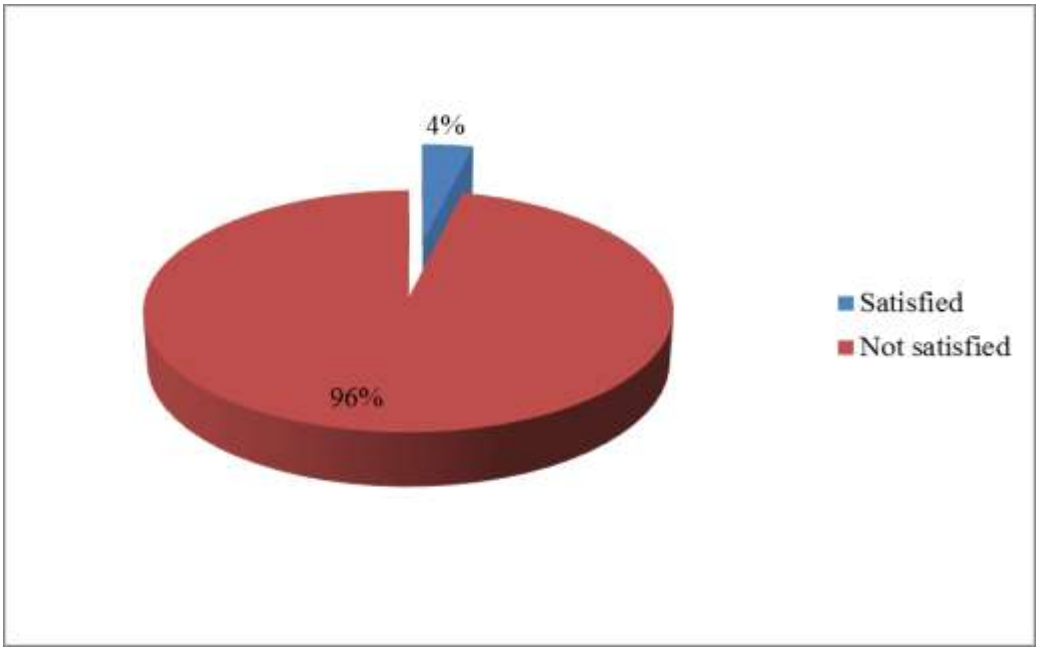

Figure 4.6: Compliance with Maximum Four Petrol Filling Stations within 2 kilometres Radius
Source: Field Survey, 2017

The tabulate intersection tool in ArcGIS was used to obtain the number of petrol filling stations in each buffer of 2 kilometres radius on both sides of the road. The result revealed that only 3.6% met the not more than four petrol filling stations in every 2 kilometres buffer radius while 96.4% had more than four petrol filling stations. The graphical representation of the buffer radius is as shown in Figure 4.7.

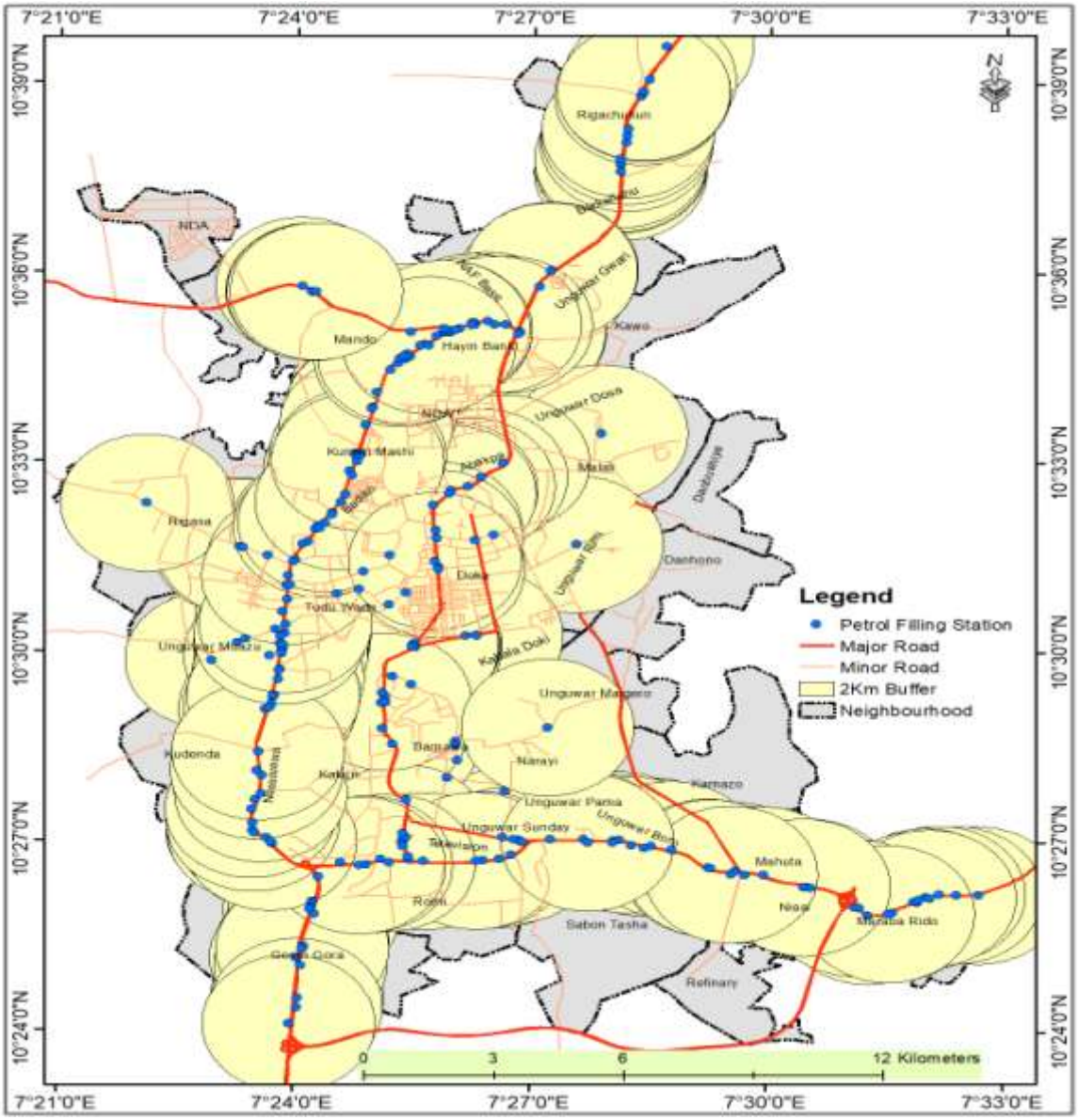

Figure 4.7: Distribution of Petrol Filling Stations Compliance with Four Petrol Filling Station within 2 kilometres Radius

Source: Field Survey, 2017

It could be inferred that petrol filling stations are not suitably sited as the locations contravene DPR standards. To that effect, this will increase the threats on the health and safety of users and residents in the vicinity of the petrol filling stations. This result agrees with Oloko-oba et al. (2016)'s findings which showed that only 1.3% satisfied the 2 kilometres stretch while

98.7% had more than 4 filling stations observed in every 2 kilometres buffer radius in Ilorin, Kwara state.

4.4.3 Distance away in all Angles of the Built-up Areas

According the criterion set by the DPR, petrol filling stations are not allow to operate within the built-up areas to create a buffer zone for the residential areas. Figure 4.8 shows the level of compliance of petrol filling stations to 50 metres distance away in all angles of the built-up areas in the study area.

