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Assessment of the Spatial Distribution of Petrol Filling Stations in Lokoja Kogi State, Nigeria

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Abstract

Lokoja the capital of Kogi state serves as a gateway between the northern and southern parts of Nigeria. Being a nodal town and in addition to its proximity to Abuja, the town is known for high traffic volume serving as a transit route to Abuja. These potentials have made the building of petrol filling stations an attractive investment in the town's spatial space. The location of the petrol filling stations spans across major roads enroute the town and the town itself. It is believed that several of these petrol filling stations are built without compliance to planning standards and requirements of Department of Petroleum Resource (DPR). However, no study has provided information on this among others. The study assessed the spatial distribution of petrol filling stations in Lokoja, analyze the factors that influence their locations and the compliance level to planning standards and DPR regulations. This study uses survey method to determine the extent or degree of relationship between two or more variables in making predictions. Data collected from field survey using questionnaires and participant observation were analyzed using remote sensing tools such as ArcGIS to show the distribution of petrol filling stations in the study area. The acquired images were analyzed using GIS techniques. Result shows that 82 petrol filling stations are currently operating in Lokoja and 62.2% of this figure are owned by independent marketing companies. Further finding shows that, though the petrol filling station exhibit linear pattern because they are cited mainly on roadside where drivers can easily get the product, the overall pattern of distribution is recti-linear-clustered with nearest neighbor value (Rn) of 0.3 and P-value of 0.218. Several factors were found to influence the location of petrol filling stations, these include traffic flow volume, areas of high demand among others. Significant numbers of the petrol filling stations do not satisfy the minimum requirement of distance from the road representing 48%, in addition to failing in other requirements. The study recommends regulations of the activities of defaulting petrol filling stations especially those that failed to meet the minimum requirement of 15-meter distance from the road and other requirements. In addition, strict enforcement of planning standards and DPR regulations for emerging petrol filling stations to instant rules is recommended, so that the observed problems with the existing ones do not persist.

Key words: *Lokoja, Petrol filling Stations, Planning Standards, Department of Petroleum Resource, Regulations*

Introduction

Petrol filling stations are roadside facilities specially design to sell gasoline and other products that automobiles use. Some also offer other minor repair services such as motor-oil tuning and tyre alignment. Energy adequacy is universally recognized as a crucial parameter for the sustainable development of a nation. Ambituuni et al. (2014) argued that petroleum consumption has been on the increase in Nigeria since the early 1980s. This upward trend is evidenced in the energy consumption data of 2006, 2007 and 2011, where petroleum products represent 53%, 67.3% and 68.5% respectively of the total energy consumed in the country (Energy Information Administration, 2012).

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Since principal function of the petrol 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 (1957) maintained that, then specialized outlets for selling gasoline and lubricant were unknown. Rather motorist then purchase their product from number of retailing stores and service establishments that sell petroleum product together with other business activities.

The history of petrol filling station in Nigeria date 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 independence, the mileage of motor able roads hardly increased and the vehicles plying these roads were quite few. However, with the independence in 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 petrol filling stations across the country. The filling stations operators are often referred to as oil marketing companies.

Petrol is originally hydrocarbon that contains benzene which can be harmful when in contact with human skin or when exposed to the environment. At ambient temperature, petrol gives out vapour when it mixes with air. To some extent, it is also linked to radiation (Abiola & Oyinloye, 2021). Petrol stations are associated with pollution, risk of fire inferno, accidents and traffic congestion occasioned by long queue during fuel scarcity among others. Hence, the location of such stations deserves adequate planning guidance and adherence to standards and planning principles because compliance to standards is significance to the health and safety of the public.

Cities all over the world have varying degree of vulnerability based on their level of development, pressure, their resilience and coping capacity as well as the extent to which development control is effective in restraining development and ensuring compliance to planning standards (Njoku & Alagbe, 2015).

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According to Nieminen (2005), while nations all over the world have evolved their Urban and Regional Planning Laws, guidelines and standards pertaining location of services, the observed trend in many African countries is the growing incidence of locating petrol filling stations without recourse to these standards.

According to Bassuah (2019), the number of petrol station all over the world had increased by 2,432% between 1996 and 2016. The same study reported that in Africa alone, the number of filling stations had increased by 17,500%. In Ghana for instance, the number of petrol station had risen from 4,750 to 18,500 over the same period amounting to 389% increase (Bassuah, 2019). The rise in the number of filling stations in Africa raises a lot of concern about land requirements and locational implications of these stations.

In Nigeria, the number had doubled that of Ghana due to high demand for petroleum product and increase mobility over time. Mshelia et al. (2015) reported that more petroleum stations are built in Nigeria without considering planning locational standards and principles. This astronomical rise in the number of petrol stations means more pressure on land and locational crisis. Nigeria being one of the oil rich nations has about 78% of its GDP coming from the petroleum sector (National Bureau of Statistics, 2008).

