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Locational Analysis of Fuel Stations, in Ilesa, Osun State, Nigeria

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Abstract
Petroleum products are highly flammable and commonly stored in underground tanks where they are retailed via meter pumps at fuel stations. Lack of strict control by the appropriate agencies and noncompliance by the fuel dealers to laid down rules and regulations led to the indiscriminate siting of fuel stations in most urban areas in Nigeria. It is worrisome the ways and manners fuel stations are sandwiched within residential neighborhoods in Nigerian urban centers. This paper uses the Institutional Analysis and Development (IAD) framework to analyse the locational pattern of fuel stations and the underlying implications in Ilesa, a medium commercial city in Osun state, Nigeria with the aim of 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 reveal a disproportionate marginal increase in the establishment of fuel stations in the study area in recent years; about 60 percent of the fuel stations were established within the last twelve years (2000 to 2012). The analysis also reveals that only 6 percent complied with setback regulation from the road; none complied with setback to adjoining residential buildings while 56 percent complied with landmass regulation. The computed nearest neighbour index was 0.16 which indicates that the distribution 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. This was confirmed by a preponderance of resentment to the location of fuel stations by the inhabitants in the study area; 82% felt that the stations were too close to each other while 94% were of the view that the stations were too close to residential buildings. The paper suggests strategies that can be adopted for different environment in locating filling station to ensure safety of lives and property in the city and other Nigerian towns and cities.

Keywords: Location, Fuel Stations, Safety, Environment, Planning

Background to the Study
Petroleum products are highly flammable and commonly stored in underground tanks where they are retailed via meter pumps at fuel stations. The location of retail outlets deserves adequate planning guidance and adherence to the existing location guidelines because of its significance to the health and safety of the people. The situation in most cities in Nigeria is that of indiscriminate location and haphazard development of fuel stations in disregard of the guidelines and regulations governing its erection, location and development.

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 et al, 2011). The situation is more explosive if the retail outlets are haphazardly located as is the case in most urban centers of Nigeria

The petroleum industry is generally categorised into two sectors: the upstream and downstream sectors. The upstream sector is better organised, monitored and managed than the downstream sector (Oyinbo and Agboola, 1984). This study however focuses on the last two stages of the downstream sector which are the storage and retailing of the products; the adherence of retailers to the guidelines and regulations governing the industry.

Research Problem

Studies and reports have revealed the arbitrary siting of fuel stations, the roles of the regulating authorities and its implications for the safety and health of urban dwellers (Adedeji, 2013; Bello, 2013), this study goes further to acquire empirical evidence on the spatial location of fuel stations and its implication in Ilesa, a medium city in Osun state, Nigeria. The aim is to determine the level of compliance of fuel stations with planning standards and regulations, and examine the physical, social and economic congruence between fuel stations and other land uses in the study area. The objectives are to determine the number of existing fuel stations, examine their locational pattern, and determine their compliance with relevant planning standards and regulations and making policy suggestions towards a functional aesthetic and safe urban environment. Also, a public survey was conducted to elicit information on the perception of the populace on the location of fuels stations in their neighbourhood.