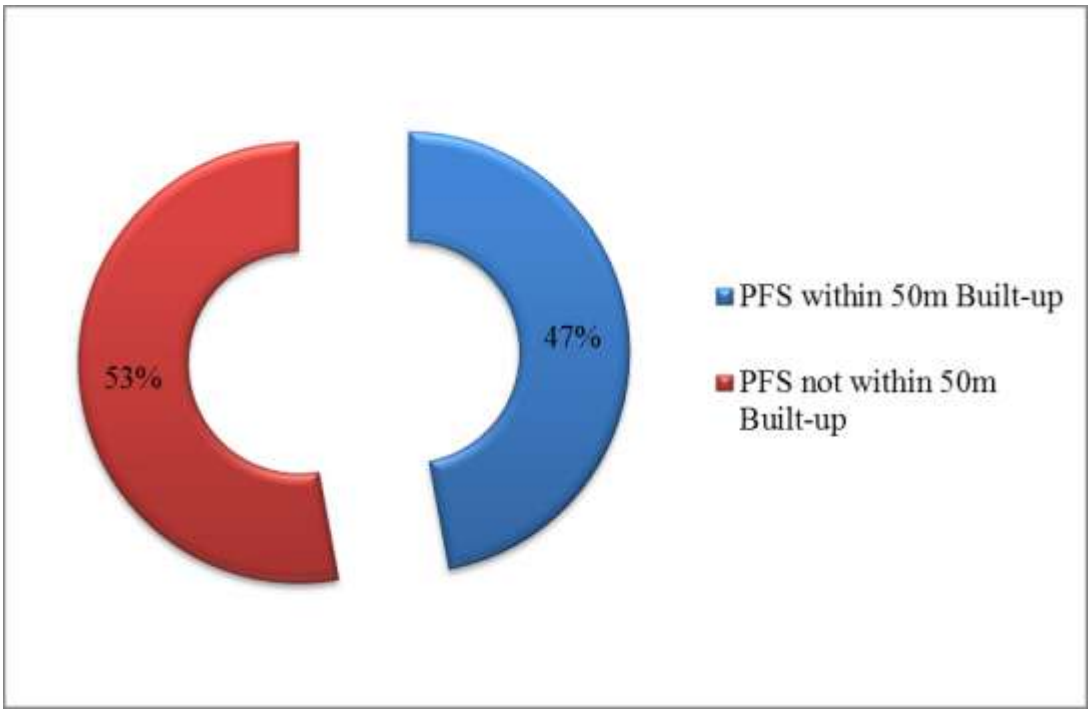

Figure 4.8: Compliance with 50 metres not Located within Built-up Areas
Source: Field Survey, 2017

Figure 4.8 indicated that 53% of the petrol filling stations were located within the 50 metres built-up areas while 47% were sited away the 50 metres buffer radius to the built-up areas. The graphical distribution of the petrol filling stations compliance to 50 metres buffer radius to the built-up areas is as shown in Figure 4.9.

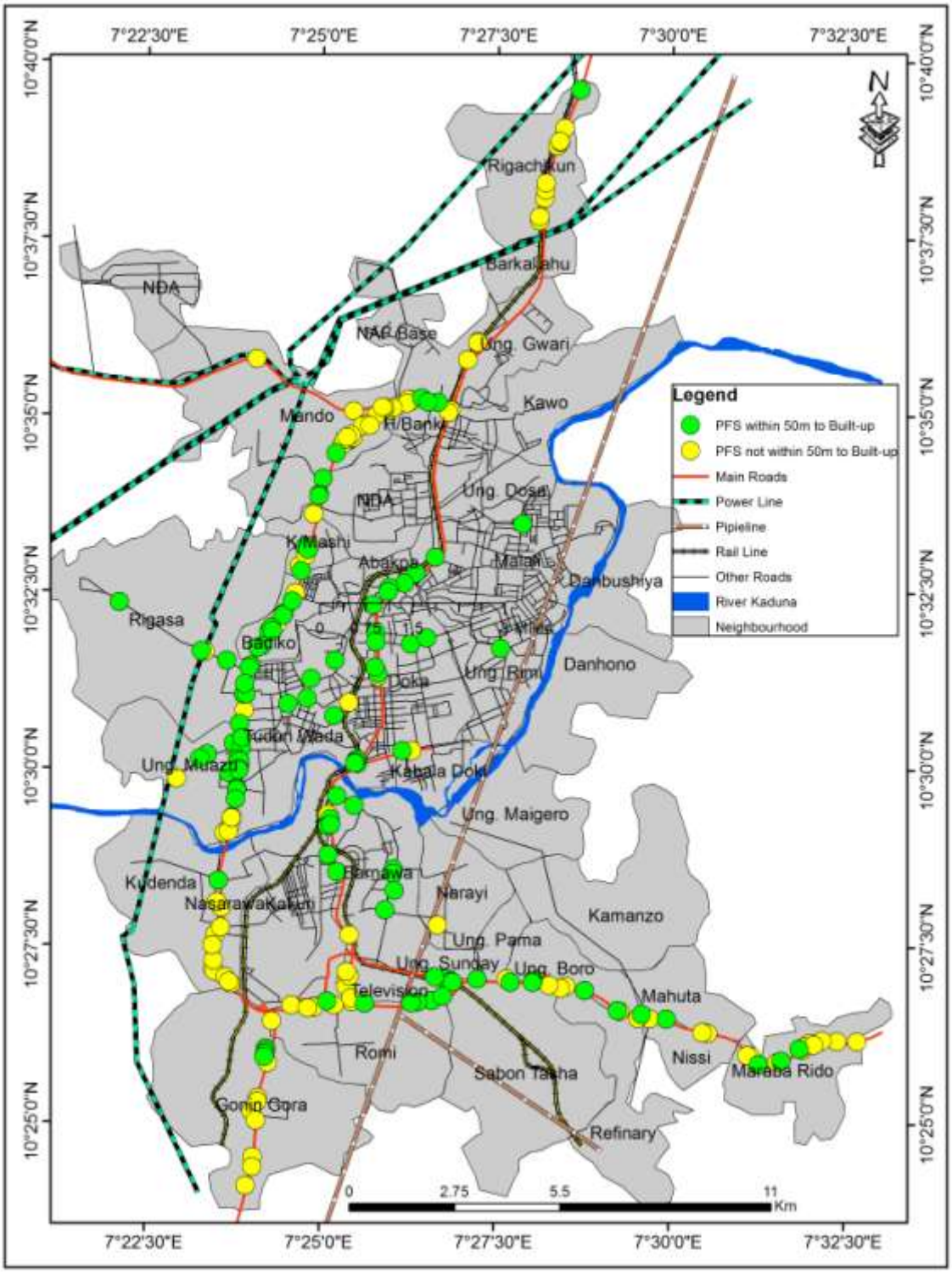

Figure 4.9: Distribution of Petrol Filling Stations Compliance with 50 metres Distance Away in all Angles of the Built-up Areas
Source: Field Survey, 2017

This result is an indication that more than half of the petrol filling stations in Kaduna metropolis were sited within the residential areas. A high proportion of the petrol filling stations that were sited within residential areas were observed in Abakpa, Badiko, Tudu Wada and Unguwar Muazu neighbourhoods. This implies that these neighbourhoods will feel the implications of petrol filling stations distribution pattern when compared with the other neighbourhoods in the study area.

4.4.4 Petrol Filling Stations not sited within NNPC and PPMC Pipelines Right of Way

Figure 4.10 shows the level of compliance of petrol filling stations to not been sited within 15 metres NNPC and PPMC pipelines right of way standard.

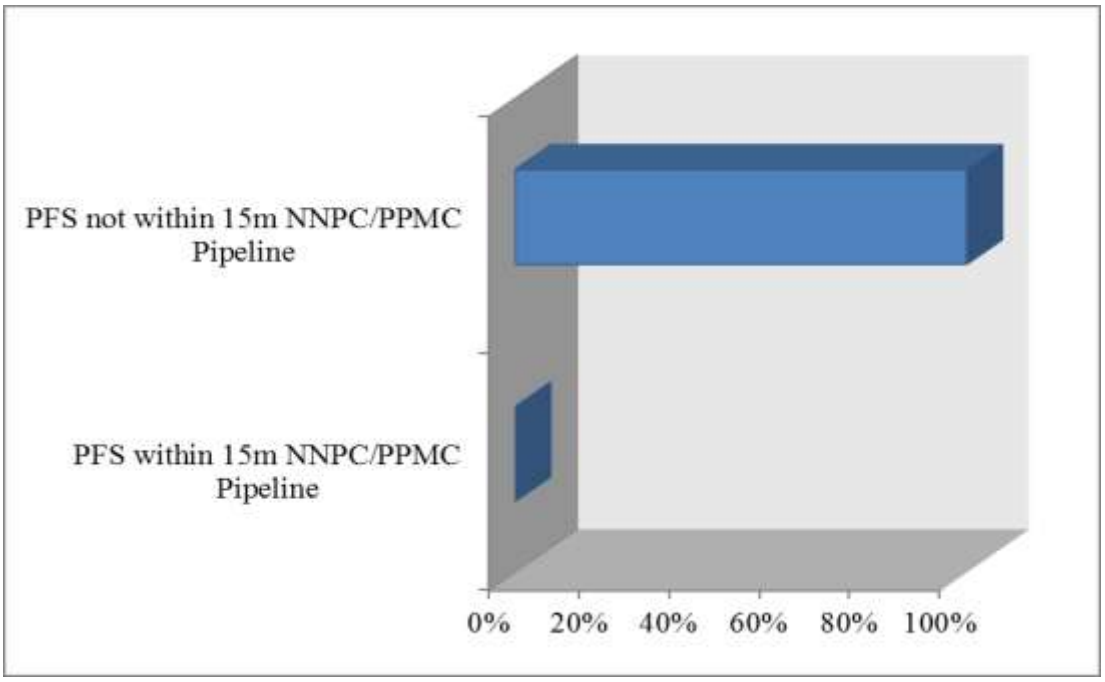

Figure 4.10: Compliance with 15 metres not Located within NNPC and PPMC Pipeline Right of Way
Source: Field Survey, 2017

As showed in Figure 4.10 all the petrol filling stations in Kaduna metropolis were located outside the 15 metres buffer radius to the NNPC and PPMC pipeline right of way. Figure 4.11

depicts the graphical distribution of the petrol filling stations compliance to 15 metres not located within NNPC and PPMC pipeline right of way.

