

An Analysis of Petrol Filling Station Distribution in Birnin Kebbi using Geospatial Techniques

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ABSTRACT

A petrol filling station as a facility that sells fuel and engine lubricants for motor vehicles and other major modes of transportation around the globe needs to be properly located in a well-planned area and supervised by assigned relevant authorities. This study analysed the geospatial location of filling stations in Birnin Kebbi Metropolis against the Department of Petroleum Resources (DPR) and Kebbi Urban Planning and Development Authority (KUDA) Standards. Global Positioning System Garmin eTrex 10 GPS was used to capture the locations of the filling stations. The Birnin Kebbi cadastral, street and boundary base maps were obtained from the Ministry of Lands and Survey and Kebbi Urban Planning and Development Authority and imported into the ArcMap environment of ArcGIS 10.5, integrated and geo-referenced to the same coordinate system. Mapping of the existing filling stations, conditions and conformity were conducted in GIS environment using analyzing pattern of the spatial statistic tools to determine the locations, conditions of the filling stations and Proximity (Buffering) Analysis used to determine the level of conformity. The results revealed that 9% of the petrol filling stations were government owned, 17% were owned by oil and gas industries while private individuals owned 74% of the filling stations. The findings also indicated a clustered pattern of spatial distribution of petrol filling stations in the area. Based on the Department of Petroleum Resources and KUDA guidelines, 51% of the total petrol filling stations were in line with the existing standard while 49% were in contravention of the Department of Petroleum Resources (DPR) standards. The study therefore concludes that the location of petrol filling stations in Birnin Kebbi metropolis is skewed and clustered in areas where the population is dense and characterised by a mix of commercial and industrial activities. It is recommended that the regulating bodies be strengthened to enforce strict compliance with the guidelines in the distribution of petrol filling stations across the study area.

Keywords: Filling Stations, GIS, Urban Planning, Proximity Analysis, Mapping

1. INTRODUCTION

Petrol is the lifeblood of industrialised nations. It has become the world's most important energy source since the mid-1950s. Its products fortify modern society, mainly supplying energy to the power industry; providing fuel for vehicles and motorcycles

to carry goods and people worldwide while supporting machines at home for daily use (Mshelia *et al.*, 2015). According to Ehinomen and Adeleke (2012), the petroleum industry can be classified by type of actors or by sectors. The actors in the Nigerian industry consist of both private and public organisations. The public actors are

the government agents and functionaries such as the Nigerian National Petroleum Corporation (NNPC) and its subsidiaries, the Department of Petroleum Resources (DPR), the Petroleum Products Pricing Regulatory Authority (PPPRA), among others. The private segment consists of both indigenous and foreign actors. The indigenous actors numbered about 1,000 in 1979, a year after formulating the act that established them but increased to 7,948 in 2010 (Murtala *et al.*, 2016). They compete with foreign or multinational marketers (referred to as major marketers) like Mobil Oil Nigeria Plc., MRS Nigeria Plc., Total Nigeria Plc., Conoil Plc., Oando Nigeria Plc. and African Petroleum Plc (Murtala *et al.*, 2016).

Selecting a better site for business enterprise is foremost in the minds of governments and entrepreneurs who invests their capital to earn profit. Some of the variables considered when selecting a location for utility are proximity to population centres, distance from neighbouring stations, easements to use existing utilities and the magnitude of environmental pollution parameters (Mohammed *et al.*, 2014). Other factors to consider when deciding the location of businesses include finances, customers, transport and neighbourhood (Oetomo and Sesulihatien, 2012). Bolen (1988) stated that every location on the earth surface has its analysable advantages and disadvantages. According to him the factors which influence such locations can be classified into two physical conditions; the real physical and analysis physical. Real physical is a visible condition about an area such as land condition, the width and the distance from the highway (Bolen, 1988). Analysis physical, on the other hand, is physical condition obtained from physical analysis such as population analysis, neighbourhood factor and competitor analysis (Bolen, 1988). Both factors are important in locating a business as the physical condition can affect the nature

and type of business to be conducted while analysis physical can affect the business performance.

In most towns and cities in Nigeria, improper planning and contravening of planning standards have resulted in illegal conversion of land-uses and haphazard development as in the case of the location of petroleum filling stations (PFSs) in unsuitable areas which are highly likely to cause hazards. Birnin Kebbi is an old town developed without a proper development plan and so suffers from a near absence of planning laws. In a mostly hot and dry semi-urban environment like the area under study, PFS could significantly contribute to hazardous problems. The decision on number and the location of petrol filling stations is one of the fundamental problems facing urban planners (Israel, 2009).