The Study Area

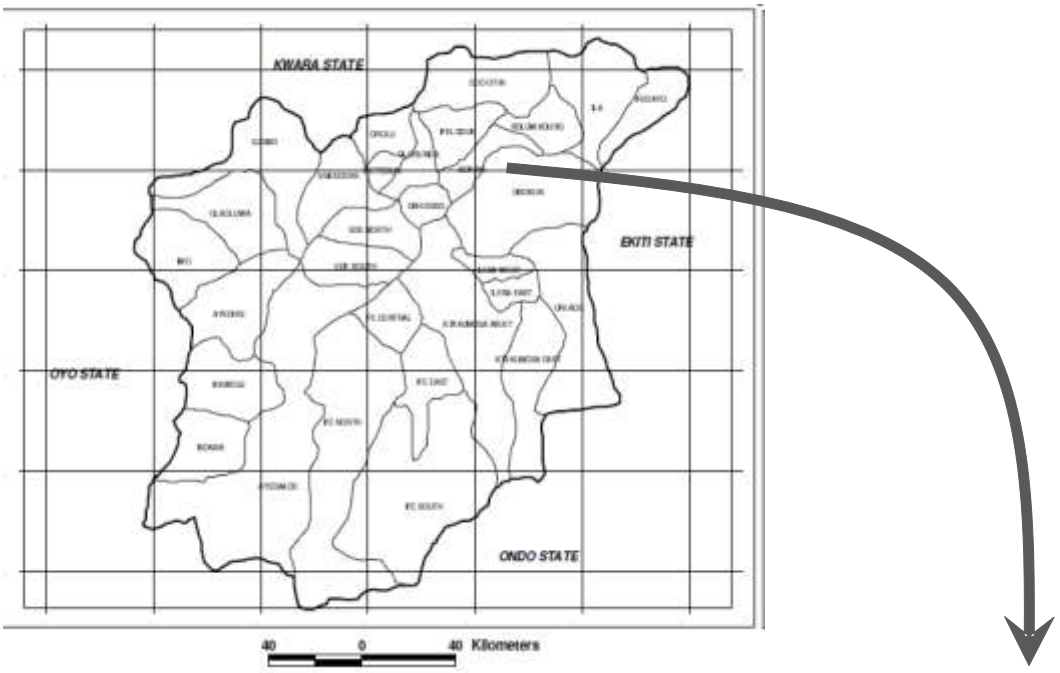
llesa is a city located within latitudes 7°37'0?N and 7.616667°N; longitude 4°43'0?E and 4.716667°E South West of Nigeria; it is also the name of a historic region (also known as Ijesha or Ijesa) centered around that city. The region is ruled by a monarch with the title of Owa Obokun Adimula of Ijesaland. llesa region consisted of llesa itself and a number of smaller surrounding cities such as Ibokun, Erin-ljesa, Ipetu-Jesa, Ijebu-Jesa, Esa-Oke, Ipole, Ifewara, Ijeda, lloko, Iwara, Erinmo, Iwaraja, Idominasi, llase, Igangan, Imo and many others. The Ijesas, a term also denoting the people of the state of llesa, are part of the present Osun State of Nigeria. By virtue of its position in the region, it serves as the central place for socio-economic activities.

Ilesa was named the capital of the first Local Council in Nigeria (Ijesa/Ekiti Parapo Council) comprising of the present day Ondo and Ekiti States of Nigeria by the British Colonial Administrator on 21 June 1900. The city right from its beginning had a well-defined layout, a healthy environmental quality and strict physical planning discipline to the extent that the city was described by Rev. Williams Howard Clark in 1854 in the following words: "*For its cleanliness,*

regularity in breath and width, and the straightness of its streets, the ancient city of Ilesa far surpasses any native town I have seen in black Africa" (Wikipedia 2012). Till date, Ilesa Township still retains the elements of good physical planning observed by Rev. Clark; the streets are well laid out and the road network is wheel-like and dense.

Ilesa township is currently made up of two local government councils namely Ilesa East Local Government and Ilesa West Local Government areas. Owing to the regional importance and influence of Ilesa, Atakumosa, the main market was and is regionally significant drawing patrons and marketers from the entire region and beyond.

The population of Ilesa township is estimated to be 212,225 (NPC, 2006). Based on 3.2% growth rate, the projected population for the year 2012 is 256,374. As typical of rapidly urbanizing centres, the population is demographically diverse having people from different background and tribes. The city is host to many establishments such as Osun State College of Education, School of Health Technology, Obafemi Awolowo University Teaching Hospital Complex Annex (Wesley Guild Hospital), Osun State General Hospital, International Breweries Limited, Adediran Steel and Wire Industry, Leventis Farm, primary and post-primary institutions, hotels and many light industries.