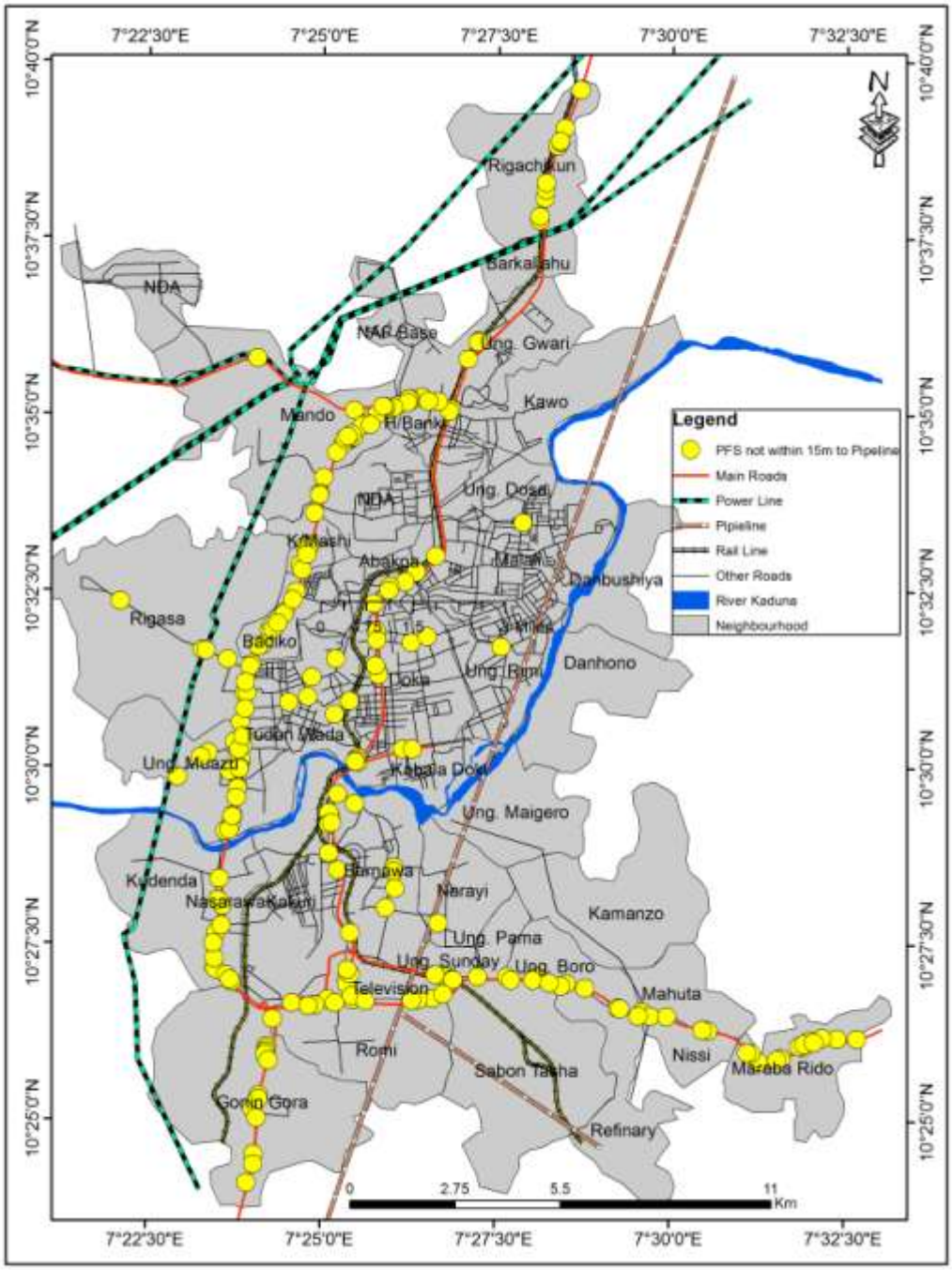

Figure 4.11: Distribution of Petrol Filling Stations Compliance with not Located within 15 metres NNPC and PPMC Pipeline Right of Way
Source: Field Survey, 2017

This clearly depicts total compliance of petrol filling stations in Kaduna metropolis to the DPR standard of not being sited within NNPC and PPMC pipeline right of way.

4.4.5 Petrol Filling Stations not sited within PHCN Right of Way

Figure 4.12 shows the level of compliance of petrol filling stations to not been sited 15 metres PHCN transmission lines right of way standard.

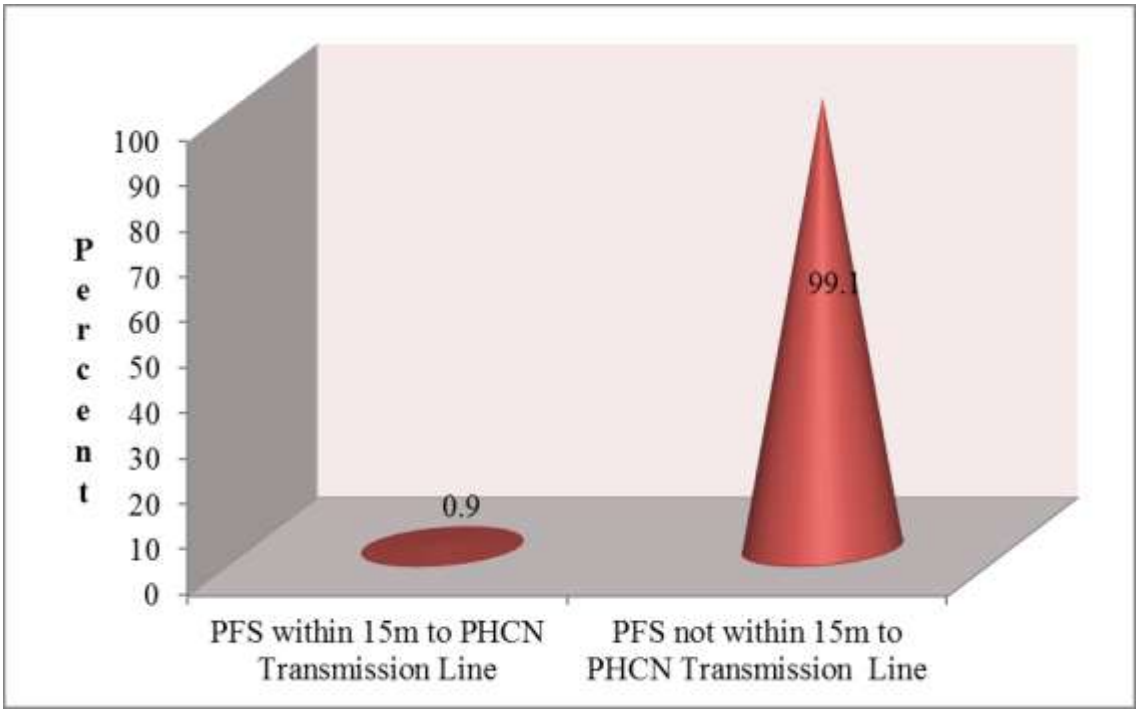

Figure 4.12: Compliance with 15 metres not Located within PHCN Transmission Line Right of Way
Source: Field Survey, 2017

Figure 4.12 showed that 99.1% of the petrol filling stations were not located within the 15 metres buffer radius to PHCN transmission power lines while only 0.9% was found sited within the PHCN transmission power line right of way. The graphical distribution of the petrol filling stations compliance to 15 metres not to be sited within PHCN transmission power lines right of way is as indicated in Figure 4.13.

