Assessing The Location and Spatial Distribution of Petrol Filling Stations in Ilaro ,Ogun State .

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Abstract

The study aims at assessing the location and spatial distribution of petrol filling stations in Ilaro , Ogun state . The objectives are to identify and map all the petrol filling stations in the study area; and assess their conformity with planning standards; and determine the distributional pattern of the petrol filling stations. The research adopted field surveys and remote sensing,especially the instrumentality of ArcGIS, in identifying the existing petrol filling stations as well as conducting queries to assess the level of compliance of the petrol filling stations with extant planning standards. Nearest Neighbour Analysis was equally employed in determining the distribution pattern of the facilities. With a Rn value of 0.36, the study amongst others, pointedlyreveal that the locational pattern of petrol filling stations in the study area tends towards clustering. The study, among others, recommends a moratorium on approval of petrol filling stations within the fully developed road corridors of the town.

Keywords: Assessment,Conformity, Location, Petrol Filling Stations,Planning,Standards

Introduction

The Nigeria's rapid urban growth rate (4.38%) as noted in Trading Economics (2016) and the growth that attended the diversification of the Nigerian economy had spawned an increased level of consumerism in virtually all sectors of the Nigerian economy. As the economy further experiences an increased level of diversification with the oil and gas sector accounting for less than 11% (The Nigerian government ,2015) of the economy ,virtually all other sectors of the economy still continue to depend on the oil and gas sector. The improved income and the expansion of the spectrum of the middle-class afforded the propensity for increased use of automobiles, generators and other petroleum demanding plants. The pathetic power situation in Nigeria had also exacerbated the increased demand for petroleum products. The foregoing had essentially created the vista for the proliferation of petrol filling stations in most urban settlements in Nigeria. Petrol filling station is defined as any facility or equipment used for the sale or dispensing of petroleum products for motor vehicles. Most filling stations sell petrol or diesel, some carry specialty fuels such as liquefied petroleum gas (LPG), natural gas, hydrogen, biodiesel, kerosene, or butane while the rest add shops to their primary business. Since the petrol filling stations have spatial dimensions, it is expected that they are sited in an organized and sustainable manner. It is however noticeable that despite the availability of standards regulating

the location of petrol filling stations in Nigeria's urban centers, most petrol filling stations are still located in a manner that is chaotic and has the potentiality for hazards (Afolabi, Olajide&Omotayo, 2011). Ayodele (2011) observed that poor sitting of petrol filling stations' culminate in traffic congestion, pollution, and fire hazards. As documented in Mohammed *et al*. (2007) the Directorate of Petroleum Resources (DPR) provides certain standards for locating a petrol filling station. Foremost, land in which a petrol filling station must be sited should have been zoned for commercial/industrial use or be designated specifically for the purpose of a filling station in a subdivision. The prospective land ,which a petrol filling station is envisaged should not be less than 33 x 33 square meters or equivalent of two plots of land allow for the free flow of traffic . A petrol filling station should be sited 400 meters away from the next petrol station. A petrol station should be sited 50 meters away in all angles of the 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 should not be less than 15meters. Moreover, the total number of stations within 2 km radius of the site should not be more than four (4) including the one under construction. Filling stations should not be located less than 100 meters from school, hospital, theaters, clinics and other public and semi-public buildings. Lastly, the site for a filling station should not lie within NNPC/PPMC pipeline right of way or PHCN transmission or railroad lines. As noted in Alesheikh and Golestani, (2011), the onus of selecting an optimal site for business enterprise such as a petrol filling station depends on factors such as proximity to population centers, distance from neighboring stations, the easements of using existing utility, and the magnitudes of environmental pollution parameters. Oetomo and Sesulihatien (2012) observed other factors to take into account when making a decision about the location of business, also include customers, transport, the neighborhood, finances and the longer term future as part of the variables that should not be wished away in the location of investments such as filling stations. In view of how important the sittings of facilities like petrol filling stations are to environmental safety and sustainability of a burgeoning settlement like Ilaro, Yewa South Local Government, it is imperative to assess the spatial location of petrol filling stations within the town in order to ascertain the extent to which they conform with the planning standards. The study aims at assessing the location and spatial distribution of petrol filling stations in Ilaro, Ogun state. The objectives are to identify and map all the petrol filling stations in the study area; and assess their conformity with planning standards; and determine the distributional pattern of the petrol filling stations.