Rapid urbanization and relative economic growth in the country has resulted in increased vehicular ownership hence, heightening demand for petroleum products. Petroleum marketers exploit this by building petrol stations indiscriminately without recourse to implications of this on the environment. This is exacerbated by lack of development plans for most urban settlements in the country and ineffective implementation of the few available ones.

Petrol stations are inarguably among the most important facilities in urban areas whose location must be taken seriously (Ekebuike et al., 2016). This is because of obvious danger the poor location of such facility can pose to the environment. The situation in most cities in Nigeria is that of indiscriminate location and haphazard development of petrol filling stations in disregard of the guidelines and regulations governing its erection, location and development (Mshelia et al., 2015).

Accordingly, petrol filling stations in many urban centres in Nigeria are located without observing Urban Planning standards in terms of location at reasonable distance from residential building, public places such as schools, markets, hospitals

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and setbacks to roads (Mshelia et al., 2015). In spite of availability of standards, guidelines and principles for locating petrol filling stations in Nigeria, most petrol filling stations are still located in a manner that is chaotic and potentially hazardous (Afolabi et al., 2011). As Ayodele (2011) noted, poor location of petrol station results in traffic hold-up, environmental pollution and fire hazards.

Location of petrol station at arterial roads often disrupts traffic flow pattern and resulting in traffic congestion and consequently accidents. According to Ayodele (2011), petrol filling stations are among the major contributors to traffic congestion, fire inferno, explosion, and pollution of the environment in most Nigerian cities. The magnitude of these problems according to him depends on location, size and distance from major roads and residential neighbourhoods.

Neighbourhoods with petrol filling stations experience more noise, congestion, and traffic related problems than those without its presence (Akinsulire & Fadare, 2020). The obvious impacts of these petrol filling station related traffic congestion is loss of productive man-hour, increase pollution and energy consumption and environmental degradation among others (Ehinomen & Adeleke, 2012).

Literature Review

There are lots of studies on locational implications of petrol stations all over the country. For instance, the works of Ayodele (2011), Mshelia et al. (2015) and Samuel et al. (2015) were all on location of petrol filling stations and their impacts on the environment. Ayoole (2011) assessed the impacts of locational distribution of petrol stations in Kaduna North, where he observed that more than twenty-two petrol filling stations were found in the area and that majority of the petrol filling stations were located along major roads and 69.5% of the stations studied contravened planning standards. Mshelia et al. (2015) did similar study in Maiduguri and observed that most of the petrol filling stations studied were located less than 100 Meters away from residential areas, posing risk of fire, pollution and accidents.

The case of indiscriminate sitting of petrol filing stations without complying to standards set by the regulatory in the country is increasing by the day. The environmental implications and dangers posed to man by these actions are imminent. There have been a lot of studies on location and distribution of petrol stations in major towns in Nigeria. Several of these studies have reported that the location of

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petrol filling stations has implications on the environment (Mohammed et al., 2014, Ekpenyong et al., 2019, Uba, 2015; Mshelia et al., 2015; Blamah et al., 2012; Ayodele 2011; Akinsulire & Fadare, 2020; Olasunkanmi & Farotimi, 2017; Bassuah, 2019; Ehinomen & Adeleke, 2012; Oyinloye & Abiola, 2021 and Samuel et al., 2015).

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. Light (2004) stressed that, retail gasoline is one of the most analyzed products in the world, especially in the United States of America because of people's reliance on cars.

Sule et al. (2006) studied the spatial distribution of filling stations in Kaduna Metropolis using ArcView GIS software. The results of the study showed that there are 193 filling stations in the area, and that independent marketers dominate the business with 68% of the stations. Blamah et al. (2012) looked at the locational impact assessment of gasoline service stations along Abuja-Keffi Road and environs in Karu, Abuja, Nigeria. The study examines the location of petroleum filling stations using Site Analysis Report (SAR) of the seventeen sampled stations in the area, a questionnaire was also administered to solicit people's perception on the effects of the location of petrol filling stations in the area. The findings of the study revealed partial compliance to planning criteria in locating filling station, that about 82% of the stations have fallen short in meeting the standards of 450m distance in-between one station to another.

As observed by Ayodele (2011), in highly urbanized areas, petrol filling station is a significant contributor to traffic problems such as traffic congestion, pollution, fire and explosion. The extent of these problems depends on the criteria or variable such as location, size and set back from road etc. Some hazards, such as traffic congestion, pollution and many more problems result from un-coordinated development. Apart from these hazards, cities are also confronted with other problems like accidents, explosion and fire. Another study by Hamid et al. (2009), discussed site potentiality for petrol station business based on traffic volume counts using a regression and Geographic Information System

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(GIS). The authors stressed that, site potentiality is an important factor that influences business success of a petrol station which relies on customer visits. On this note, Kearny (1998) disclosed that, it was empirically found in the United States of America that, site location was the primary factor for drivers to choose the service of a petrol filling station.