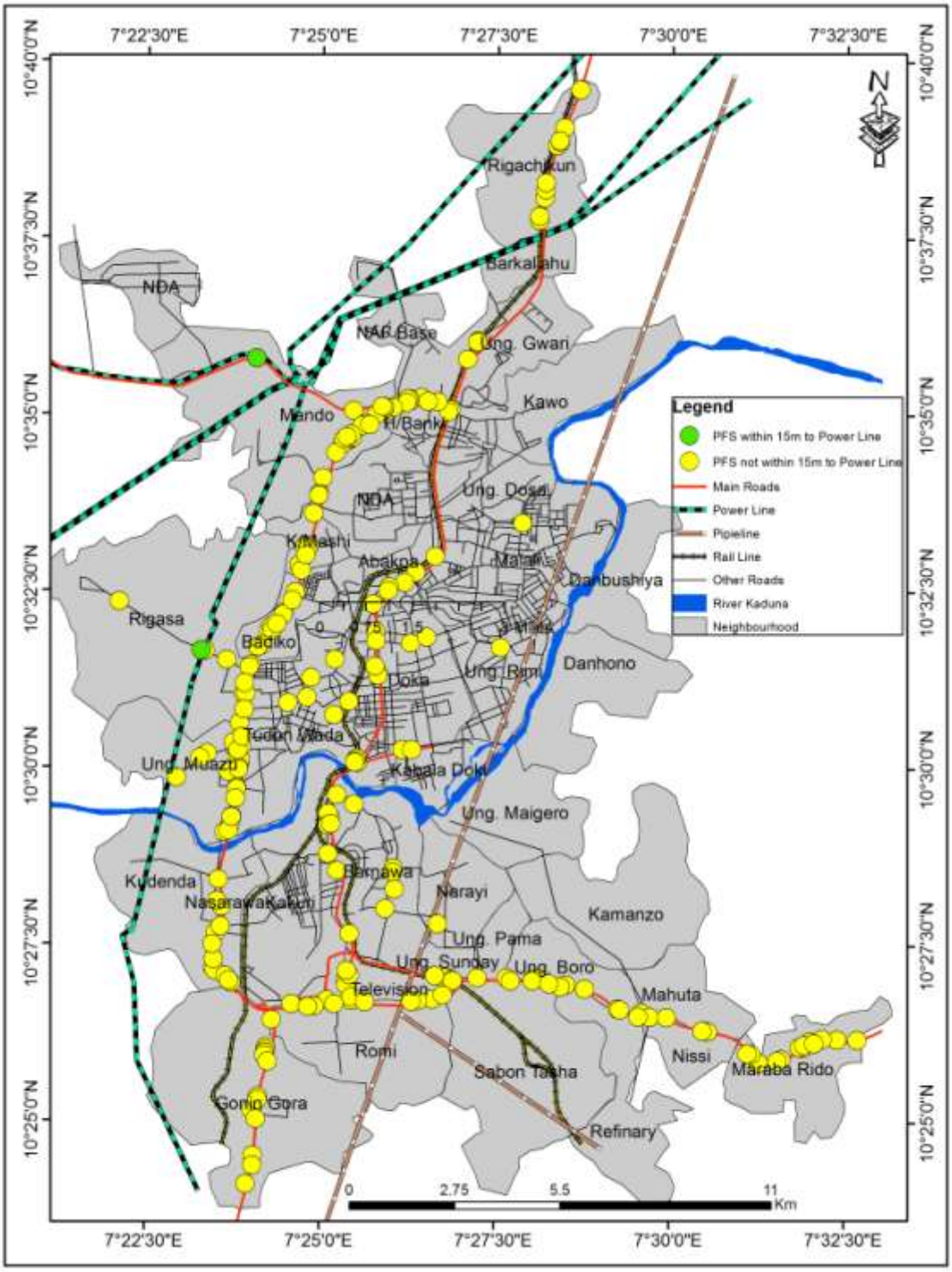

Figure 4.13: Distribution of Petrol Filling Stations Compliance with not Located within 15 metres PHCN Transmission Lines Right of Way
Source: Field Survey, 2017

4.4.6 Petrol Filling Stations not sited within Rail Lines Right of Way

Figure 4.14 shows the level of compliance of petrol filling stations to not been located within 15 metres rail lines right of way standard in the study area.

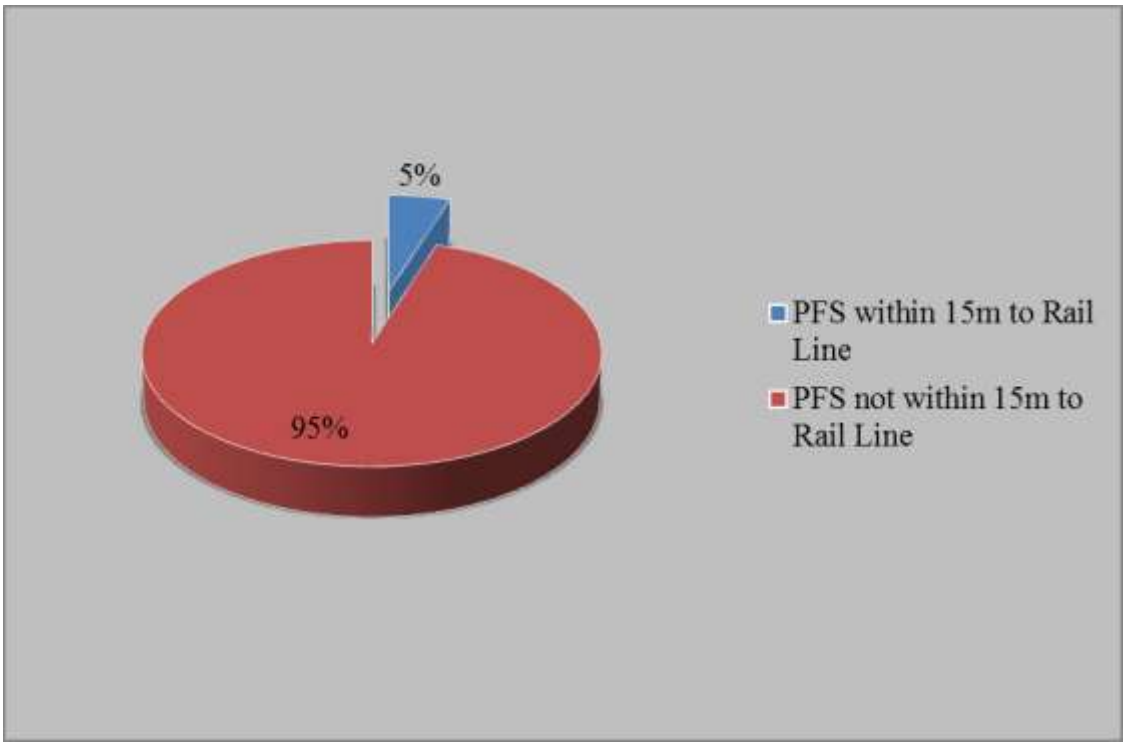

Figure 4.14: Compliance with 15 metres not Located within Rail Line Right of Way
Source: Field Survey, 2017

Figure 4.14 revealed that 95% of the petrol filling stations in Kaduna metropolis were located outside the 15 metres buffer radius to rail line right of way. Figure 4.15 further illustrates the graphical distribution of the petrol filling stations compliance to 15 metres not located within rail line right of way.