Statement of the Research Problem

Filling stations significantly contribute to traffic problems such as traffic congestion, pollution, fire and explosion in most Nigerian urban settlements (Ayodele, 2011). This is ultimately a corollary of the lack of development control and non-conformity with planning standards in semi –urban and fully urbanized settlements. The planning oddities are expressed in poor sitting, inadequate size, limited set back from road, poor radius allowance from major facilities like schools, churches, and mosques. This culminates in environmental dis-amenities such as traffic

congestion, pollution, fire and many more problems resulting from un-coordinated development. The study area is a developing urban center, which on account of its expansion had also witnessed the proliferation of petrol filling stations,most of which are poorly sitted,and essentially disregard planning standards. The imperativeness of this study is also borne out of the non-existence of spatial data in respect of petrol filling station in the area as no study has been done in this regard.

Study Area

Ilaro, a predominantly Yoruba speaking settlement is the study's area of focus. Ilarotown is about 50 km from Abeokuta, the capital Ogun state, and about 100km from ikeja, the city of Lagos state. It is defined by co-ordinates 6.88333^{o}N and 3.01667^{o}E. Ilaro, the headquarter of Yewa South L.G, has an area of 106km^{2}and a population of 68,617, as extrapolated from the 2006's census result of 46,999 at a growth rate of 3.5% (Oyesile and Olapeju 2013). The population growth and physical expansion had been majorly occasioned by the establishment of growth poles like the Federal Polytechnic Ilaro and Dangote cement Ibese.

Literature Review and Conceptual Framework

GIS application to spatial analysis has gained traction in recent years, due to the availability of low cost Geographic Information System (GIS) software with user-friendly interfaces. Studies are copiously available with respect to the locational analysis of petrol filling stations in urban spaces with GIS. Camelli (2010) concluded it was possible for motorists in Abidjan to be afforded the comfort of finding the nearest petrol filling station concluded it was indeed possible. In his work on the utility of GIS in the management of information and services offered in petrol station in Mumbasa road, Kenya, Emwandongo (2013) based the integration of GPS and GIS technology for comprehensive database and equally integrated digital mapping for efficient and effective management of information. Adsavakulchai and Huntula (2010) in their analysis of the best site for natural gas vehicles in Bankok applied GIS, and equally revealed that there are 76 filling station in the area and the optimal district site location for the facility is Nongjokdistric. Moreover, in a study conducted by Ayodele (2011) in Kaduna, GIS based technology was demonstrated and proven to have efficient capacity for analyzing the spatial spread of petrol filling stations. This study, however, is the first attempt at the application of GIS in the analysis of the location of petrol filling station in Ilaro settlement.

Conceptual Framework

Location science started with Pierre de Fermat (1601–1665) and contemporaries like Evangelisca Torricelli (1608-1647) and Battista Cavallieri (1526-1597) whose studies were premised on basic Euclidean spatial median problem in early seventieth century(Mohammed , Musa, Jeb,(2007) .In 1909 the German location economist Alfred Weber formulated a theory of industrial location in his book entitled UberdenStandart Der Industrien. Weber's theory, also known as the location triangle, deemed the optimum location for the production of good as being a function of location

of the point of production to market and to raw material sources. This was given a graphical expression in the form of a triangle.Webers name resonated mostly in the field of location sciencewith the formulation of this model .The 1930s saw contributions by Christaller, who founded central place theory and Weiszfeld (1916-2003) who developed his popular algorithm that solved Weber problems with an arbitrary number of customers. Moreover, important contributions that had bearing with locational concepts included those by Lösch (1906-1945) and the regional scientists Isard and Alonso in 1964. However, modern quantitative location theory came to fore in the mid- 1960s, when Hakimiwrote his seminal thesis on the analysis of a location model on networks (Eisalt and Marianov, 2012).