According to Uba (2012) who analysed the locational pattern of filling stations in Kano metropolis, the petrol filling station exhibit linear pattern because they are cited mainly on road side where drivers can easily get the product, the overall pattern of distribution is clustered with nearest neighbour value. Olapeju (2017) in his study in Ilaro Ogun revealed that the locational pattern of petrol filling station tends towards clustering.

According to a study by Ogunyemi et al. (2017) in Sango Ota metropolis, the nearest neighbor analysis for the spatial pattern of petrol service stations in each region revealed three major spatial distributions. The spatial pattern from Iju to Iyana and Iyana to Ojuore showed dispersed pattern, Abeokuta highway showed random pattern, while Sango Ota showed clustered pattern. Ogundahunsi (2014) in his study of the locational pattern of fuel stations in Ilesa, Osun state, revealed that the computed nearest neighbor index for his study was 0.16 which indicates that the distribution of pattern of the fuel stations was tending towards clustering which is not an ideal situation for such a facility in view of the safety implications. In a study carried out by Oloko-oba et al. (2016) in Ilorin, Kwara state, reveals that the spatial pattern of distribution of petrol filling stations in the study area shows a clustered pattern with nearest neighbor ratio of 0.43 and z-score of -16.14.

Ayodele (2011) examined the spatial distribution of filling stations in Kaduna North. The study identified the pattern and distribution problem in the area. The study found that there are twenty-two filling stations in the area and the distribution is uneven as the stations are mostly concentrated along major roads. In addition, the study looked at the setbacks and locational situation of the stations and concluded that 69.5% did not conform to the standard. On this study, though GIS was applied for mapping, it was not employed for measuring the standards compliances. Similarly, a study was carried out in Agege Local Government Area of Lagos State by Abdullahi (2012), the study observed that petrol filling stations are randomly distributed

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in the area. The study observed that, due to land shortage, people build petrol filling stations wherever the land is available and this creates a pseudo development pattern.

Ioja and Tudor, (2011) examined the temporal changes in proximity of residential land use to filling stations in Bucharest suburban, Romania. The results of the study revealed that 21 gas stations are located in residential areas and 39 gas stations are located in non-residential area. The study found that, ten gas stations were located in residential areas. However, the study limited itself mainly to buffer analysis and only on residential land use, distance of petrol filling stations to other conflicting land use like public buildings, hospitals and the likes were not analyse by the study.

Ujjwal and Sokhi (2006) applied GIS for petrol station vulnerability assessment in New Delhi, India. In their study, land uses within the 200 meters 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-meter buffers. Compliance to regulatory standards were found to have been compromised in some cases.

Preferences for the location of petrol filling stations on heavily travelled streets so as to obtain the maximum patronage from road users result to traffic congestion and hazards. Several of the results as reported has shown that level of compliance to planning and regulations are generally low. The dark side of petroleum especially fueling of vehicles is the environmental effects on the eco-system hence its service location points must be strategically and consciously done to minimize its negative effects on both human beings and their immediate environs.

Despite this large body of literature on the same subject matter, none of this research was conducted in Lokoja. This is the gap in literature, this study intends to fill. Consequently, this study analyzes the spatial location of petrol filling stations in Lokoja, examine the factors influencing the locations of the petrol filling stations and to examine compliance to some urban planning standards and Department of Petroleum Resource (DPR) regulations.

Planning Standards and DPR Regulations for the Location of Petrol Filling Stations in Nigeria

Petrol filling stations are concerned with distribution and retailing of petroleum products with or without other businesses attach to it.

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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. Petrol filling stations have been identified as one of the major generators of traffic hazards, aestheticism reduction and potential fire causal agents (Ujjwal & Sokhi, 2006). It is on this basis that states and nations make laws and regulations on its location so as to minimize and reduce the risk associated with it. In Nigeria the DPR is responsible for registering and regulating the downstream petroleum sector including the petrol filling station business. Other agencies involve are the state ministries for town planning.

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 petrol filling stations (Proshare, 2013).

According to the DPR manual, before operating filling station one has to certify some physical planning standards. The critical requirements in terms of physical planning standards include, location of such petrol filling stations should be zone within commercial and industrial land use or be designated specifically for such purpose in a subdivision, the parcel of land should not be less than 33 x 33 square meters or equivalent of two plots of land to allow for free flow of traffic, and that a station be sited 400 meters away from the next petrol station. Others

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include siting a station 50 meters away in all angles of the build-up areas to create a buffer zone for the residential house, the buffer zone can be devoted to any non-residential land use, the distance from the edge of the road to the nearest pump will not be less than 15meters, the total number of stations within 2 km radius of the site should not be more than four (4) including the one under construction. Furthermore, no station should be located less than 100 meters from school, hospital, theaters, clinics and other public and semi-public buildings and the site for petrol filling station should not lie within NNPC/PPMC pipeline right of way or PHCN transmission or railroad lines (DPR, 2007).