Modern Ilesha is a major collecting point for the export of cocoa and a traditional cultural centre for the Ilesha (Ijesha) branch of the Yoruba people. Palm oil and kernels, yams, cassava, corn (maize), pumpkins, cotton and kola nuts are collected for the local market. Local industries manufacture nails and carpets, and the town has a brewery; there are also a recording company and a publishing firm, and the Supreme Oil industry at Ilesha. Several prominent quartzite ridges lie east of Ilesha, and gold mining is an important activity in the area.

As the city continue to grow economically and in terms of human population, so are the number of vehicles and the rate of fuel consumption. In the light of this, the daily fuel consumption expectedly increases thereby creating opportunity for potential investors to establish fuel stations in order to fill the supply gap and more importantly to make money. Marketing petroleum products is a very lucrative business that guarantees quick returns; hence, there is a daily upsurge in the establishment of fuel stations in every nook and crannies of the city. Preliminary observation reveals flagrant disregard for the rules and regulations governing establishment of fuel stations, indiscriminate siting of fuel stations at undesirable locations and lack of control by the appropriate agencies.

Research Methodology

Data for this research were generated from the primary source and complimented by secondary data from Osun State Environmental Protection Agency (OSEPA), the Local Planning Authorities of the two local government councils and the Department of Petroleum Resources (DPR). The primary source included the administration of structured questionnaires, oral

interview and personal observation. Two different questionnaires were prepared; one for fuel station owners or managers and the other for residents and vehicle owners in the study area. There were fifty fuel stations in the city and they were all enumerated to determine their level of compliance with the guidelines set by the Department of Petroleum Resources.

The second questionnaire was used to conduct a survey of public opinion regarding the location of fuel stations and its implications. It was administered to sampled households in the study area. The sample was selected through a multi-stage sampling procedure involving stratified, random and systematic technique. The city was stratified into eleven strata, from each strata, a housing unit was chosen randomly from which other housing units are selected systematically. The population of the city was 256,374 and according to NPC and ICF Macro (2009), the average household size in the south west of Nigeria, the region in which the study area is located, is about five (5); hence, the number of households was determined by dividing the population with five resulting in 51,275 households. Based on the formula of Creative Research Systems (2012) and for a 95% confidence level and 2.5% margin of error, a sample size of 1,550 out of which 1,494 were valid. The questionnaire were distributed pro-rata across the eleven strata (Table 1)

Table 1; Questionnaire Distribution

S/N	Area	No. of Questionnaire
1	Bolorunduro	95
2	Ita Ofa	93
3	Oke Ooye	128
4	Oke Iro	107
5	Sabo	166
6	Ayeso	116
7	Isokun	201
8	Oke Omiru	144
9	Okesa	231
10	Imo	103
11	Ireti Ayo	110
	Total	1494

Source: Author's Compilation, 2012

The acquired data was analysed using descriptive statistics. Nearest neighbour analysis was used to determine the location pattern of the fuel stations from which inferences were made.

Literature Review

The choice of a location is the most crucial decision retailers and service providers must take because it is a basic requirement for business success and growth determinant (Jones, Mothersbaugh and Beatty, 2003; Lööf and Nabavi, 2013). It establishes the visibility of business to potential customers, patronage and level of profitability. 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).

Location theory provides a useful basis for dissecting the internal structure of cities. The theory contends that one of the principles governing human spatial behaviour is the maximization of the net utility of place at minimum cost. This emphasizes the importance of location in business decisions. The central place theory of Christaller (1966) laid the basic foundation for understanding the importance of place. He identified four factors as being contributory to the differences in the distance consumers overcome in order to enjoy a good. These are the size and importance of the central place, the price willingness of a consumer, the subjective economic distance and the quantity and price of goods. The most important aspect of Christaller's work is the concept of range which is quite relevant to the consideration of service area of fuel stations.

The supply and demand for fuels is an example of spatial interaction which is related to reciprocal and continuing flows. The implication is that the decision to purchase petroleum products at fuel stations initiates continuous traffic flows to and fro within the system. The right location of fuel stations will put it in an advantageous situation for maximum profitability. Such location obviously will have not only positive outcomes but also negative effects.