The planning of petrol filling stations in accordance with standards has been neglected in many urban centres. The Department of Petroleum Resources (DPR) set up procedures and guidelines which comply with Petroleum Amendment Decree no. 37 of 1977 safety rules and regulations for the construction and operation of petrol stations. The guidelines stipulate that a petrol filling station should be sited 50 meters away from residential, public or private buildings; 500m minimum distance from the nearest petrol filling station; have a 30m buffer zone of open space from the road; 40 meters' buffer zone of open space or 40-meter frontage for the road; be located 500m away from the nearest petrol filling station; cited 100m away from water bodies. Most of the urban centres in the world are exposed to problems such as inflow of population, congestion and many more problems resulting from uncoordinated developments that may lead to uneven distribution of facilities and services (Israel, 2009). Moreover, cities are likely to be confronted with other problems such as overstretching of

the existing infrastructure and spread of diseases and shortage of water supply (Tukura and Sawa, 2018). Birnin Kebbi is not exempted from the current situation. The area is experiencing rapid spatial expansion and continuous population growth (Mujeeb, 2018). Consequently, enormous pressure is exerted on social amenities including petrol filling stations as the existing ones are overstretched and new ones are built haphazardly. Therefore, the study aims to analyse the distribution of petrol filling stations in the Birnin Kebbi metropolis using Geospatial techniques with the view to comparing them with DPR standards. The specific objectives are to identify and locate the existing petrol filling stations in Birnin Kebbi, examine the conditions of the existing petrol filling stations and examine the extent to which the petrol filling stations conform to the physical planning standard.

2. MATERIAL AND METHODS

2.1 The Study Area

Birnin Kebbi, the capital of Kebbi State is located in the northwestern part of Nigeria. It lies between latitudes $12^{\circ}15'00''N$ to $12^{\circ}35'00''N$ and Longitudes $4^{\circ}0'00''E$ to $4^{\circ}38'00''E$. It is bounded to the northeast by Argungu Local Government Area, to the south by Kalgo Local Government Area, to the east by Gwandu Local Government Area and to the west by Arewa Dandi Local Government Area (Adelani, 2018). The population of Birnin Kebbi increased from 47,682 in 1984 to 63,147 in 1991 to 74,027 in 1996, and 268,620 in 2006 (NPC, 2009).

Multiple ethnic groups found in the study area include Kabawas, Fulanis, Zabarmawas and Dakarkaris. However, the diversity of the ethnic composition within the metropolis has greatly multiplied, especially with the present status as a state capital. Such ethnic diversities in the capital include the Kambaris, Gungawas, Dandawas, Yorubas, Igbos, Urhobos, etc. (Onwuka *et al.*, 2021).

Economically, it is important to point out that opportunities availed to the people of Birnin Kebbi have been determined principally by its economic base (Danboyi, 2006). The performance of the town's economy in the last twenty-three years (23) years has greatly influenced population growth, employment structure and development (Danboyi, 2006). Birnin Kebbi is thus now serving triple functions as the state capital, Local Government Headquarters and the seat of Gwandu Emirate (Danboyi, 2006). Owing to these functions, it has become the centre of trade and commerce, serving the whole sub-region of the far north-western zone including the neighbouring Niger and Benin Republics (Danboyi, 2006). The local economy has attracted, and is still attracting migrants, from within and outside the country. This trend is manifested in the rapid population increase, physical growth and development of the town induced by the change in its status (Danboyi, 2006).

2.2 Methodology

2.2.1 Field Survey

Following a reconnaissance survey, a field survey was conducted to identify and document existing filling stations in the study area. A street map of Birnin Kebbi Metropolis at a scale of 1:2000 was sourced from the Kebbi State Ministry of Lands and Survey and was updated by open street map download of Birnin Kebbi. Quickbird imagery (2020) of 2.5-meters resolution was also sourced from Kebbi Geographic Information System (KEGIS) and was integrated with the street map to produce an updated street map of the study area. The

