GIS-Based Location Analyses of Retail Petrol Stations in Ilorin, Kwara State, Nigeria

Oluwaseun Odipe, Abosede Lawal, Zulkarnaini Adio, George Karani, Henry Sawyerr

Abstract— The increasing demand for petroleum products in Nigeria has led to the increase in retail petrol stations construction all over the country. The study therefore assessed these stations within Ilorin with the objectives of determining the age range, functionality status, total number of pumps and identifying premises of public concern that are within close proximity to these stations. Data for the study were obtained through field surveys; where the coordinates of the stations were acquired using handheld Global Positioning System (GPS) device, and other information through administration of questionnaires to owners and workers in each petrol station. Spatial analysis was done using the ArcGIS 10.4 by ESRI on an OpenStreet Map database, while simple descriptive analysis used Excel 2016 package. Results were presented in maps, tables and charts. The findings revealed 297 retail petrol stations were in Ilorin, of which 112 (38%) of these stations were above 15 years of age. The study also revealed that 224 (75%) of the stations were functioning at the time of study while 73 (25%) were either abandoned or under construction. The number of dispensing pumps per station varies but 215 (72%) stations has 4-6 operating pumps. Most of the stations were found at close proximities to public premises such that 10 (3%) were in close proximities to school, 226 (76%) to shops, 192 (65 %) to residential houses and 11 (4%) were close to hospitals. The research concludes that retail petrol stations are highly congested within the metropolis forming cluster pattern which poses a great threat to the densely populated region of the town.

Index Terms— Environment, Geographic Information System (GIS), Ilorin, Nigeria, Retail Petrol Stations.

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1 INTRODUCTION

A retail petrol station is a facility where petroleum products such as gasoline, diesel and dual purpose kerosene are kept for the purpose of selling to end users [1]. These retail petrol stations are called by different names such as service stations, fuelling station, petrol station, petrol bunk, filling station, garage, gas station etc. in different countries all over the world [2]. The sprawl and proliferation of petrol stations across Nigeria has resulted in rapid increase over the years as a result of the dependency of the country's economy on crude oil and other petroleum resources. Other factors such as increase in population (growth) yielding a higher demand on automobile use, lack of stable electricity aiding a generalized use of petrol-fuel generators, and also petroleum products like dual purpose kerosene (DPK) and liquefied petroleum gas (LPG) for cooking has also promoted the construction of dispensing retail petrol stations at every corner of the country and at close proximities to the end users [3], [4], [5], [6].

Previous studies such as [4], [5], [7], [8] all attest to the fact that the siting of retail petrol stations in various towns across Nigeria is drastically on the rise and there are several irregularities in its location with respect to residential settlements and other infrastructures. The location of these stations poses high risk to both the environment and human health [9]. Globally, petrol

stations have been reported to significantly contribute to pollution of water resources, outdoor air, fire disasters and

explosion leading to loss of lives and properties [6], [10], [11], [12].

Fig. 1: A typical Retail Petrol Station

Thus, this study is geared towards assessment of the locations and distribution of retail petrol stations in Ilorin, with specific objectives such as: determining of the age ranges of these stations; their functionality status, total number of pumps and identifying premises of public concern that are in close proximity to these stations.

2 METHODOLOGY
2.1 Study Area

This study was carried out in Ilorin, the capital of Kwara State,

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North-Central, Nigeria. It lies within Latitude 8° 24'N to 8° 34'N and Longitude 4° 28'E to 4° 39'E respectively as shown in figure 2 below. Ilorin is a fast growing town that is geographically divided into three Local government areas namely Ilorin East, Ilorin South and Ilorin West, with

populations at 204,310, 208,691, 364,666 respectively given a total of 777,667 as at the 2006 nationwide census [13], and geopolitically subdivided into 35 wards.

Fig. 2: Map showing the Study Area

2.2 Materials and Method

The coordinates of the retail petrol stations were determined primarily using handheld Global Positioning System (GPS) device, while attribute information such as age of stations, number of pumps, petroleum products sold, functionality status of each petrol station and distance of stations to other infrastructure were assessed through field survey and administration of questionnaires to owners and workers in each stations. Meetings where held with the independent and major petrol marketers to explain what the research entails and to obtain permission to visit and administer questionnaire to their workers. The meeting was very important in other to gain easy access to the stations, and to rule out any misconception by the petrol station owners.