Guidelines for locating fuel stations

In setting up a fuel station, the following suitability requirements by the Department of Petroleum Resources apply, among others.

i. Size of the proposed land site a minimum of 1,200m^2
ii. The site does not lie within pipeline or PHCN high tension cable Right Of Way (ROW).
iii. The distance from the edge of the road to the nearest pump will not be less than 15 meters. On a dual carriage way, it should be 50m.
iv. Total number of petrol stations within 2km stretch of the site on both sides of the road will not be more than four including the one under consideration.
v. The distance between an existing station and the proposed one will not be less than 400 (four hundred) meters.
vi. A fuel station should be sited a minimum of 8m away in all angles of the built-up areas to create a buffer zone for residential houses. The buffer zone can be devoted to any non-residential use.
vii. A fuel station should provide at least two (2) public conveniences.
Viii. The drainage from the site will not go into a stream or river.
ix. Fuel stations should not be located near schools, hospital, theatre, public and semi-public buildings.

x. The entrance and exit should allow clear line of vision, a one-way system of service is preferable, a clear line is of great advantage and adequate space should be allowed for queuing during peak period.
xi. A fuel station should not be sited on areas prone to erosion, flooding or near endangered plant and animal enclave.
xii. Apart from traffic consideration, great care must be exercised over ancillary activities such as car repair and sale of goods. These often cause additional congestion.
xiii. In some instances where site is along Federal Highway, a letter of consent from the Federal Highway is required.
xiv. DPR guided / supervised EIA study of the site by DPR accredited consultant.

Data Analysis and Presentation

There were fifty fuel stations in Ilesa township out of which twenty eight (28) were located in Ilesa East local government and the remaining twenty two (22) were located in Ilesa West local government area. Details about the fuel stations are contained in table 2. The analysis examined compliance with setback regulations from the road and residential buildings, landmass regulation, distance to nearest fuel station, provision of minimum of two public conveniences and planning permit status.

Of the 50 fuel stations, only one was established before 1960. Between 1960 and 2000, nineteen (19) were established. The period between 2000 and 2012 witnessed rapid development of fuel business in the city; hence, sixty percent of all fuel stations were established during this period (Figure 2). This was a testament to the profitability of the industry in Ilesa occasioned by rapid population increase and growth of economic activities.

Fig 2: Year of Establishment of Fuel Stations
(Source: Author's compilation, 2012)