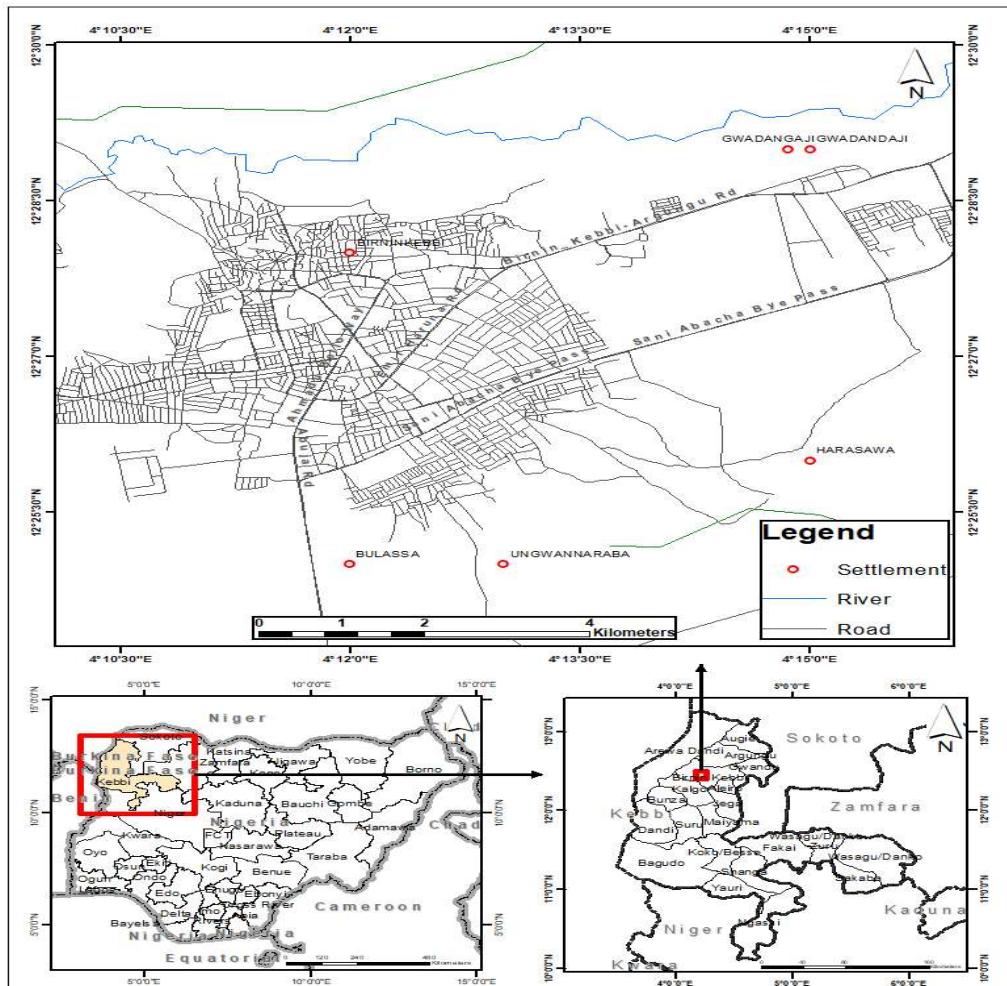


Figure 1: Geographical Location of the Study Area

Source: Author's Analysis, (2021).

Department of Petroleum Resources (DPR), under the Ministry of Petroleum Resources responsible for registering and regulating petrol filling stations, provided the list and locations of petroleum stations in the area. This was used as a guide to verify and establish the coordinate data of existing petrol filling stations using a Global Positioning System (GPS).

2.2.2 Data Analysis

The obtained street map was scanned, imported into the ArcMap environment of ArcGIS 10.5 and then geo-referenced using the map to image geo-referencing method. Quickbird 2016 image of the area was used

as a slave image for the geo-referencing. The geo-referenced maps were auto rectified and then given the same coordinates with the image. Shape-files were created in ArcCatalog imported into the ArcMap environment and used to digitize the street map and land use map separately. Fields were created for name and road type, while the lengths of the roads were calculated in meters. A simple worksheet was used to source the detailed information on the filling stations. Data was also obtained from the Department of Petroleum Resources and was used to create a simple database. Different symbolisations were used to map out the

filling stations. The number of filling stations on each road was determined. In addition, tables and charts created in Microsoft Excel were used to present the inventoried data. A comparison of the location of the filling stations with standard buffer and proximity analysis was done in ArcMap. Different queries were performed to obtain desired results.

3. RESULTS AND DISCUSSION

3.1 Geospatial Distribution and Ownership of Petrol Filling Stations

The ownership and locations of petrol filling stations in the study area are presented in

there are 46 governments and privately owned filing stations distributed across Birnin Kebbi metropolis. The statistics indicate 9% government ownership of existing filing stations, 17% is owned by oil and gas industries, while 74% are privately owned. This study agrees with Dogara (2017) who found similar spatial distribution pattern of petrol filling stations in the Kaduna metropolis.