Materials and Methods

For this study, a preliminary field survey was first conducted to identifythe location of petrol filling stations, name, area in the study area, and document their geographic coordinates. A 2016 google-earth imagery of Ilaro townof 2.5 meter resolution was sourced from the Department of Surveying, Federal Polytechnic Ilaro, Ogun State, Nigeria. The imagery was imported into ArcMap environment of ArcGIS 9.2 and then georeferenced using map to image georeferencing method. Two shape files for roads and for the filling stations were created in ArcCatalogenvironment . Fields were created for name and the type of the road, and to calculate the length of the road in metre. A simple checklist were drafted and used to source the detailed information on the filling station. The data were saved in the project folder (created in C drive) and exported toArcMap environment of ArcGIS 9.2. The data was converted to shape file and used to perform all the analysis. Different symbolization was used to map out the filling stations. Further, tables and charts created in Microsoft Excel were used to present the inventoried data. This helped in achieving the first objective of the work, which is to identify and map out the filling stations. For the second objective ,which is to assess the conformity of the filling stations with planning standards, standards buffering and proximity analysis were done in ArcMap. For the standard on road setbacks, a buffer of 9 meter, which is according to the Ogun State Urban and Regional Planning Law of 2010 were established on the roads abutting the identified filling stations, in order to ascertain the level of compliance with road setback. Query by location was performed using selection menu in ArcMap environment. Data were queried to give all locations that are within the 9m buffer from the roads. For the standard of what should be the distance apart for petrol filling stations (300 meters according to Ogun State Government (2010)) within built up areas, query operation was done using selection menu. The essence of the query was to determine filling stations that were within the radius of 300 metre from other station. The selected stations were established as those that did not meet the criterion of 300 meter between stations. For the standard of the radius between a filling station and public facilities like hospitals, schools, churches and mosques, which, according to DPR guidelines, should be 100 meters, database of the identified public facilities was 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 meter from either of the public facilities. In achieving the last objective,

which is to determine the distributional pattern of the petrol filling stations, nearest neighbor analysis was brought to bear. This attempts to measure the distributions according to whether they are clustered, random or regular. Nearest neighbour analysis is used to determine the distribution pattern of facilities, and has a distribution spectrum that ranges from random, regular to clustered. The nearest petrol stations neighbours to each of the petrol filling stations were determined with the nearest neighbor distance for each of the petrol filling station documented. Having determined the area the study area and ascertained the total number of petrol filling stations, the formulae below was thus applied in determining the distribution pattern.

$$Rn = \frac{\bar{D}(Obs)}{0{\cdot}5\sqrt{\frac{a}{n}}}$$

Rn is the nearest neighbor value;D(Obs) is the mean observed nearest neighbor distance; a is the area under study; and n is the total number of petrol filling stations. The nearest neighbour formula will produce a result between 0 and 2.15, where the following distribution patterns form a continuum:

Discussion of Findings

Identification and Mapping of all the Petrol Filling Stations in the Study Area

From table 1 below, it is evident that there are 34 petrol filling stations in the study area. However, out of the 34 petrol filling stations, 4 (11.76%)are yet to be fully constructed, 7(20.59%) have become abandoned, while 23(67.65%) are essentially functioning. The spatial distribution of the petrol filling stations are presented in figure 1 below.