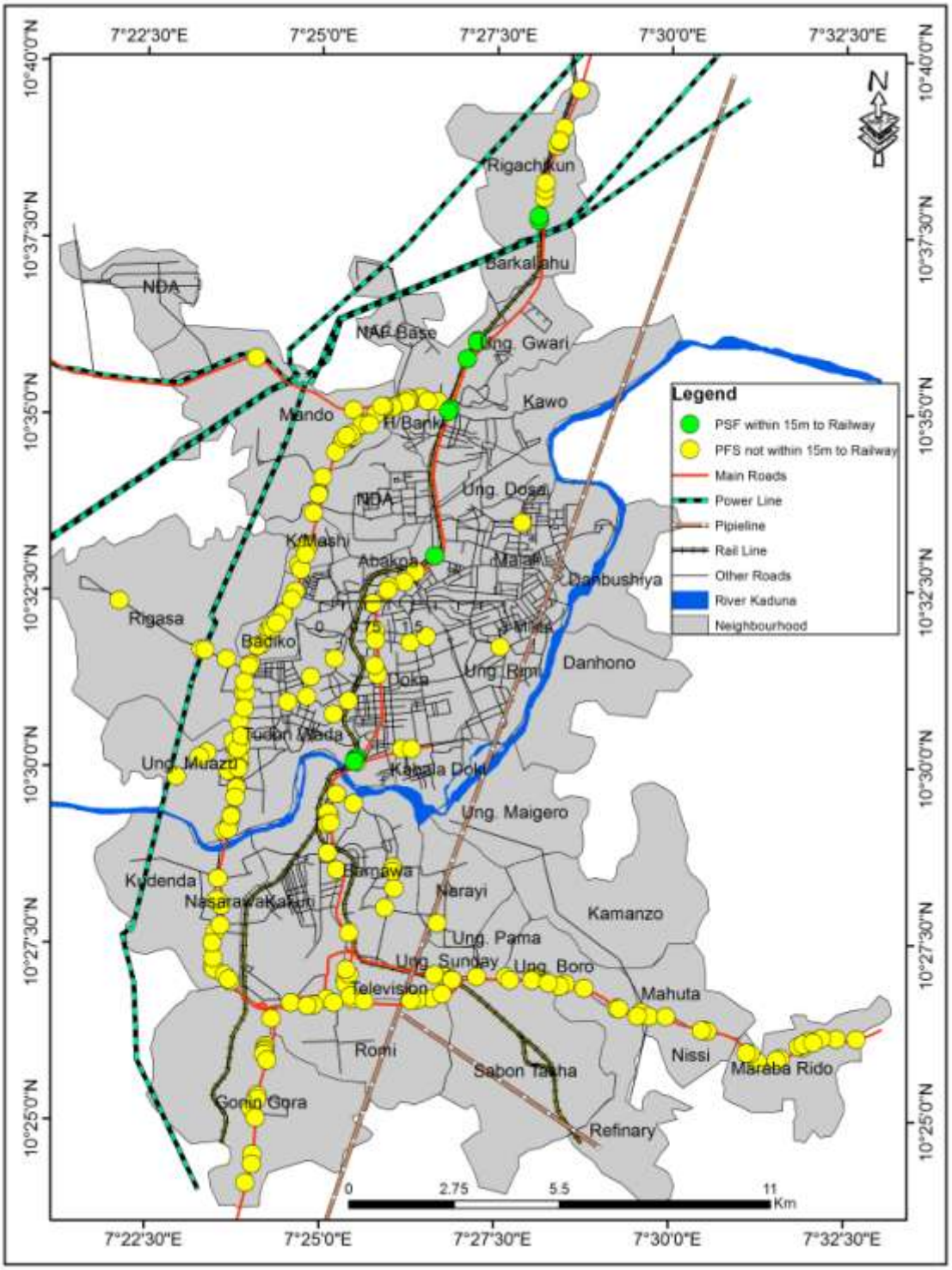

Figure 4.15: Distribution of Petrol Filling Stations Compliance with not Located within 15 metres Rail Lines Right of Way
Source: Field Survey, 2017

The petrol filling stations that did not meet with the not to be sited within the rail lines right of way were found in Abakpa, Hayin Banki, Rigachukun, Tudu Wada and Unguwar Gwari neighbourhoods in Kaduna metropolis.

4.5 PERCEIVED IMPLICATIONS OF PETROL FILLING STATIONS DISTRIBUTION PATTERN

4.5.1 Socio-economic Characteristics of the Respondents

The understanding of the socio-economic characteristics of the people is important to their identifying the perceived factors responsible for the pattern of distribution. In this study, the socio-economic characteristics of respondents such as sex, age, religion and marital status of respondents were examined. Table 4.7 shows the sex, age, religion and marital status distribution of the respondents.

Table 4.7: Sex, Age, Religion and Marital Status of the Respondents

Sex	**Frequency**	**Percentage**
Male	281	70.2
Female	119	29.8
Total	400	100
Age		
21-30 years	166	41.5
31-40 years	108	27.0
41-50 years	74	18.5
51-60 years	42	10.5
Above 60 years	10	2.5
Total	400	100
Marital Status		
Married	212	53.0
Single	163	40.8
Separated	8	2.0
Divorced	17	4.2
Total	400	100

Source: Field Survey, 2017

As shown in Table 4.7, about 70% of the respondents were males while only 29% were females. This result is a true reflection of population census of 2006 for Kaduna state where the males were more than the females. Regarding age distribution, 41.5% were between age ranges of 21-30 years, followed by respondents of age ranges of 31-40 years with 27%, while the least was respondents of age ranges of 60 years and above with 2.5%. This result is an indication of a youthful and productive population. In terms of marital status, observed was that 53% of the respondents were married. Table 4.8 shows the highest level of education and occupation distribution of the respondents.

Table 4. 8: Highest Level of Education and Occupation of Respondents

Level	Frequency	Percentage
No formal education	34	8.5
Primary school	24	6.0
Secondary school	156	39.0
Tertiary	184	46.0
Others	2	0.5
Total	400	100
Occupation		
Civil service	92	23.0
Farming	33	8.3
Trading/business	161	40.3
Unemployed	39	9.8
Artisan	35	8.8
Others	40	10.0
Total	400	100

Source: Field Survey, 2017

Regarding highest educational level attained by respondents, 46% of the respondents had tertiary education, followed by those with secondary education 39% (Table 4.8). About 40% of the respondents have trader/business as their major occupation, while 23% and 10% represents those in civil service and others respectively. The socio-economic characteristics highlighted

shows that the respondents were educated and responsible. This is very important because it indicates that the respondents are able to understand, reflect, articulate and provide objective responses as regard the factors influencing the spatial distribution of petrol filling stations as well as its socio-economic implications.

4.5.2 Residents Perceived Safety Living within Petrol Filling Station Area

Figure 4.16 reveals the distribution of the respondents with regards to the feeling of being safe living within area petrol filling stations is located.

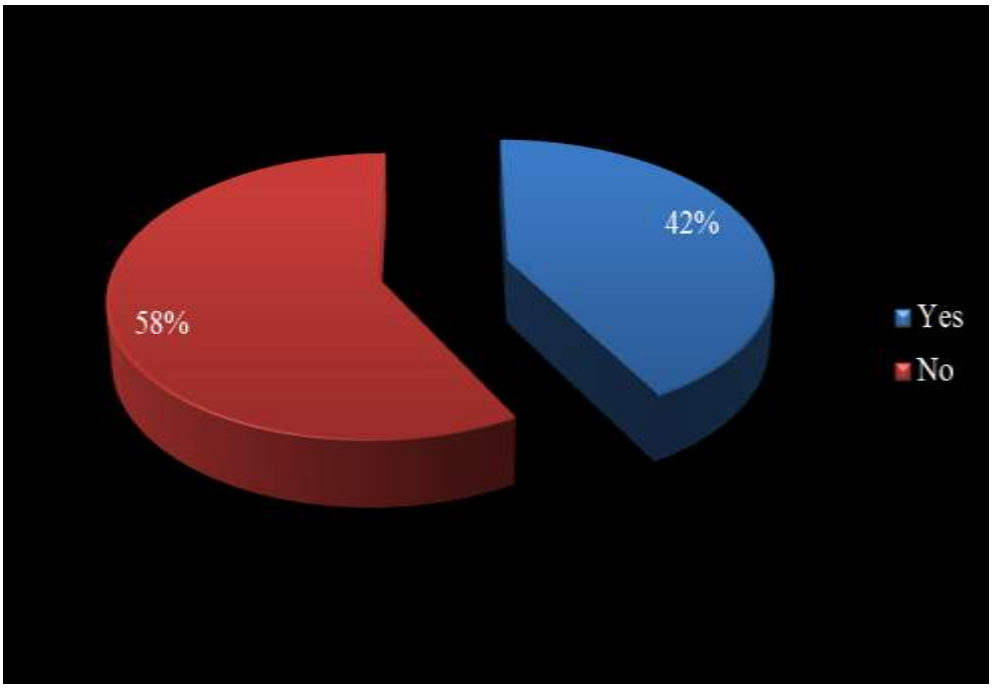

Figure 4.16: Respondents Perceived Safety Living in Petrol Filling Stations Areas
Source: Field Survey, 2017

Figure 4.16 reveals that just a little above half (58%) of the respondents agreed to their not feeling safe in an area where petrol filling station is situated which accounted for 58% while 42% said that they feel safe living in their present area where petrol filling stations are situated. The perceived danger of fire or even an explosion is a serious threat might account for residents not feeling safe living within petrol filling station area.