The ownership distribution indicates that the government-owned filling stations are located in GRA, Gesse and Gen. Sani Abacha bye-pass. The filling stations owned by the oil and gas companies are Oando filling

Table 1: Database of Petrol Filling Stations in Birnin Kebbi

Filling_Station										
FID	Shape *	S_N	NAME_OF_TH	LOCATION	LAT_DD	LONG_DD	DISTANCE_F	PROXIMITY	FUNCTIONAL	
0	Point	1	Oando	Haliru Audu	4.196117	12.444067	30m	Market	Yes	
1	Point	2	Total	Haliru Audu	4.195467	12.443433	30m	Market	Yes	
2	Point	3	Zumunchi	Tasha	4.1998	12.442617	20m	Market	Yes	
3	Point	4	Zango Kangiwa	Tasha	4.2022	12.443533	20m	Market	Yes	
4	Point	5	A.A Range	Tasha	4.200883	12.443867	20m	Market	Yes	
5	Point	6	A.S G Yaye Nigeria Ltd	Haruna Road	4.2107	12.456417	20m	Near by pass	Yes	
6	Point	7	Sal Allah Investment & Haulage Ltd	Haruna Road	4.2106	12.45755	20m	By pass	Yes	
7	Point	8	N.N.P.C	Gesse 2	4.205317	12.4492	20m	Central Mosque	No	
8	Point	9	A.P Filling Station	E. Haruna	4.203533	12.446533	10m	Central Market	Yes	
9	Point	10	N.N.P.C	G.R.A	4.20385	12.461467	10m	Bank	Yes	
10	Point	11	A.S.G Nig. Ltd	Rima Area	4.216783	12.464455	10m	Bank	No	
11	Point	12	Sani Sajent Nig. Ltd	Rima Area	4.218767	12.464683	10m	Bank	Yes	
12	Point	13	Gajere Filling Station	Gesse 1	4.220267	12.465483	10m	Waziru Umar	No	
13	Point	14	Oando Filling Station	Gwadangaji	4.25735	12.478733	8m	Gwadangaji	No	
14	Point	15	Ahaji Inuwa Birnin Kebbi	Gwadangaji	4.239717	12.474833	10m	Waziru Umar	No	
15	Point	16	Jantul Kry Oil & Gas	Gwadangaji	4.23935	12.474683	10m	Waziru Umar	Yes	
16	Point	17	Asajai Oil & Nig. Ltd	Gesse 1	4.220917	12.466533	10m	Waziru Umar	Yes	
17	Point	18	Global Petroleum Nig. Ltd	Rima	4.21905	12.465733	20m	Market	No	
18	Point	19	Nasiru Adamu Jega Ltd	Rima Area	4.218667	12.465417	20m	Market	No	
19	Point	20	Aliyu Ahmed Mai Ahu	Junju	4.21865	12.465417	10m	By pass	No	
20	Point	21	B.N.A Filling station	Central Market	4.211533	12.443567	10m	Central Market	Yes	
21	Point	22	A.S Garba Kamba Nig. Ltd	Central Market	4.2108	12.439417	8m	Central Market	Yes	
22	Point	23	Oando	Central Market	4.212233	12.44075	10m	Central Market	No	
23	Point	24	Jai Global Investment Ltd	By pass	4.215517	12.4429	10m	Central Market	No	
24	Point	25	Conoil	By pass	4.21825	12.444917	10m	Central Market	No	
25	Point	26	Forte Oil Plc.	By pass	4.219117	12.445483	10m	Eastern By pass	Yes	
26	Point	27	Khayyaj Pacific Link Ltd	By pass	4.220233	12.44585	10m	Eastern By pass	Yes	
27	Point	28	Mrs. Oil Nig. Ltd	By pass	4.226717	12.449067	10m	Eastern By pass	Yes	
28	Point	29	Malamawa Enterprises Nig Ltd	By pass	4.228217	12.44995	10m	Eastern By pass	No	
29	Point	30	Jayyars Global Energy Ltd	By pass	4.233733	12.45195	10m	Eastern By pass	Yes	
30	Point	31	Oando Nig. Plc	By pass	4.22095	12.44469	8m	Eastern By pass	Yes	
31	Point	32	Forte Oil Nig. Ltd	Central Market	4.207983	12.437883	10m	Central Market	Yes	
32	Point	33	Nasiru Adamu Jega Nig Ltd	Old By pass	4.204183	12.4357	8m	Central Market	No	
33	Point	34	N.N.P.C	Old By pass	4.202233	12.434417	10m	Central Market	Yes	
34	Point	35	Nabasa International Ventures Ltd	Old By pass	4.198817	12.4325	8m	Central Market	No	
35	Point	36	N.N.P.C	Old By pass	4.195517	12.4305	8m	Prison	Yes	
36	Point	37	Forte Oil Nig. Ltd	Old By pass	4.194833	12.429833	10m	Prison	No	
37	Point	38	S.B Petroleum Nig Ltd	Old By pass	4.194617	12.430483	10m	Prison	Yes	
38	Point	39	Shirash Petroleum Services Ltd	Old By pass	4.1941	12.432117	10m	Prison	No	
39	Point	40	K.M Kamba Ventures Nig. Ltd	Old By pass	4.194067	12.4366	10m	Prison	Yes	
40	Point	41	K.M Kamba Ventures Nig. Ltd	Old By pass	4.193433	12.4368	10m	Prison	Yes	
41	Point	42	Total	A.P.1	4.195567	12.443383	10m	Tasha	Yes	
42	Point	43	NIPCO	A.P.2	4.193783	12.42895	10m	Prison	Yes	
43	Point	44	Muhammad Tila Jega Nig. Ltd	A.P.2	4.19385	12.42965	10m	Prison	No	
44	Point	45	Forte Oil Nig. Ltd	A.P.2	4.194583	12.429683	10m	Prison	Yes	
45	Point	46	A.S. Magare Ltd	A.P.2	4.194167	12.426133	10m	Bypass	Yes	