The locations of services in cities are usually guided by urban planning standards and principles as enshrined in Urban Master Plan or Structure Plan (Taylor et al., 2016). Implementation of the plan during development control ensures strict adherence to these standards and principles. Despite development control activities in Lokoja, there seem to be no compliance with urban planning standards in the locations of most of the filling stations in the town. This raises a lot of questions. It is therefore important to analyze the spatial location of the petrol stations in the town with respect to the extent of compliance to urban planning standards and DPP regulation and investigate the factors responsible for the existing pattern of location and distribution. Findings of this study are expected to provide policy makers with useful information that will enhance location and the regulation of the activities of petrol filling stations in Lokoja.

The Study Area

Lokoja is the capital of Kogi State in North-Central Nigeria (See Fig 1). It is located on the West Bank of the Niger River opposite the mouth of the Benue River (See Fig. 2). The town comprise of several indigenous ethic groups including the Bassa –Nge/Nupe, Oworo, Egbura koton as well as migrants including Hausa, Yoruba, Igala who over the years have more or less harmoniously fused devoid of obvious dichotomy. Lokoja also double as headquarter of Lokoja Local Government Area of Kogi State with an area of 3,180 km^2.



Figure 1: Map of Nigeria Showing Kogi State
Source: Kogi State Ministry of Land and Environment, 2008

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Figure 2: Map of Lokoja
Source: Kogi State Ministry of Land and Environment, 2008

Available population for Lokoja Local Government is 195,261 by 2006 census report (National Population Commission (NPC), 2006). The population of the study area as at 2024 is estimate at 885, 882 by the United Nations World Urbanisation Prospects. (World Population Review, 2004)

Methodology

The data needed for the study include information in terms of the spatial location of petrol filling stations in Lokoja. This will include information such as, distribution patterns and trends and direction of petrol filling stations, factors influencing the site selection and location of the stations and compliance level to planning standards and regulations. Both primary and secondary data sources were used for data collection. The primary sources of data include information sourced from field survey using questionnaires and participant observation. While secondary sources include data collected and documented in previous research work, which were retrieved and used to strengthen the theoretical base of the study. Other secondary data were sourced from published and unpublished materials such as textbooks, previous dissertations, magazines, journals, maps among others. Meteorological stations report, google earth, questionnaire and direct observations were used as instruments for data collection. Analysis of data were done through the use of descriptive statistics and GIS and presented in form of tables, charts and graphs.

The data acquired through physical survey were collated by means of various data analytical techniques. The spatial data were analyzed using remote sensing tools such as ArcGIS to show the distribution of petrol stations in the study area. The acquired images

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were analyzed using GIS techniques A proper classification of these imageries was done by adopting the Maximum Likelihood Technique through which information on the distribution of petrol stations and their spatial characterization were done. Quantitative techniques of data analysis were adopted to analyze the socio economic and demographic characteristics of the study since the research is analytical in nature.

Data Analysis based on DPR standards were first entered in Excel Microsoft (2007) applications to create a simple database. Columns were used as field to store information on filling station. These fields are the company name, detailed address and road location. The data were saved in the project folder created in C drive and exported to ArcMap environment of ArcGIS 10. The data was converted to shape file and used to perform all the analysis. Different symbolizations were used to map out the filling stations. The numbers of filling station in each road were determined and the densities of the filling stations per roads were computed as ratio of the number of stations along the road to the length of the road in km. In addition, tables and charts created in Microsoft Excel were used to present the inventoried data.

In order to achieve the location pattern(s) of the filling stations in the area, pattern analysis was done using spatial statistics tools in ArcMap environment to identify the location pattern of filling stations in the area, a nearest neighbor analysis was used to compute the nearest neighbor index (NNI), the Z-Score and probability (p) value in order to determine the pattern of the distributions.

To achieve the objective of examining the factors influencing the location of filling stations, interview was conducted with 50 sampled owners of petrol filling stations to gauge possible factors that influence choice of the location of their petrol filling stations. Some of the factors examined include population density, traffic volume and urban planning regulations among others. Query by location was performed using selection menu in ArcMap environment. In addition, the data were queried to give all locations that are within 15m buffer. The selected stations were highlighted, right clicked was done on the shape file containing the station and the software was commanded to create layer from the selected features. The stations selected were identified as those not meet the distance criterion of 15m from road. Chart was created to see the proportions of the stations that do not

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meet this criterion. Another query operation was done using selection of stations that do not meet distance of 400 meter from other stations. Linkert scale was used in determining the factors that influence location of petrol stations in the study area.

Shape file for these stations was also created, saved and used to compute the proportion that does not meet 400m criterion. A hospital (being a public building) database was also imported into the ArcMap environment and a query by location was performed. The software was asked to find and highlight all stations that are within 100 meters from the hospitals. The selected stations were identified as those that do not meet the criterion of 100 meter from public place (hospitals). A similar operation was done using schools shape file to identify those that do not meet the distance of 100 meter from school. Worshiping places though consider as public or semi-public were not included in this work because their lack of spatial data. In addition, places of worship are built everywhere in the city and that comparison with them will prove difficult and nearly impossible.