4.5.3 Perceived Implications of Petrol Filling Stations Distribution Pattern

Table 4.9 shows respondents opinion on the implications of petrol filling stations distribution pattern in the study area.

Table 4.9: Perceived Implications of Petrol Filling Stations Distribution Pattern

Implication	Mean Score	Std. Deviation	Ranking
Traffic congestion due to queues in filling station	2.67	.659	1
Air pollution	2.65	.618	2
Exposure to fire disasters	2.60	.662	3
More sales for petty businesses	2.57	.716	4
Easy access to means of transportation	2.57	.688	4
Increased traffic volume at road intersections	2.55	.663	6
Offers better business/job opportunities	2.53	.711	7
Occurrence of road traffic accidents	2.45	.728	8
High incidence of fire outbreak	2.36	.739	9
Increased neighbour ambient noise	2.33	.786	10
Reduce open space	2.27	.768	11
Exposure to high dose of fuel vapour	2.27	.817	11
Poor neighbourhood aesthesis value	2.19	.699	13
High crime rate	2.07	.702	14
Soil pollution due to oil spillages/leakages	2.07	.800	14

Source: Field Survey, 2017

As shown in Table 4.9, traffic congestion due to queues at filling stations (2.67), air pollution (2.65) and exposure to fire disasters (2.60) were the main implications of petrol filling stations distribution pattern. This implies that the closer the petrol station is to residential areas; the more likely the residents will be affected by the traffic congestion especially during fuel scarcity. The vehicles queuing to take fuel usually cause obstructions and other related hazards to the nearby houses such as accident especially as vehicles rush to queue during fuel scarcity.

Again, the experience of air pollution in relation to the distance between the petrol stations and the residential settlements is expected given that the closer the houses are the more likely the residents will be exposed to air pollution as a result of vehicles move in and out of petrol stations to take fuel and the use of generators to power pumping machines. This finding is in agreement with Samuel (2011) that identified traffic congestion, pollution and fire outbreaks as the consequent of petrol filling stations' location. Also Isabel, Graciela and Monica (2010) stated that the disadvantage petrol filling stations located very close to residential areas has increased air pollution caused by the continued emission of toxic gases into the air and that these emissions originate from gasoline delivery to the stations, tank breathing which occurs due to temperature and pressure changes, during vehicle refueling.

Traffic congestion is a common feature at petrol stations situated especially close to each other, near a market place or next to road intersection and junction. This usually occurs during loading and unloading of passengers and goods around the premises of petrol stations. This is an indication that the distribution pattern of petrol filling stations in Kaduna metropolis has negative consequences on the residents within the petrol filling stations location. This corroborates Ogundahunsi (2014) finding that 78% of the respondents agreed that the observed concentration of fuel stations had dire consequences for the residents of the city in Ilesa, Osun State. Plate V shows a petrol filling station close to a residential building (Appendix B).

Despite the negative implications associated with the distribution pattern of petrol filling stations, a few positive implications were identified by the respondents which included more sales for petty businesses and easy access to means of transportation with a mean score of 2.57

each among others. Plate VI shows a few business centres beside the fence of petrol filling station (Appendix B).

It could be deduced that small scale business owners often take the advantage of petrol filling station being high attractors of both human and vehicular traffic to establish their businesses like snack and soft drinks which motorists patronage while queuing to purchase petroleum products. Arguably, the situation of petrol filling station contributes to the locale economy of an area. However, high crime rate and soil pollution due to oil spillages/leakages with mean score of 2.07 each are the least perceived implications of distribution pattern of petrol filling stations in Kaduna metropolis (Table 4.9). The strict adherence to safety measures when loading and on loading petroleum products might account for low occurrence of soil pollution as a consequent of petrol filling location in the study area.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECCOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the major findings in relation with the objectives that guided this study. It as well presented several conclusions based on the findings and consequently recommendations made. Also other area for further research was indicated at the end of this chapter.

5.2 SUMMARY OF FINDINGS

The study assessed the implications of petrol filling stations distribution pattern in Kaduna metropolis, Kaduna State. The findings revealed that there were two hundred and twenty-five (225) petrol filling stations and were located along twenty four roads in Kaduna metropolis which Nnamdi Azikiwe (36.9%), Sabo Tasha-Kachia (14.2%), Kaduna-Zaria (6.7%) and Abuja-Kaduna (6.2%) roads had the high proportion of petrol filling stations. This accounted for 64% of the entire petrol filling stations in Kaduna metropolis. About 69% of the petrol filling stations were owned and operated by independent marketers and 76% were located along the major roads in the area.

Regarding the spatial pattern of petrol filling stations, computed Nearest Neighbour Ratio (NNR) for the petrol filling stations was 0.399 which indicated that the distribution of petrol filling stations was clustered. More so, the result showed that only 16% and 3.6% of the petrol filling stations in Kaduna metropolis did satisfy the 400 metres distance apart from the nearest petrol filling station and 2 kilometres stretch of not more than four petrol stations DPR guideline respectively. Also, it was found that 53% of the petrol filling stations were sited 50 metres away

in all angles of the built-up areas, none was within NNPC and PPMC pipeline right of way whereas 99% and 95% were not sited within PHCN transmission and rail lines right of way respectively.

Finally, traffic congestion due to queues in filling station with mean score 2.67, followed by air pollution (2.65) and exposure to fire disasters (2.60) were the main perceived implications of petrol filling stations distribution pattern by the residents within petrol station locations.

5.3 CONCLUSION

The distribution of petrol filling stations, despite its importance to the economy, among other things is expected to be guided by a definite environmental law. The study has shown the uneven spatial distribution of petrol filling stations in the study area. There was low level compliance of petrol filling stations to DPR standards such as 400 metres distance apart to the nearest petrol filling station, and not more than four petrol stations within 2 kilometres radius, while high compliance level was observable on not sited 15 metres within NNPC and PPMC pipeline right of way or PHCN transmission or rail lines DPR standards. However, a sizable number of the petrol filling stations were sited within 50 metres in all angles of the built-up areas hence it was common to see petrol filling station within the residential neighbourhood. From the results of the study, it can be concluded that petrol filling stations in Kaduna metropolis has a clustered pattern which has negative implications on the residents within petrol filling stations area. Therefore urgent actions should be taken to arrest this ugly trend in the pattern of development.

5.4 RECOMMENDATIONS

Based on the outcome of this research, the following are recommended:

i. The DPR should strictly enforce filling station operators' submission of Environmental Impact Assessment (EIA) report to include the geographic location of the site. This can be helpful in updating the spatial database for the petrol filling stations thereby making easy to check for location conformity.

ii. The Kaduna state government should enforce the relocation of petrol filling stations that did not meet the established planning standards. Alternatively, the petrol filling station owners should provide indemnity for buildings within 50 metres radius in case of fire outbreak

iii. Public enlightenment by the DPR on the regulation and standards governing the establishment of petrol filling stations and the right of the populace to call the attention of the regulatory bodies to illegal establishment of fuel stations should be carried out frequently.

iv. The regulatory agencies like DPR, National Environmental Standards and Regulations Enforcement Agency, (NESREA) saddled with environmental protection should intensify their periodical inspection and fine petrol filling stations operators that violates the standards.

5.5 SUGGESTION FOR FURTHER STUDIES

There is need to undertake an empirical study on the monitoring activities of regulatory agencies such as DPR, National Environmental Standards and Regulations Enforcement Agency, (NESREA) as it regards siting of petrol filling stations.

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APPENDIX A

QUESTIONNAIRE FOR RESIDENTS

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

Dear Respondent,

The researcher is a Masters student from the above named university carrying out a study on **"Assessment of the Implications of Petrol Filling Stations Distribution Pattern in Kaduna Metropolis, Kaduna State, Nigeria".** The study is an academic research leading to the award of Master of Science in GIS/RS. Any information given will be kept confidential and used for academic purpose only. Your kind gesture is appreciated.