Source: Author's Field Analysis (2021)

Table 1 and Figure 2 respectively, while Figure 3 shows the geospatial distribution of filling stations in the study area at the time of study. The results of this study revealed that

stations located in Gwadangaji, the Central Market, Gen. Sani Abacha bye pass, Haliru Abdu road; AP filing station along Emir Haruna Rashid road, Conoil and Total filing

stations at AP 2 roundabout and Haliru Abdu road.

The distribution also shows that for the privately owned filling stations, one (1) is located in Junju, two (2) each in Gwadangaji, Emir Haruna Rashid road and in Gesse, three

The existing petrol filling stations in the study area are grouped into two (2); functional and non-functional filling stations. These are shown in Figure 4.

The results show that 63% of the petrol filling stations in the study area are functional while

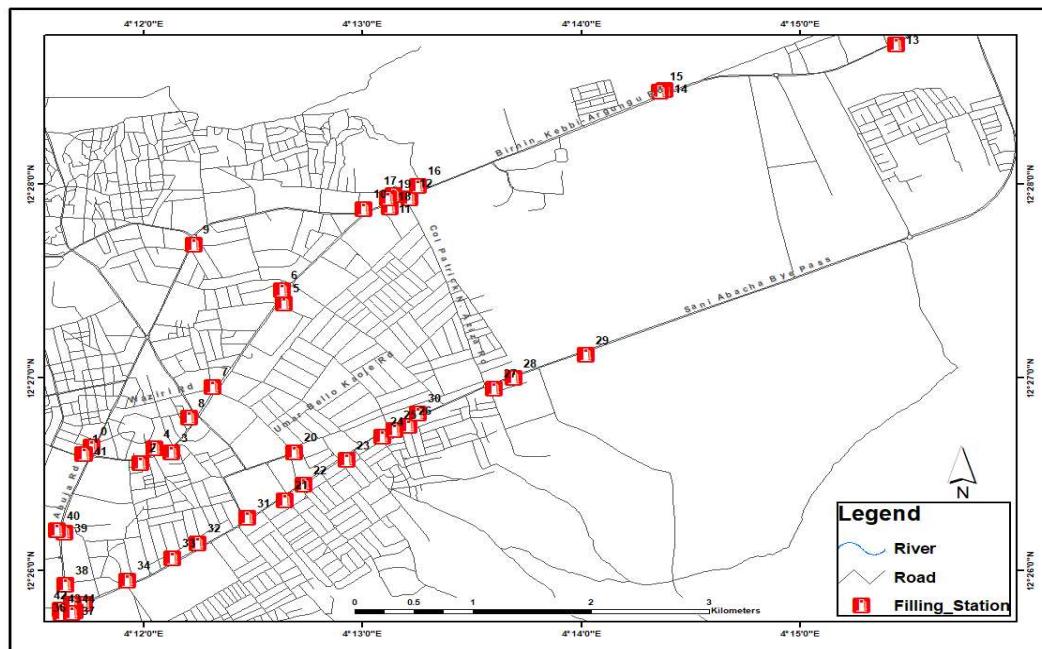


Figure 2: Filling Stations in Birnin Kebbi Metropolis

Source: Author's Field Analysis, (2021)

(3) each in Tasha area and Central market area, four (4) in Rima area and AP2, six (6) along Gen. Sani Abacha bye-pass and seven (7) along old bye-pass.

The geospatial distribution of the petrol filling stations in Birnin Kebbi metropolis is skewed and clustered in the areas characterized by dense population and a combination of commercial and industrial activities. This result agrees with the findings by Magaji (2020) who found that majority of the petrol stations in Bauchi town were clustered.