The updated feature on the map will be presented as the current base map of the study area. Similarly, the outputs of the GIS analysis will be presented as maps. Statistical Packages for Social Sciences (SPSS) and Microsoft excel and the data analyze are presented using simple statistical presentation such as frequency, tables, charts and graphs will be used to present the findings from the socio economic, demographic and housing development and environmental quality data. Also maps and pictures, satellite imageries will be used for illustrations and depicting the location of filling stations in Lokoja.

Results and Discussions

Spatial Location of Petrol Filling Stations

Results on the number of petrol filling stations, spatial location and pattern of distribution is as presented in Table 1 and Figure 3. There are eighty-two (82) petrol filling stations in Lokoja at the time of this study. These petrol filling stations are located and distributed along the ten (10) roads in the area as shown in Table 1. However, the petrol filling stations are not equally distributed between the roads. Ganaja road has the highest number of stations which is twenty-six (26), followed by Okene-Lokoja Abuja road in Felele area with seventeen (17) and Okene-Kabba road and Lokoja-Abuja express way with ten (10) each respectively, these four (4) roads account for more than half of the petrol filling stations in the area

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representing 77.0%. This result is not surprising because the four roads are the major roads in the town. The roads are the longest and link Lokoja to major cities of Nigeria. Equally IBB Way and Ahmadu Bello Way, have significant number of petrol filling stations as can be observed from both Table 1 and Figure 3. On the other hand, access roads have least number of petrol filling stations. This can be seen in roads like Murtala Muhammad Way, John Holt Way and Wallace Street and many others with one petrol filling station each. Indeed, this finding has corroborated with some earlier reported previous studies where it was established that most petrol filling stations are not built in town centres but rather along its road's axis.

In terms of ownership status, majority of the petrol filling stations in Lokoja are owned by independent marketers representing 62.2%, while major marketers represent 30.4% and NNPC 7.3%. These results corroborated with that of DPR report which indicated that independent marketers owned most of the petrol filling station in the country between year 2008 and 2012. Equally the result agreed with Sule et al. (2006) who reported similar finding in Kaduna where more than 60% of the petrol filling stations were owned by the independent marketers

Table 1: Location and distribution of petrol filling station in Lokoja

S/No	Name of Road	Road Type	Frequency	Percentage (%)
1	Okene-Kabba Road	Arterial	10	12.2
2	IBB Way	Arterial	5	6.1
3	John Holt Way	Access	2	2.4
4	Ahmadu Bello Way	Arterial	5	6.1
5	Okene-Lokoja Abuja Road	Arterial	17	20.7
6	Lokoja-Abuja Road	Expressway	10	12.5
7	Wallace Street	Access	1	1.2
8	Ganaja Road	Arterial	26	31.7
9	Lokoja -Okene Road	Arterial	3	3.7
10	Muritala Muhammed Way	Access	3	3.7
		Total	**82**	**100**

Source: Field Survey (2025)

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Another feature of the location of petrol filling station is that they tend to be dominant on the exit side of the town. Out of the twenty-six filling stations along the Ganaja road, majority are situated on the exit side along Lokoja-Ganaja road. This same result is equally seen along Felele, Okene-Lokoja road, Lokoja-Abuja expressway and Okene-Kabba road. One major reason for this is that most drivers fuel their vehicle when moving out of the city. This explains the reason why majority of the petrol filling stations in the town are located on the exit points of the roads.

Attempt was made to establish relationship between the road rank and the number of filling station using Pearson Product Moment Correlation and it was discovered that there is significant relationship even at alpha=0.01 because the p-value for the relationship is 0.00110. In other words, the higher rank of the road, the more the number of filling stations located along it.