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

1. **Name of LGA/Street**……
2. **Sex** Male [ ] Female [ ]
3. **Age (years)** 21-30 [ ] 31-40 [ ] 41-50 [ ] 50-60 [ ] Above 60 [ ]
4. **Religion** Islam [ ] Christianity [ ] Traditional [ ]
5. **Marital Status** Married [ ] Single [ ] Separated [ ] Divorced [ ]
6. **Educational Status** No Formal Education [ ] Primary School [ ] Secondary School [ ] Tertiary [ ] Others specify ……
7. **Occupation** Civil service [ ] Farming [ ] Trading/Business [ ] Unemployed [ ] Artisan [ ] Others specify …….

SECTION B: IMPLICATIONS OF PETROL FILLING STATIONS DISTRIBUTION PATTERN

8. **Do You Feel Safe Living in this Area** Yes [ ] No [ ]
9. **What are the socio-economic implications of having filling station in this area? Tick where appropriate**

Experience	Agree	Not Sure	Disagree
Offers better business/job opportunities			
More sales/market for petty business within the neighbourhood			
Easy access to means of transportation			
Increased neighbour ambient noise			
Reduction neighbourhood open space			
Exposure to fire disaster outbreak			

High crime rate			
Air pollution due to increased vehicular emission			
High incidence of fire outbreak within the neighbourhood			
Poor neighbourhood aesthesis value			
Increased traffic volume at road intersections			
Soil pollution due to oil spillages and leakages			
Traffic congestion due to queues in filling stations			
Common occurrence of road traffic accident			
Exposure to high dose of fuel vapour in and the pungent odour of hydrocarbon fuels.			

10. Suggest ways the negative implications of filling station location can be solved

……
……
……
……
……

Thank You

APPENDIX B

Plate I: Petrol Filling Station of a Major Marketer at Television Road through Garage
Source: Field Survey, 2017

Plate II: Petrol Filling Station of an Independent Marketer at Television Road through Garage
Source: Field Survey, 2017

Plate III: Petrol Filling Station along Television Road (High Traffic Corridor) by Sabo Express
Source: Field Survey, 2017

Plate IV: Petrol Filling Station Located at Romi Junction Express Road
Source: Field Survey, 2017

Plate V: Petrol Filling Station Located within Residential Buildings at Television Road Opposite Kaduna Polytechnic
Source: Field Survey, 2017

Plate VI: Business Shops within the Petrol Filling Station Area at Command Junction Road
Source: Field Survey, 2017

APPENDIX C

Filling Stations and their Coordinates

S/No	Name	Eastings	Northings
1	Duhlahi Filling Station	7.454140113	10.45051416
2	Conoil Filling Station	7.475385957	10.44889649
3	OPL Petrol Filling Station	7.467553371	10.45034303
4	Valid Petrol Filling Station	7.468794901	10.45039624
5	Suleman Danbaba Petroleum & Co.	7.47401449	10.44844375
6	Total Filling Station	7.467370905	10.44979844
7	Goldstar Petroleum Co. Ltd	7.471266771	10.4491334
8	AP Filling Station	7.479778243	10.44792132
9	Asio & Son Nig. Ltd Filling Station	7.487609744	10.4432166
10	Chioce Filling Station	7.493328102	10.44236892
11	Forte Filling Station	7.495277435	10.44137142
12	Dullahi Petroleum Nig. Ltd	7.444630316	10.46321631
13	Yusuf Filling Station	7.395871319	10.50586504
14	Fadiya Integrated Filling Station	7.397280064	10.50059647
15	Linhab Oil	7.38962319	10.50324679
16	A.A.Sokoto Co. Ltd	7.434044865	10.47582345
17	Northern Pacific Investment	7.43408999	10.47634147
18	Eternal Filling Station	7.424654861	10.49128086
19	A.P Filling Station	7.420554377	10.49350143
20	A.P Filling Station	7.419044499	10.48815512

21	RoyalConsolidated Investment Ltd Station	7.433980484	10.4753258
22	Potisworth Filling Station	7.434339675	10.47129699
23	Vivan Filling Station	7.432188695	10.46676264
24	Tonjos Filling out	7.418478323	10.4891547
25	Total Petrol Station	7.418322058	10.48639606
26	Mobil Filling Station	7.387775681	10.50221095
27	Oando Filling Station	7.382335276	10.49756269
28	TC Filling Station	7.394692077	10.49888025
29	Himma Filling Station	7.451209626	10.5963488
30	NIPCO Filling Station	7.447173544	10.58440832
31	Petrol Filling Station	7.44679349	10.58390095
32	AP Petrol Filling Station	7.464508525	10.55773711
33	Mobil Filling Station	7.437980328	10.52934691
34	AP Filling Station	7.441813492	10.53077917
35	Total Filling Station	7.459397714	10.52841546
36	NNPC Mega Filling Station	7.416950909	10.56826895
37	Mukaila Abass Petrol Filling Station	7.413668833	10.55217351
38	Forte Oil Filling Station	7.410464232	10.54131159
39	NIPCO Petroleum Ltd	7.411350314	10.54763993
40	Mashasha Company Nig. Ltd	7.412705969	10.55222193
41	Songai Oil & Gas Nig.	7.412601524	10.55180381
42	Ungwar Rimi Filling Station	7.404183238	10.5322885
43	Total Filling Station	7.402573913	10.52883519

44	Audu Manager & Sons Nig Ltd	7.401540648	10.52835086
45	Conoil Filling Station	7.399926249	10.52412283
46	Asaka Filling Station	7.398203196	10.5173235
47	Bee-em Oil & Investment Limited	7.397285871	10.51040207
48	Bushara Nig. Ltd Filling Station	7.398759002	10.51741974
49	Total Filling Station	7.408783632	10.51522364
50	AL-Mudeco Petroleun Ltd Filling Station	7.398394078	10.5136303
51	AP Filling Station	7.419908681	10.52541866
52	Smart Filling Station	7.414265025	10.52109297
53	Oando Filling Station	7.413383776	10.51645951
54	Yusuffa Filling Station	7.419719717	10.51236805
55	Himshat Petroleum Nig. Ltd	7.388083731	10.52759382
56	General Filling Station	7.394162378	10.52530671
57	Sal-Sabil Investment Ltd	7.388953449	10.52737703
58	Kamoh Oil	7.368490013	10.53898609
59	AP Filling Station	7.401055047	10.59637826
60	AP Filling Station	7.468211097	10.62670918
61	Bakori Filling Station	7.468299347	10.62874308
62	Marnazan Filling Station	7.468269562	10.62909113
63	Oando Filling Station	7.468254822	10.6301171
64	New Coming Filling Station	7.477893958	10.65991609
65	AJ Mai Kogi Filling Station	7.469426384	10.6343965
66	Oando Filling Station	7.469641237	10.6363156

67	Amana Petrol Filling Station	7.469787793	10.63797169
68	Conoil Filling Station	7.472446474	10.64666409
69	Kanjeed Oil Ltd	7.474234685	10.65102569
70	Kabeji Nig. Ltd	7.473101906	10.64763097
71	Kabere Enterprises Nig. Ltd	7.472987976	10.64789886
72	Zeepet Filling Station	7.436027586	10.50422304
73	Oando Filling Station	7.438357694	10.50419359
74	Oando Filling Station	7.443754737	10.54977436
75	Forte Oil Filling Station	7.439109912	10.54598626
76	Mobil Filling Station	7.436475601	10.54366633
77	Total Filling Station	7.432783161	10.54259806
78	M. R. S Filling Station	7.428965893	10.5385361
79	NNPC Mega Filling Station	7.432517938	10.54163981
80	Edi Jen Filling Station	7.429588338	10.53209107
81	Kamlik Oil Station	7.423286243	10.51549879
82	Total Filling Station	7.425449844	10.50113976
83	Oando Filling Station	7.425235011	10.50218502
84	ConOil Filling Station	7.424912832	10.50157946
85	Texaco Filling Station	7.424732553	10.50121305
86	Mobil Filling Station	7.422936005	10.57715476
87	NNPC Mega Filling Station	7.423475003	10.57753756
88	Major Oil Filling Station	7.423908212	10.57783381
89	A.A Sokoto Filling Station	7.434464937	10.5852835