The coordinates were captured by travelling to each of the retail petrol stations in the three local government in Ilorin. During the visit to the stations, field checklist was used to record name, functionality status and presence of shops, hospital, schools and residential houses around the retail petrol stations. The retail petrol station coordinates and the functionality status data were integrated into ArcGIS 10.4 by ESRI on an OpenStreet Map of the study area showing road networks and local government area boundaries. Questionnaire were administer to all functioning retail petrol station during the second visit to each of the stations using the data obtained with the handheld GPS and field checklist.
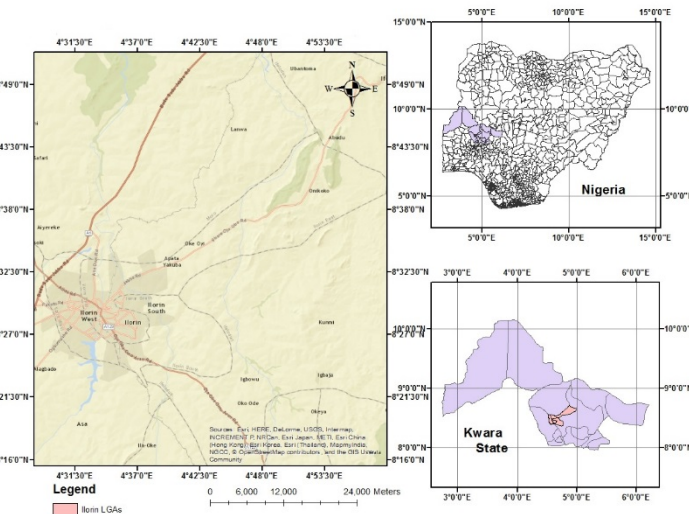
Spatial analysis using the GPS coordinate of the retail petrol stations and other attribute data were used for map production using ArcGIS 10.4 by ESRI on an OpenStreet Map database, while tables and charts were developed using Excel 2016 package.

3 RESULTS AND DISCUSSION

The study revealed that there were a total of two hundred and ninety-seven (297) retail petrol stations within Ilorin as at the time of the survey which were mostly sited along major roads in the area. The total number of 297 which included the functioning and the non-functioning retail petrol stations in Ilorin was higher in number by 72 than the total number of filling station in Ilorin of 225 reported by Oloko-oba et al., 2016 [5], the high increase in the number shows the rapid increase in the establishment of retail petrol station in Ilorin within a short period of time. In figure 3 below, it shows an appreciable percentage of the stations are within the metropolis showing a haphazard distribution pattern [5] and the possible reasons includes accessibility and marketability [14]

3.1 Age ranges of these stations

The data from the survey as shown in table 1 below shows the number and the percentage of the retail petrol stations and their years of establishment. Stations in existence above 15 years have the highest percentage of 38% followed by stations 6 to 10years, 11 to 15 years, less than 5years and the N/A with 21%, 20%, 17% and 4% respectively. The stations classified under not available include the newly established stations, the stations under construction and abandon station with no means of getting information. The survey shows that most stations owned by major petroleum marketers are sold to private owners also, the newly established stations are owned by independent petroleum marketers. The independent private marketers' retail stations has been on the increase since its introduction into the petroleum sector in 1978 [15]. These indicates the trend in retail petrol stations construction as 185 of the 297 stations (62%) were less than 15 years old and almost 70% of this fraction are less than 10years. The map in
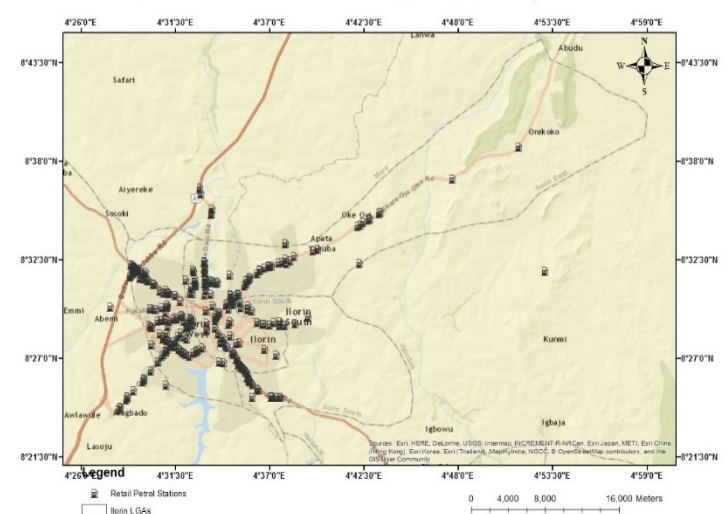
Fig. 4 below shows that all the stations above 15 years are located mainly along major road which indicates the importance of road network to petrol retail stations and easy access to travelling vehicles.