3.2 Status of Petrol Filling Stations in the Study Area

37% of them are non-functional. Out of the functional filling stations, 10% are government owned and are located in Gesse I, old bye-pass. On the other hand 14% of the functional filling stations are owned by oil and gas companies and are located at AP 2 roundabout, one (1) each at Emir Haruna Rashid and Gen. Sani Abacha bye-pass while two (2) are located at Haliru Abdu road. Private individuals own the larger percentage of functional filling stations at 76% with four (4) at Gen. Sani Abacha bye-pass, three (3)

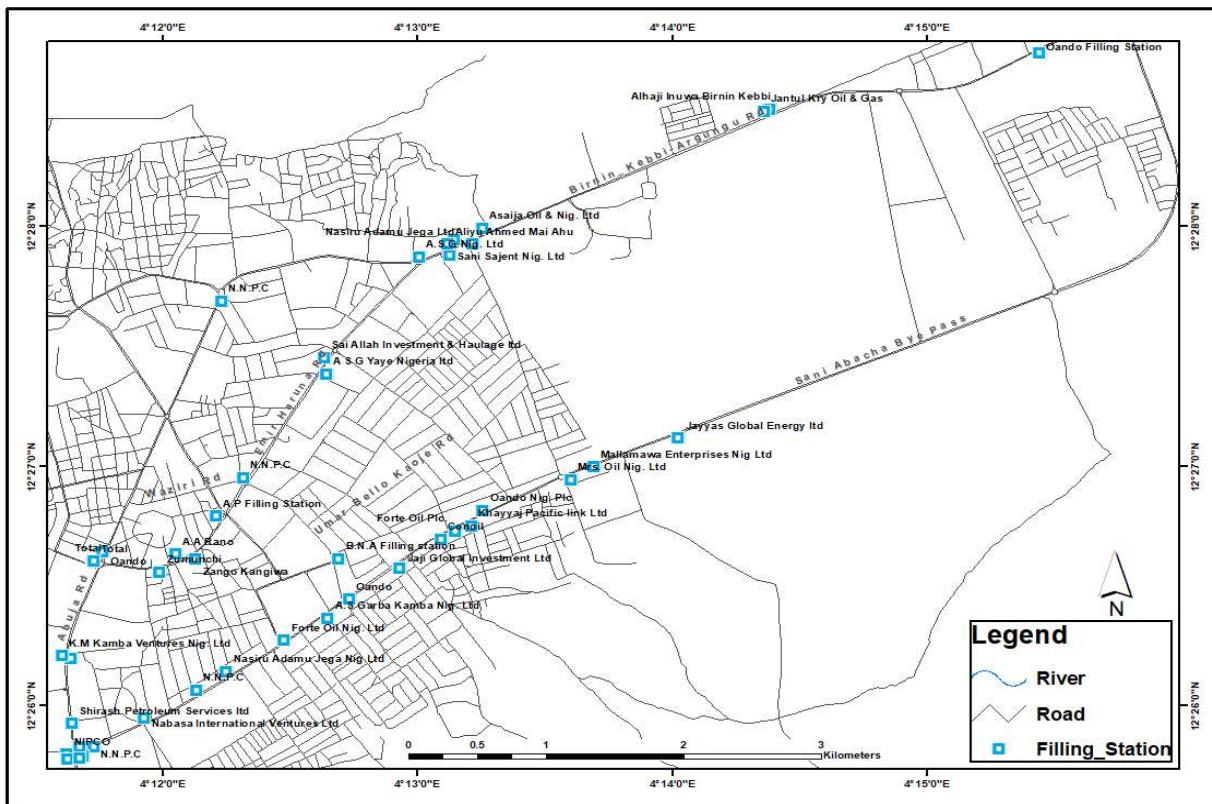


Figure 3: Spatial Distribution of Filling Stations in Birnin Kebbi Metropolis
Source: Author's Field Analysis, (2021)

each at Tasha, Central Market, old bye-pass and AP2 roundabout, two (2) at Emir Haruna Rashid, one (1) each at Rima and Gesse.

However, 6% of the non-functional filling stations is government owned and located in Gesse, 24% is oil and gas company-owned and are located each at Gwadangaji, Central Market, and Gen. Abacha bye pass, while 72% are privately owned with four (4) at Gen. Sani Abacha bye-pass, three (3) each at Tasha, old bypass and AP2 roundabout, two (2) at Emir Haruna Rashid and one (1) at Rima.

3.3 Distribution of Petrol Filling Stations and DPR Guidelines

A 30 meters buffer zone was generated in the ArcGIS 10.5 to show the specific number of petrol filling stations in contravention of the standards. These are shown in Figure 5 and 6.