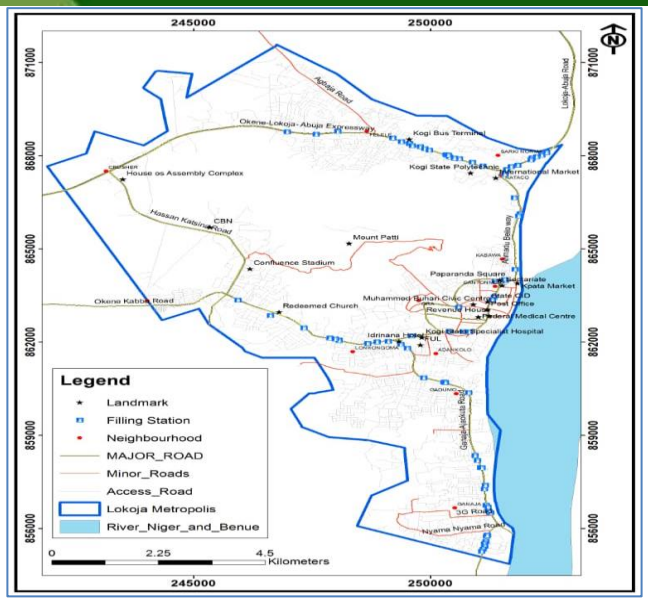


Figure 3: Spatial distributions of petrol filling stations in Lokoja

In terms of the pattern of distribution, the results of the analyses revealed a perfectly clustered distribution because the nearest neighborhood index (Rn) value is less than 1 and Z-value is -15.87, less than -1.96. Also, there is significant difference between the distribution of petrol filling stations in the area and random distribution at both 95 and 99 percent because the p-value is less than 001. However, it is important to note that nearest neighbor analysis is just a technique that explains the distribution of phenomena but cannot explain the reason for the distribution (Wough, 2007). The reason for clustered distribution of the filling stations in the area may be linked to the fact that petrol filling stations are located mainly on the road side and tend to concentrate on the highways and major

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roads as found to be typical of Lokoja. The reason is obvious because the major consumers of their products are motorists on transits.

Factors Influencing the Location of Petrol Filling Stations

The perceived factors that influence the location of petrol filling stations were tested on fifty sampled owners of petrol filling stations. The possible perceived factors that influence the location of petrol filling stations were examined. Fifty owners of petrol filling stations were asked to comment on the factors that influence the choice of location of petrol stations in Lokoja and their responses were gauged in Table 2 based on 5 Likert Scale.

Table 2: Factors Influencing the Location of Petrol Filling Stations in Lokoja

Factors	**1** Strongly Disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly Agree
Population Density	2 (4%)	3 (6%)	1 (2%)	21 (42%)	23 (46%)
Traffic Flow Volume	1 (2%)	1 (2%)	2 (4%)	17 (34%)	29 (58%)
Urban Planning Regulation	1 (2%)	1 (2%)	2 (4%)	10 (20%)	36 (72%)
Areas of High Demand	1 (2%)	1 (2%)	1 (2%)	9 (18%)	38 (76%)
Owner's Preference	2 (4%)	3 (6%)	2 (4%)	7 (14%)	36 (72%)
Proximity to Existing Ones	5 (10%)	10 (20%)	5 (10%)	10 (20%)	20 (40%)

Source: Field Survey (2025)

Population density was found to have influence the location of petrol filling stations indicating 42% for those who agreed and 46% for strongly agreed. On the basis of these perceived responses, it is therefore safe to conclude that population is indeed a factor that influences the location of petrol station in the study area. Petrol filling stations are generally assumed to be located on routes with high volume of traffic. This assumption was tested in Lokoja the study area. The result of the perceived influence of location of petrol filling stations on routes with high traffic was found to be positive and 58% of the those interviewed strongly agreed with this assertion.

The influence of urban planning regulations on land use activities was perceived to have positively also determine the location of petrol filling stations in Lokoja. Analysis of the result on this factor indicate that, while 20% agrees, 72% perceived strongly that urban planning regulation has influenced the location of petrol filling stations in the study area.

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Investors usually respond to demand especially as it affects sale of petroleum product. The demand of petrol commodity in an area is generally believed to influence its sitting and location. The result of demand as factor influencing the location of petrol station in the study show high influence. As greater percentage of the respondents strongly agreed on the influence of this factor represented by 76%. Based on the level of agreement as presented, it is safe to conclude that demand factor is among the strong actors influencing location of petrol filling stations in Lokoja.

Result on proximity to existing ones was assessed as one of the factors influencing the location petrol filling stations in Lokoja. Responses were gleaned from respondents on whether locating petrol station close to one another matters as a factor influencing the location of petrol filling stations. The factor shows moderate influence, as 20% agreed and 40% strongly agreed with the influence of this factor.

Compliance Level of Petrol Filling Stations with Standards and Regulations

Kogi State Town Planning and Development Board (KSTPDB) have the duty of regulating all development within Lokoja and Kogi state. The petrol filling stations activities are also regulated by DPR as established earlier. The DPR is a department under the Ministry of Petroleum Resources saddled with responsibility of registering and regulating the downstream petroleum sector. Petrol Filling stations must meet the planning standards set by these agencies for their business safety. This study correlated the compliance level of petrol filling stations against some KSTPDB and DPR standards and regulations using proximity analysis tools available in ArcGIS 10 and the results presented and discussed.

Distance from Road

According to the physical planning Standards set by DPR (2007), the procedure guide for granting an approval to construct and operate a petrol products retail outlet is that the distance from the road to filling station pump should not be less than 15m. They idea is that, since petrol filling stations are point facilities and road as line feature, a buffer of 15m is needed. Compliance to this regulation was tested by using the data collected from the petrol filling stations through the use of ArcMap environment. The query assisted with selecting all locations that are completely within 15meter road buffer. The result of the analysis is presented in Figure 3.