Fig. 3: Map showing the distribution pattern of Retail Petrol Stations within the Study Area [13]
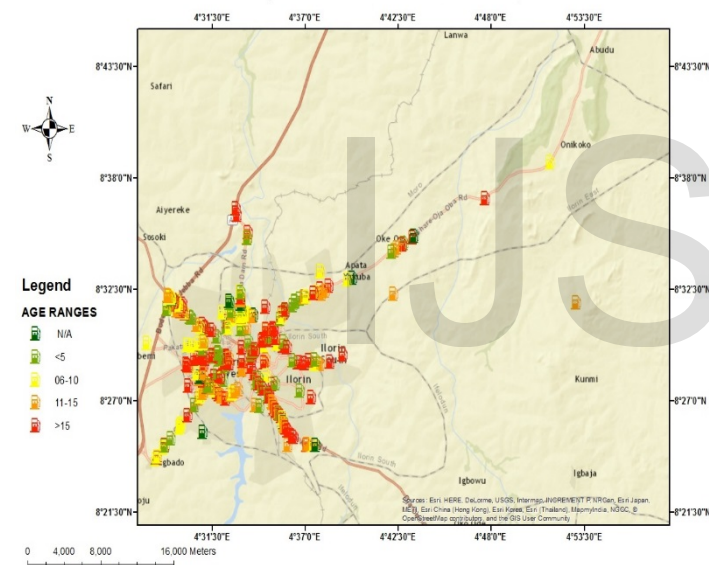
Table 1 showing the frequency of retail petrol stations with various age ranges

Age Ranges	Frequency
N/A	12
Less than 5	52
Within 6 to 10	62
Within 11 to 15	59
above 15	112

N/A includes petrol stations under construction and those without information on age
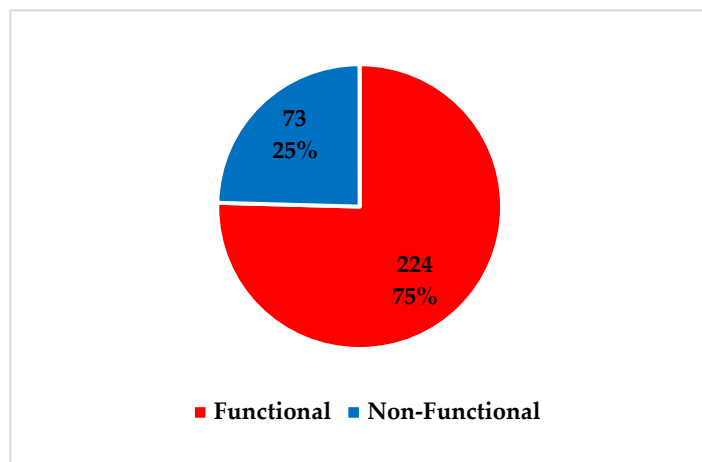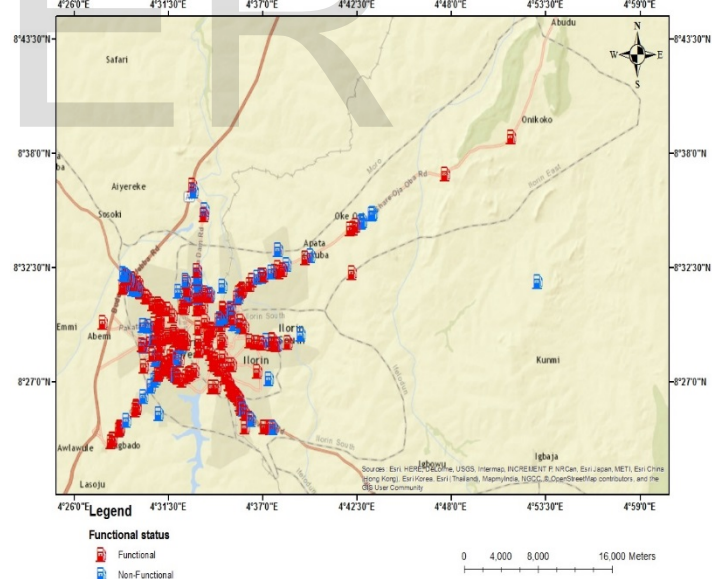

Fig. 5: Pie chart showing the functionality status of the Retail Petrol Stations in Ilorin

Fig. 4: Map showing distribution of retail petrol stations and their various age ranges in Ilorin

3.2 Functionality Status

The functioning petrol retail stations were all stations actively dispensing any of the three or all three major petroleum products (gasoline, diesel and dual purpose kerosene) commonly sold in Nigeria to consumers while the non-functioning stations were all stations previously active in service but are closed down, those under construction and those newly completed but not yet in use at the time of the survey. The result of the study revealed that 224 of the stations were functioning at the time of study (i.e. 75%) while the remaining 73 (25%) were either abandoned, newly completed or under construction (Fig. 5 & 6).