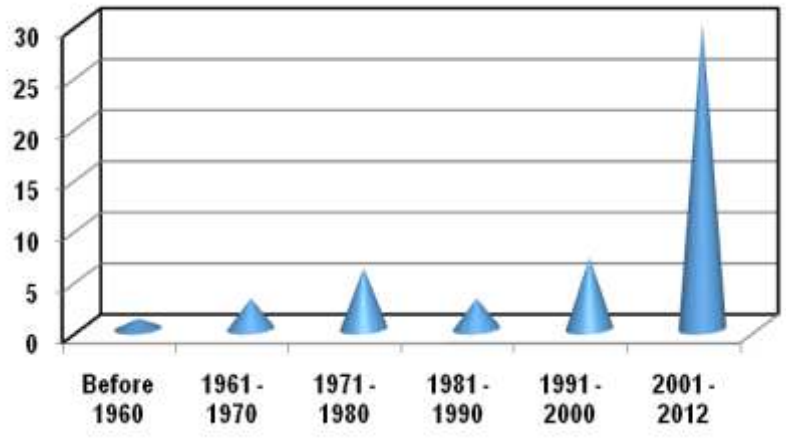


Table 2: Characteristics of Fuel Stations in Ilesa Township

S/N	Name	Location	LG Area	Land Area	Set-back	Distance to nearest fuel station	No. of Pumps	Yr. Established	Remark
1	Jakaf Oil	Breweries Area	East	922.5m ^{2}	20m	120m	4	2000	Poor
2	Total	Fadahunsi Area	East	1,7 70m ^{2}	30m	120m	4	1975	v. good
3	Unicorn	Imo Area	East	1,350m ^{2}	5m	300m	2	Abandoned	
4	Mrs.	Imo Area	East	1,800 m ^{2}	5m	9m	3	1968	Fair
5	Yom-Yimka	Imo Area	East	1,800 m ^{2}	5m	9m	4	2003	Fair
6	AP	Okesa	East	1,600 m ^{2}	10m	10m	2	Abandoned	
7	Oando	Okesa	East	1749 m^2	9m	7m	4	1980	Fair
8	Globe	Okesa	East	646 m ^{2}	1m	60m	4	1972	Fair
9	Yeunice	Okesa	East	1,610 m ^{2}	10m	60m	6	2008	Fair
10	Oando	Okesa opp. Mrs.	East	1,431 m ^{2}	3m	8m	4	2005	Fair
11	Mrs.	Okesa opp. Oando	East	2,383 m ^{2}	6m	8m	5	1980	Good
12	Kentab	Okesa	East	900 m ^{2}	3m	7m	4	2010	Fair
13	Alade	Okesa	East	510 m ^{2}	10m	8m	4	1970	Fair
14	Total	Ereja Square	West	1,200 m ^{2}	9m	8m	5	1965	Good
15	Conoil	Ereja Square	East	720 m ^{2}	8m	15m	5	1980	Good
16	Keto	Isokun	West	648 m ^{2}	2m	300m	4	2010	Fair
17	Oando	Isokun	West	648 m^2	2m	400m	3	Abandoned	
18	Sak Oil	Isokun	West	900 m ^{2}	2m	6m	3	2001	Fair
19	Total	Isokun	West	1,447 m ^{2}	2m	6m	4	2005	Good
20	Hammeda	Oke Omiru	West	2,520 m ^{2}	2m	5m	8	2005	Good
21	Alesh	Oke Omiru	West	1,800 m ^{2}	2m	5m	5	2007	Fair
22	Topmost	Oke Omiru	West	1, 440 m ^{2}	2m	170m	5	2010	Good
23	Unnamed	Oke Omiru	West	1,296 m ^{2}	6m	6m	Under construction		
24	Gladys	Oke Omiru	West	1,296 m ^{2}	2m	6m	4	2006	Fair
25	Honors	Oke Omiru	West	1,296 m ^{2}	2m	6m	4	2004	Fair
26	Voas	Oke Ooye	East	648m ^{2}	1m	300m	6	2009	Fair
27	Omuni	Oke Ooye	East	1,296 m ^{2}	1m	300m	6	2008	Fair
28	Moap	Irojo	East	864 m ^{2}	3m	300m	6	1997	Fair
29	Randok	Irojo	East	1,107 m ^{2}	3m	240m	5	1993	Fair
30	AP	Irojo	East	1,982 m ^{2}	10m	240m	6	2008	Fair
31	Omikunle Awe	Bolorunduro	East	1,780 m ^{2}	3m	800m	6	2009	Fair
32	Zak	Bolorunduro	East	648 m ^{2}	3m	500m	6	2006	Poor
33	Dayef	Ijofi	East	648 m ^{2}	2m	300m	6	2008	Fair
34	Unnamed	Oke Iro	East	960 m ^{2}	3m	200m	Under construction		
35	JFK	Ita Balogun	East	1,200 m ^{2}	2m	300m	4	1991	Good
36	Total	Odo-Iro	West	1,080 m ^{2}	3m	100m	4	1960	Good
37	Mobil	Odo-Iro	West	1,296 m ^{2}	9m	100m	5	1975	Good
38	Triumph	Ayeso	West	648 m ^{2}	1m	200m	6	2007	Fair
39	NNPC	Ayeso	West	1,296 m ^{2}	1m	200m	7	2004	Good
40	Mrs.	Ijoka	East	648 m ^{2}	7m	50m	2	1988	Fair
41	Unnamed	Ijoka	West	600 m ^{2}	1m	600m	2	2011	Poor
42	Gra celand	Ireti Ayo	East	760 m ^{2}	3m	150m	7	2001	Good
43	Gracious love	Ireti Ayo	East	1,296 m ^{2}	5m	100m	4	2010	Good
44	General Oil	Ireti Ayo	West	1,800 m ^{2}	20m	100m	4	1981	Fair
45	Holas	Ireti Ayo	East	2,160 m ^{2}	3m	120m	6	2003	Good
46	Yeunice	Ireti Ayo	West	900 m^2	5m	300m	4	1998	Good
47	Johndeck	Ireti Ayo	West	1,296 m ^{2}	3m	300m	6	1996	Good
48	Unnamed	Ita Ofa	West	600 m ^{2}	3m	150m	2	2011	Poor
49	Holas	Ita Ofa	West	1,080 m ^{2}	4m	300m	5	2010	Good
50	Gracious Love	Ita Ofa	West	600 m ^{2}	2m	300m	4	2010	Fair