Based on the DPR guidelines, any petrol filling station within the buffer zone and does not extend to the access road is up to standard while petrol filling stations which contravene the DPR standard extend and even intersect the access roads. As indicated in Figure 6, 51% of the petrol filling stations are within the DPR standard. However, 49% of the petrol filling stations in the study area were in contravention of the DPR standard. Mshelia *et al.*, (2015), in a study of environmental effects of petrol stations at close proximities to residential buildings showed that most of the petrol stations were located close to each other and did not comply with DPR guidelines. The results further showed that NNPC owns the standard

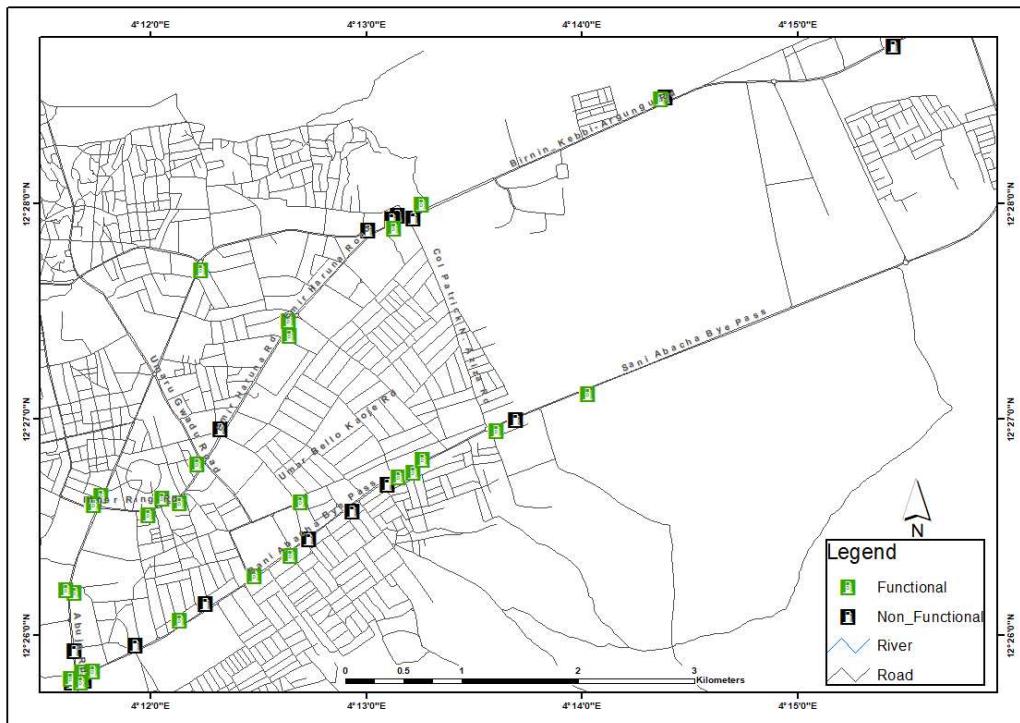


Figure 4: Functional and Non-functional Filling Stations in Birnin Kebbi Metropolis
Source: Author's Field Analysis (2021)

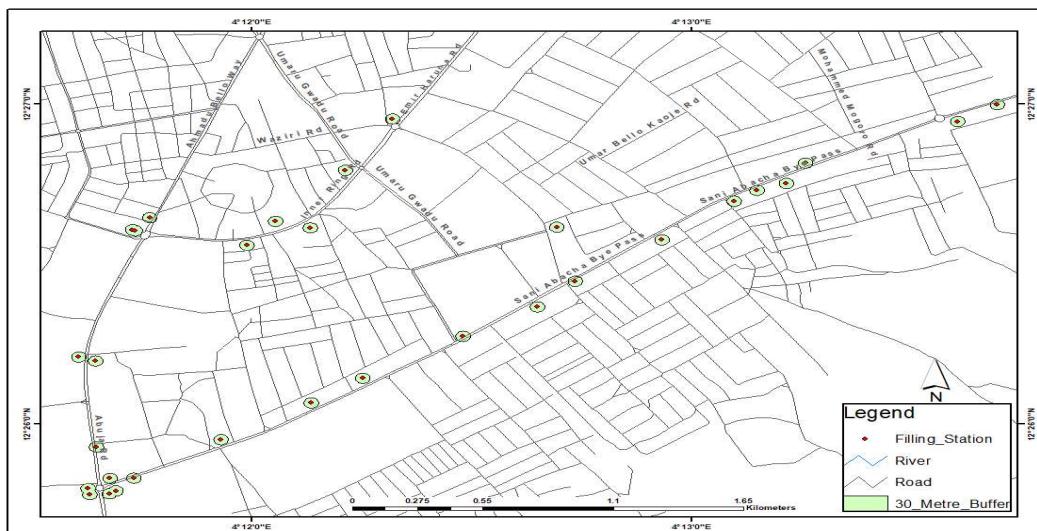


Figure 5: Spatial Location of Filling Stations in 30M Buffer Zones
Source: Author's Field Analysis (2021)

filling stations located at Gesse, GRA and old bye-pass. However, out of the total number of the private owned petrol filling stations, only 26% are up to standard. Similarly, 76%

of the private owned petrol filling stations contravene the standards and are located across the metropolis. This is attributed to the negligence of the regulatory bodies in