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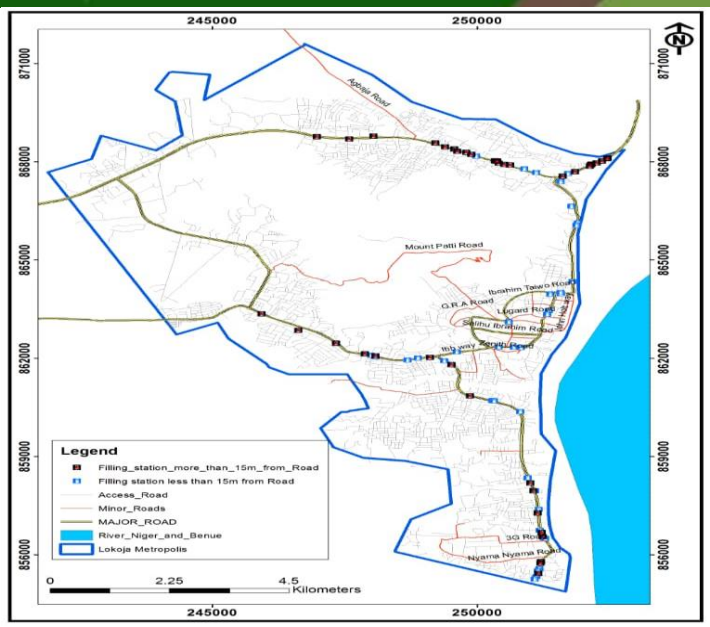


Figure. 4: Filling station in Lokoja metropolis that observe 15m road setback

The result of the study indicates that while 52% complied to this regulation, 48% were found not to have complied. Among the filling stations that did not meet this criterion, independent marketers accounts for 70.0%, major marketers account for 27.9% and NNPC 2.0%. The stations that do not meet the 15m requirement were found along the major and access roads. The result further reveals that in Ganaja road, about 18 petrol filling stations are below the 15m minimum setback. Some other petrol filling stations located along John Holt Way, Ahmadu Bello way, Lokoja-Okene, Okene-Kabba, and IBB Way roads were found to have also violated this standard.

Distance between Filling Stations

Another DPR regulation is 400 metre away distance of location of petrol filling stations from each other. Distances between filling stations in the area were determined in ArcMap environment using proximity operation analysis tool. The finding reveals that longest distance between neighboring filling stations was about 2,300 metres. This was found along Ganaja road in Gadumo area. Apart from the above mentioned, the mean distance between neighboring filling stations was about 300 meters. The shortest distance was that of less than a metre where filling stations were observed to be located back-to-back. The result also shows that more than half of the filling stations were located more than 400 metres away from neighbouring filling stations. While 75% of the petrol filling stations were found to meet the requirement of 400m distance from each, 25% of the petrol filling stations did not meet the minimum distance of 400 metres away from their neighbors with no road separating them see Figure 5.

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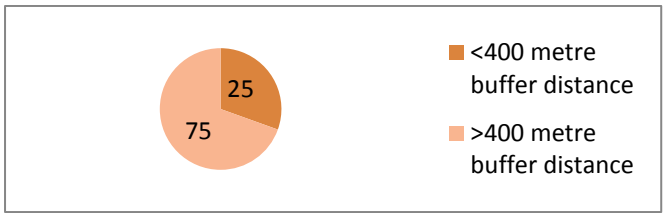


Figure 5: Compliance to setbacks of 400m between Filling Stations in Lokoja Metropolis

The petrol filling stations that did not satisfied this standard were found along the major roads and the cause of this agglomeration will not be far fetch from the marketer's desire to take advantage of traffic volume and motor park areas for high sales of petrol product. The highest number of those that meet the minimum standard of 400m distance between the locations of filling station was observed in exits and major roads linking Lokoja to other major Nigeria's cities.

Compliance level of petrol filling stations to DPR and KSTPDB standards and regulations

Principal Component Analysis (PCA) was used to evaluate the extent of compliance of petrol stations in Lokoja town to urban planning and DPR locational standards and principles. PCA which is some data reduction techniques is used to analyzed data, so PCA results identifies three components and classify the components body. According to Liu et al. (2003), the loading values signify "Strong" 0.75-050 signifies "moderate" and 0.50-0.30 signifies "weak" $\underline{Z = X_i - X_1}$ $\sum x$

The results of the principal component analysis (PCA) three orthogonal components were identified from the PCA results accounting for accumulative variance of 74% in original variables using a cut-off point value (Eigenvalue) of 1, the first PCA contributed of 36.9% the total variance while the second 31.8%, and third 11.5% (See Tables 3 &4 and Figure 6). The three PCA components one named based on their loadings in relation to the original variables from the first components had positive loadings 70.300 station not located under high tension, distance to the nearest station not less than 400m, availability of EIA report adequate size, and availability of adequate waste management equipment, while the rest variables had leadings <0.300 road setback that is less than 15m, non-compliance with zoning and development control guidelines and non-compliance with sanitary and environmental standard. This mixture of characteristics describes those filling stations that are actively engaged in lack of compliance to planning standards so these are therefore referred to here as violating planning regulations.