90	Mobil Filling Station	7.437587207	10.58637369
91	NNPC Filling Station	7.424171017	10.58418578
92	AP Filling Station	7.453806363	10.60063474
93	AP Filling Station	7.453626716	10.60041721
94	Ultimate Eng Co Filling Station	7.440336676	10.58727692
95	Kubarachi Filling Station	7.437441127	10.58692255
96	Conoil Filling Station	7.437087944	10.5868879
97	M.R.S Filling Station	7.44419458	10.58630013
98	Oando Filling Station	7.436857975	10.58604722
99	Yuhassib Filling Station	7.432418055	10.5842217
100	Acorn Filling Station	7.433528923	10.58490758
101	Afdin Petroleum Service Ltd	7.441828215	10.58631778
102	ACORN Filling Station	7.423671081	10.46077653
103	Abdulaminu Filling Station	7.423067322	10.45029601
104	Faz Filling Station	7.422893719	10.44964845
105	Vine Filling Station	7.422947062	10.44865553
106	Jotco Filling Station	7.418377884	10.44516575
107	NIPCO Oil Filling Station	7.40990233	10.44425963
108	NNPC Mega Petrol Filling Station	7.391789795	10.46085506
109	Mobil Petroleum Ltd	7.391045917	10.45830104
110	Royal Crown	7.393169267	10.46715546
111	Dalten Alheri	7.395476124	10.44917199
112	Oando Filling Station	7.403925078	10.43405943

113	Conoil Filling Station	7.403801123	10.43336246
114	Sharon Filling Station	7.403682194	10.43270824
115	Ada Chris Filling Station	7.403494868	10.43204148
116	Pilot Oil Resources	7.400837416	10.40851723
117	Thelifa Filling Station	7.401955923	10.42201638
118	God Exalt Petrol Filling Station	7.404279912	10.43066582
119	M.O Udoye & Sons	7.461132353	10.45057854
120	Yaman Filling Station	7.447529373	10.45038147
121	Japco Filling Station	7.446474791	10.45055814
122	Nipco Petroleum Filling Station	7.447976635	10.44986215
123	Geebest Petroleum Filling station	7.448295757	10.44983978
124	Ascon Filling Station	7.444059459	10.45100088
125	Total Filling Station	7.42062417	10.47565492
126	Mobil Filling Station	7.418454079	10.47964497
127	Total Filling Station	7.42418657	10.44509351
128	Joaco Petroleum	7.424091728	10.44593029
129	NNPC Mega Station	7.423715794	10.45099078
130	NNPC Mega Station	7.423000193	10.45211753
131	Boltund Investment Nig Ltd	7.427409086	10.44472088
132	NNPC Mega Station	7.443397834	10.44541254
133	Ejeg Filling Station	7.44596073	10.44639086
134	Petroleum Messenger	7.439961775	10.44506983
135	Kazabachat Petroleun	7.438476613	10.44484728

136	NNPC Mega Station	7.405243426	10.44051867
137	NNPC Mega Station	7.508438505	10.43817141
138	MRS Petroleum Ltd	7.509215787	10.43798067
139	Aloba Global	7.544742838	10.43613788
140	Rhonda Nig. Ltd	7.539979639	10.43621235
141	Grand System Petroleum Ltd	7.536397971	10.43635445
142	NNPC Mega Station	7.531840704	10.43414463
143	Meo-On Petroleum Ltd	7.533523956	10.43569058
144	Forte Oil	7.526633699	10.4314573
145	Reson Investment Ltd	7.521266418	10.43070205
146	Juldan Petroleum Nig. Ltd	7.519487433	10.43273051
147	Total filling Station	7.429724826	10.5298535
148	Mobil Fillig Station	7.430138332	10.52238056
149	M.R.S Petrol Sation	7.430185334	10.5216903
150	Shemaco Petroleum Nig Ltd	7.396705489	10.49521244
151	Ruma Petroleum Nig. Ltd	7.396643722	10.4948862
152	Tonimas	7.391225293	10.45270916
153	Pathfinder Petroleum Nig Ltd	7.391532819	10.45212225
154	Badmus Petroleum Nig. Ltd	7.394125315	10.45083401
155	Samrada Filling Station	7.420089598	10.44431354
156	Stallion Petroleum	7.402003814	10.42238475
157	NNPC Mega Station	7.400606754	10.41913407
158	Mama Posa Oil and Gas	7.401530579	10.41709343

159	Filling Station	7.401924373	10.42157278
160	NNPC Mega Station	7.401924373	10.42157278
161	CKI Petroleum	7.400686639	10.40614705
162	Daddu Ventures	7.531005433	10.43436311
163	Decy Investment Nig Ltd	7.53207465	10.43491704
164	Omapet Energy	7.499335497	10.44127512
165	Forte Oil	7.48816387	10.44308356
166	Ogwola Oil & Chemical	7.534448642	10.43532075
167	Toniset Nig Ltd	7.518540697	10.43282415
168	Texon Petroleum Nig Ltd	7.525730987	10.43117853
169	Sesa Oil and Gas	7.507859185	10.43812155
170	NNPC/KRPC Cooperative P/F Station	7.492492167	10.4414523
171	Ibafon Nig Ltd	7.462079393	10.44976193
172	Ilia-Amins Petroleum	7.399107994	10.40172268
173	Meo-On Petroleum Nig Ltd	7.41531675	10.44378594
174	Fure View Petroleum	7.413817056	10.44357755
175	Meo-on Petroleum Ltd	7.413817056	10.44357755
176	Sharon Filling Station	7.419134595	10.48671303
177	Zemba Oil Ltd	7.431002724	10.58418367
178	Honey Ocean Investment	7.431455479	10.58453517
179	Ammasco	7.4295331	10.5831579
180	A.A Rano Petroleum Ltd	7.426961207	10.58114049
181	Rahamiya Petroleum Ltd	7.42617062	10.5806629

182	Afono Petroleum Nig. Ltd	7.423473762	10.5785061
183	Under Construction	7.421352307	10.57612251
184	Abba Petroleum Nig. Ltd	7.419915262	10.57417771
185	Tetra Investment	7.416008319	10.56450238
186	SAssada Petroleum Ltd	7.415952192	10.56413252
187	M.S Petroleum Ltd	7.414741265	10.55983141
188	Gura Petroleum	7.413380591	10.55150006
189	Alh. Mohammed Yola Petroleum	7.411854657	10.54641157
190	NNPC Mega Station	7.407789857	10.53650218
191	S O Petroleum Ltd	7.407556915	10.53596638
192	NIPCO Petroleum	7.404758295	10.53312124
193	Under Construction	7.397773074	10.50469781
194	Kurfi Investment	7.396800159	10.50212379
195	Rain Oil Filling Station	7.397327157	10.501172
196	Under Construction	7.397436887	10.50168925
197	Dahiru Garba Nig Ltd	7.397207122	10.49984019
198	NNPC Mega Station	7.397143915	10.49944159
199	El-Mukadas Petroleum	7.396355867	10.49265602
200	Alico Petroleum Nig Ltd	7.395518233	10.48846085
201	Suabco Petroluem Ltd	7.395444337	10.48802631
202	Aliyu Yau Investment Ltd	7.395001314	10.48605418
203	Samico Brothers and Sons	7.393775406	10.4847455
204	NIPCO Petroleum	7.394698187	10.48507668

205	Shema Petroleum Ltd	7.399497964	10.52369629
206	A U Future Investment	7.395479463	10.48824536
207	Oando Filling Station	7.395001394	10.44967331
208	A.I.M Sadi Nig. Ltd	7.431471237	10.58500726
209	A.I.M Sadi Nig. Ltd	7.430970046	10.58514685
210	Under Construction	7.391304309	10.45473579
211	Mobil Filling Station	7.391045917	10.45830104
212	Under Construction	7.392950582	10.46248597
213	Blue Star Petroleum	7.392071387	10.46850036
214	Jirwa & Sons Nig. Ltd	7.392359587	10.47354315
215	Royal Arms Petroleum Ltd	7.396882565	10.50399565
216	STK Oil & Gas	7.397906987	10.50712909
217	Danbaba Oil Company Ltd	7.398407876	10.51989832
218	Value Oil	7.405057932	10.53237849
219	Northern Oil	7.406061188	10.53377804
220	Kamlik Nig Ltd	7.409632798	10.53939209
221	NNPC Mega Station	7.412954178	10.55004973
222	Under Construction	7.421852899	10.57738517
223	Yamoyus Petroleum Ltd	7.422604128	10.57799174
224	NIPCO Petroleum	7.427962067	10.58078856
225	Royal Arms Petroleum Filling Station	7.429477322	10.52386315