Fig. 6: Map showing the functionality status of the Retail Petrol Stations in Ilorin

From Fig. 6 above, it shows that most of the stations in the heart of the metropolis are functioning which poses a great threat to the environs and populace through its contribution to the increasing air pollution from the continuous emission of vapour, release of toxic gases and constant traffic thereby endearing the health of the people [16], [17].

3.3 Number of Pumps in Use

In assessing the possible threat these stations could pose during its activities, it was required that the number of pumps in each station was assessed, 35 stations had < 3 pumps, 215 stations had 4 – 6 pumps, 41 stations had 7 – 9 pumps, while 6 stations operated with more than 10 pumps. Furthermore, large number of this petrol retail stations lack appropriate safety measure in terms of their waste management, location and fire safety precaution and evacuation plans [18]. Also, it been indicated by Health and Safety Authority that retail petrol stations are associated with the risk of explosion or fire than other types of business outlets because of the high flammable properties of petrol vapours [19]. Knowing the numbers of pumps at the different petrol stations could be considered an important information to the fire safety and the health service department in case of emergency because, the more pumps at a petrol station, the likelihood of large fire when ignition happens.

The maximum pump at any station within the metropolis was 13 as shown in Table 2 and Fig. 7.

Table 2: showing the Frequency of Stations with respect to number of pumps in use

Number of Pumps	Number of Stations	Percentage
0-3	35	12%
4 to 6	215	72%
7 to 9	41	14%
> 10	6	2%
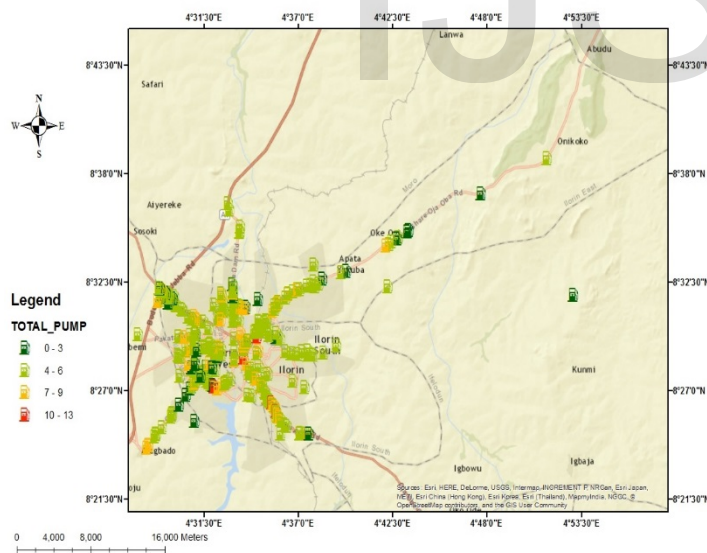
Fig. 7: Map showing the number of pumps used at each stations within Ilorin

3.4 Public Premises of close proximity to Retail Petrol Stations

According to [2], [16], [17], & [18], it has been reported that large number of retail petrol stations in different state of Nigeria has not adhere to approved distance between residential buildings, public places (schools, hospitals and markets) as stated in the department of petroleum resources

guidelines. Large number of retail petrol station in Ilorin are located in close proximity to residential building during the survey thereby showing the same trend as reported by other article. At the end of the study, it shows that 273 (92%) premises (shop, houses, school, hospital) are in close proximity to retail petrol station in Ilorin. The total number of stations not located close to any premises are only 24 (8%) and this shows that large percentage of the petrol station are potential risk to the premises within their vicinity. Table 3 below shows the frequency of petrol stations in close proximity to the selected premises. Therefore, these indicates that the location of most retail petrol stations within Ilorin poses great risk to shops and houses.

Table 5: Frequencies of stations at close proximity to public premises

Premises	Numbers in Close proximity
Shop	77
House	41
School	1
Hospital	1
Shop & House	137
House & Hospital	2
Shop, House & Hospital	8
Shop, House & School	5
House, School & Hospital	1
Total	**273**

4 CONCLUSION

From the study, it can be concluded that retail petrol stations are highly congested within the metropolis forming cluster pattern which poses a great threat to the densely populated region of the town. The assessment revealed over 40% of these stations were constructed within the last ten years which indicates the creation of more stations in years to come is possible owing to the fact that the economy of Nigeria still depends chiefly on petroleum products and the investment remains lucrative. The study recommends further researches to look into the environmental pollution that could arise from these stations as it was revealed that 75% of the stations are functioning, and over 88% actively dispense various petroleum products from over 3 pumps at public areas close to shops, houses, hospitals and schools.

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