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Table 3: Principal Component Analysis Showing Compliance with Standards (The Components)

Component	Eigenvalue	Difference	Proportion	Cumulation
Comp 1	2.7842	1.01948	0.3094	0.3094
Comp 2	1.76472	.660536	0.1961	0.5054
Comp 3	1.10418	.0650965	0.1227	0.6281
Comp 4	1.03909	.229873	0.1155	0.7436
Comp 5	.809212	.194262	0.0899	0.8335
Comp 6	.61495	.147604	0.0683	0.9018
Comp 7	.467346	.0510365	0.0519	0.9537
Comp 8	416309	.416309	0.0463	1.0000
Comp 9			0.0000	1.0000

Table 4: Principal Component Analysis Showing Compliance with Standards (The Variables)

Variable	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7
Z1	0.4044	-0.5364	0.0590	0.0766	0.1603	-0.0107	0.0889
Z2	0.0237	0.3001	-0780	0.7807	0.4047	-0.2061	0.2931
Z3	0.4044	-0.5364	0.0590	0.0766	0.1603	-0.0107	0.0889
Z4	0.3579	0.2903	-0.2195	-03636	-0.3636	-0.3186	0.5722
Z5	0.4250	0.2263	-02675	-0.1582	-01582	0.2165	0.0984
Z6	0.0722	0.2750	-5550	-0.3658	-03658	0.0733	-0534
Z7	0.3862	0.2600	-0.2645	0.1580	0.1580	0.5837	-0.3682
Z8	0.4119	0.1921	0.1794	0.0862	0.0862	-0.6147	-0.5787
Z9	0.1990	0.1371	0.6760	0.2352	0.2352	0.2916	0.2964

The second component had negative loadings on (0.3001). Road setback less than 15m, no EIA report, no adequate spacing to allowing maneuvering for trucks and other vehicles, lack of compliance with zoning and development control, no adequate size, lack of waste management equipment and compliance with sanitary and environment standard. These variables had negative loadings were negative or zero stations with distance less than 400m. This component describes filling station are liable to fire accident. So, this filling stations are categorized as hazardous to public safety.

The third component had positive loadings on station not located under high tension, distance of 400m, compliance with zoning and development control, guidelines, availability of waste management equipment and stations that comply with sanitary and environmental equipment, filling stations not located under high tension, distance to the nearest station of 400m, compliance with zoning and development control, availability of waste management equipment and compliance with sanitary management equipment.

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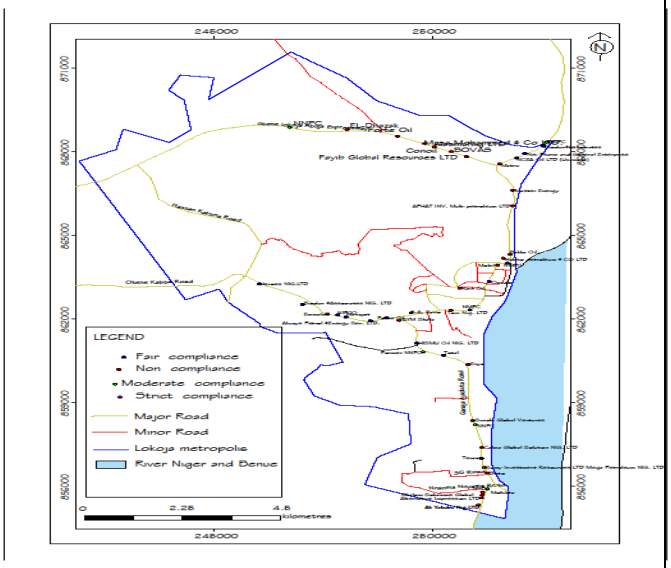


Figure 6: Compliance Level of Petrol Filling Stations with Urban Planning and DPR Standards

However, the components are retained at this stage and describe filling stations that complied with planning standard and regulation. The lowest density of filling stations per road is found in Lokoja–Okene road, Muritala Muhammed Way, Ahmadu Bello Way and Ganaja Road having the density of 0.4, 1.88, 1.34 and 3.31 respectively.

Conclusion and Recommendations

The research findings revealed that there are 82 petrol filling stations currently operating in Lokoja. The number of petrol filling stations correlated significantly with road hierarchy. Though the filling station exhibit linear pattern because they are cited mainly on roadside where drivers can easily get the product, the overall pattern of distribution is recti-linear-clustered with nearest neighbor value (Rn) of 0.3 (less than 1) and P-value of 0.218. Various factors were found to have influenced the location of the petrol filling stations at different degrees and magnitude. Compliance level of petrol filling stations to urban planning and DPR standards and regulations were generally below minimum requirements. The study recommends strict compliance to urban planning and DPR regulations in the location of petrol filling stations especially for fresh applications and revalidation of the existing ones in order to ensure that minimum requirements for overall public interest and safety are met.

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