Source: Author's Fieldwork, 2012

Table 3: Compliance with regulations

Regulation	% Compliance
Setback to road	6
Setback to residential building	0
Landmass regulation	56
Distance to nearest station	8
Provision of 2 public conveniences	7
Full Approval	30

Source: Author's Computation, 2012

According the DPR, a fuel station should maintain a minimum distance of 15 metres from the edge of the road; fulfil the environmental inhibition requirement of 8 metres setback to residential buildings and the minimum landmass of 1,200 square metres. As evident from table 4, only 6% of the fuel stations complied with the setback regulation to the road; none of the fuel stations located within residential areas complied with setback regulations to residential buildings while 56% complied with land mass regulation of 1,200 square metres and 7% provided the minimum two public conveniences, the remaining provided just one public conveniences. Only 30% showed evidence of full approval.

Location Pattern of Fuel stations

In order to determine the locational pattern of the fuel stations, the nearest neighbour statistics (R_n) formulated by Clark and Evans (1954) was applied. The statistics is defined as

$$R_n = 2\bar{d}\sqrt{\frac{n}{A}}$$

Where R_n =nearest neighbour index
A = land area of the study area
d = total mean distance between the fuel stations
n = number of fuel stations

The R_n values ranges from zero to 2.15 interpreted as follows
R_n = 0: the distribution is clustered
R_n = 1: the distribution is random
R_n = 2.15: the distribution is regular

Therefore, Ilesa Township comprises fifty (50) fuel stations as at the time of this research, a built-up land area of 134km^2 and total mean distances of 6.54km. The nearest neighbour index is calculated thus:

$$\bar{d} = \frac{6.54}{50} = 0.1308$$

$$R_n = 2(0.1308)\sqrt{\frac{50}{134}}$$

$$R_n = 2(0.1308)\sqrt{0.3731}$$
$$R_n = (0.2616)0.6108$$
$$R_n = 0.1598$$
$$R_n = 0.16$$

The computed R_n is 0.16 is far from 1 but close to 0. Hence, the distribution of fuel stations in Ilesa Township is approaching or tending towards clustered pattern. An ideal location pattern of facilities should not be that of clustering but regularly distributed in space for easy access. The clustering of a facility that dispenses potentially highly flammable and toxic material is not ideal due to its consequences for the safety and health of the people.

Implications

The observed locational pattern of fuel stations in the study area manifests unhealthy competition among fuel station owners and the failure of the regulatory bodies. The haphazard location violates the fundamental objective of planning which is providing the right site for the right use at the right time for the right purpose in order to achieve spatial functionality, efficiency and aesthetics. During periods of fuel crises, queues of vehicles at few stations that had fuel often resulted in serious traffic hold-up on adjoining road. This obviously has negative implications for social and economic activities in the city.

In case of fire outbreak, adjoining residential buildings and their occupants are in serious danger. Also, the residents of proximate buildings are exposed to high dose of fuel vapour in and the pungent odour of hydrocarbon fuels.

Public Survey

The profile of the respondents is graphically displayed in Figure 3.