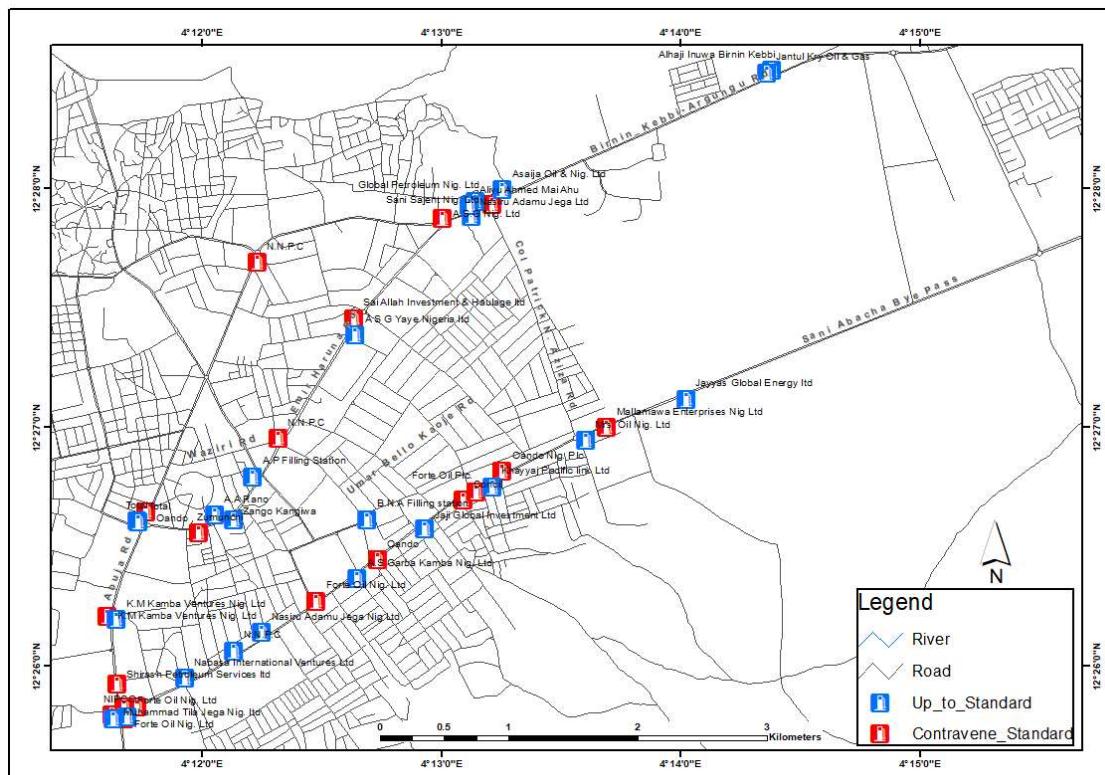


Figure 6: Degree of Petrol Filling Station Conformity to DPR Standard
Source: Author's Field Analysis, (2021)

enforcing the law as well as the failure of the entrepreneurs to comply with the specified guidelines.

4.0 CONCLUSION AND RECOMMENDATIONS

The study analysed the distribution of petrol filling stations in Birnin Kebbi metropolis. Findings from the study show that 63% of the petrol filling stations in Birnin Kebbi metropolis are functional while 37% are non-functional. The results also showed that 49% of the petrol filling stations in the study area are not in conformity with the Department of Petroleum Resources (DPR, 2007) guidelines, with 76% of the privately owned petrol filling stations in contravention of the Department of Petroleum Resources (DPR, 2007) standards. The study concludes that the location of the petrol filling stations in Birnin Kebbi metropolis is skewed and

clustered in the areas characterized by dense population (Magaji, 2020). The distribution of the petrol filling stations in relation to the population indicates high demand of petrol demand in Birnin Kebbi metropolis. This is because the distribution is based on the population, client choice and market value. The study affirms that population and standard of living determine the demand for petrol, consequently affecting the spatial distribution of petrol filling stations in the study area. There is therefore need for: legislations and regulations to check the proliferation and disproportionate distribution of petrol filling stations, improved capacity of the regulatory agencies like the DPR and KUDA in enforcing compliance by petrol filling stations, improved public screening techniques and tools to reduce risks and improved public

participation in environmental monitoring and auditing of hazardous public facilities.

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