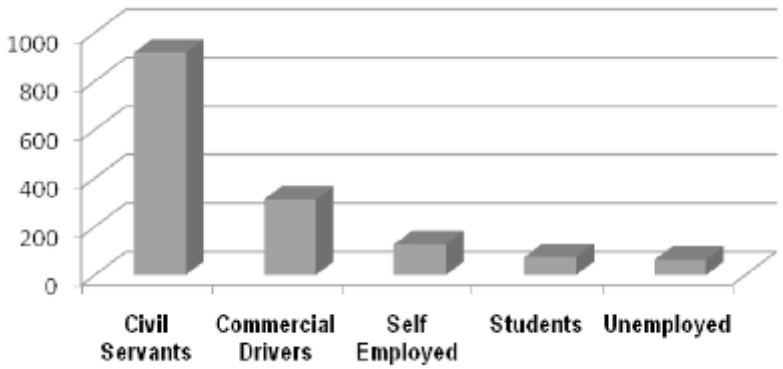


Figure 3: Occupation of Respondents (Source: Author's Compilation, 2012)

Of the sampled residents, 61.4% were civil servants, 20.9% were commercial drivers, 8.5% were self-employed and the remaining was made up of students, apprentices and unemployed. Among the civil servants, about a third owned cars. This coupled with the commercial drivers were direct fuel consumers and patrons of fuel stations. The remaining respondents could be regarded as indirect consumers of petroleum products. 82% of the sampled population stated that the fuel stations were too close to each other, 94% reported flagrant disregard of the setback regulations to residential buildings while 78% agreed that the observed concentration of fuel stations had dire consequences for the residents of the city.

Table 4: Reported Problems Associated with Location Pattern

S/N	Problem	% of Respondents
1	Noise Pollution	42.5
2	Air Pollution	33.2
3	Fire Disaster	91.8
4	Traffic Accidents	47.2
5	Traffic Disturbance	27.1

Source: Author's fieldwork, 2012

Identified Factors Responsible for Observed Locational Pattern

1. Inefficiency of regulatory bodies such as Department of Petroleum Resources, Local Town Planning Authority, Nigerian Police Force and State Fire Service impacts negatively on the approval process
2. Lack of synergic collaboration among the regulatory bodies gives room for abuse of the process of getting approval.
3. Corruption: this is one of the challenges facing government establishments in Nigeria. Corrupt practices undermine the effectiveness and efficiency of the regulatory bodies to function efficiently.
4. Political interference; most of the fuel stations are either owned by politicians or people related to them.
5. Absence of master plan to give direction to physical development is a serious challenge in most Nigerian cities. This is equally true of the study area; the lack of master plan creates room for uncoordinated physical development which often lead to undesirable consequences.

Way Forward

Improving the situation in the study area requires deliberate surgical action to correct the observed anomaly. In the first instance, the existing stations that violated the rules and regulations of the DPR and Local Planning Authorities need to be adequately processed in such a way that others wishing to emulate them will be discouraged.

Curative Measures:

a. The fuel stations that violated setback regulations to residential buildings should be demolished in order to remove the potential danger they represent to the surrounding population.

b. Those that failed the landmass regulation should be made to serve only motorcycles and tricycles because inadequate space implies that bigger vehicles may find it hard to make a clean turnaround in and out of the station.

Preventive Measures

Prevention is better than cure. In order to prevent the continued haphazard location of fuel station, the following suggestions are made:

a. Public enlightenment on the regulation and standards governing the establishment of fuel stations and the right of the populace to call the attention of the regulatory bodies to illegal establishment of fuel stations.
b. Investors wishing to establish fuel station within residential areas should provide indemnity for buildings within 500 metres radius in case of fire outbreak. This will discourage concentration of fuel stations within residential areas.
c. Strengthening the regulatory bodies with adequate equipment, facilities and tools required for effective functioning.
d. Sanctioning public servants and professionals involved in propagating illegal fuel stations to serve as deterrent to others.
e. Preparation of master or development plan for our cities in order to give direction to physical development and to act as the benchmark for all other developments.

Plate 1: Violation of setback regulation to residential building

Plate 2: Violation of landmass and setback regulations

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