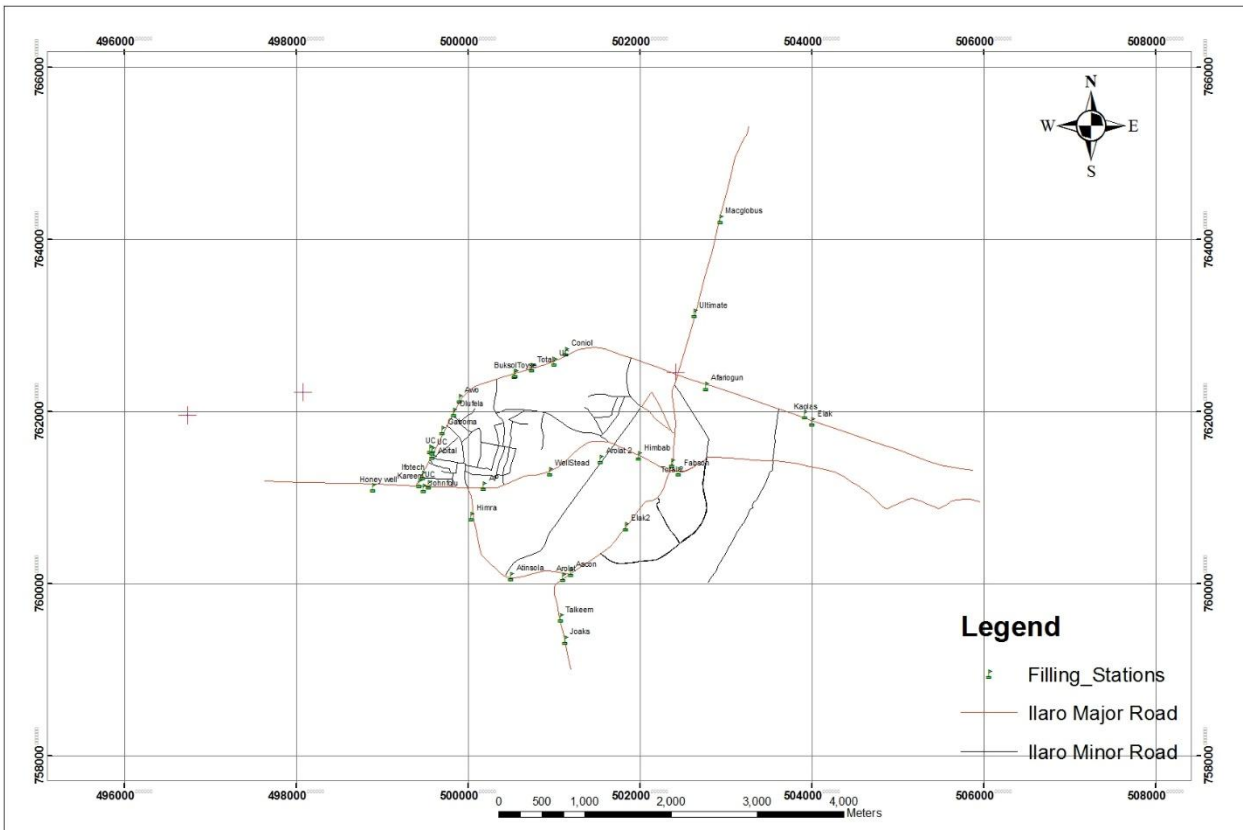
Table 1: The Location ,Status, Geographic Coordinates of Petrol Filling Stations

S/N	Name Of Filling Stations	Location	Status	Easting	Northing
1	Honeywell	Ilaro – Oja – Odan Road	Functioning	498898	761106
2	Johnfolu	TundeIbikunle Road	Functioning	499485	761106

3	Kareem	TundeIbikunle Road	Functioning	499540	761153
4	AP	TundeIbikunle Road	Abandoned	500177	761101
5	Wellstead	TundeIbikunle Road	Functioning	501985	761483
6	Himbab	TundeIbikunle Road	Functioning	501985	761483
7	Ifotech	Ilaro-Oja-Odan Express Road	Functioning	499471	761258
8	Abital	Ilaro-Oja-Odan Express Road	Abandoned	499581	761498
9	Gaboma	Ilaro-Oja-Odan Express Road	Functioning	499702	761782
10	Olufela	Ilaro-Oja-Odan Express Road	Functioning	499837	761991
11	Awo	Ilaro-Oja-Odan Express Road	Functioning	499900	762153
12	Buksol	Ilaro-Oja-Odan Express Road	Functioning	500540	762439
13	Toyse	Ilaro-Oja-Odan Express Road	Functioning	500553	762441
14	Total	Ilaro-Oja-Odan Express Road	Functioning	500746	762510
15	Conoil	Ilaro-Oja-Odan Express Road	Functioning	501139	762699
16	Afariogun	Ilaro-Oja-Odan Express Road	Functioning	502768	762295
17	Kaolas	Ilaro-Oja-Odan Express Road	Functioning	503921	761964
18	Elak	Ilaro-Oja-Odan Express Road	Abandoned	504005	761878
19	Total2	Owode – Ibese Road	Functioning	502372	761402
20	Fabson	Owode – Ibese Road	Functioning	502452	761306
21	Elak 2	Owode – Ibese Road	Abandoned	501835	7606665
22	Ascon	Owode – Ibese Road	Functioning	501197	760130

23	Arolat	Owode – Ibese Road	Functioning	501105	760075
24	Atinsola	Gbogidi	Functioning	500501	760084
25	Himra	Gbogidi	Functioning	500036	760783
26	Arolat2	Atewolara	Functioning	501542	761445
27	Macglobus	Owode – Ibese Road	Abandoned	502934	764239
28	Ultimate	Owode – Ibese Road	Abandoned	502630	763140
29	JOAKS	Owode – Ibese Road	Abandoned	501127	759345
30	TALKEEM	Owode – Ibese Road	Functioning	501007	759602
31	UNDER CONSTRUCTION 1	Owode – Ibese Road	Underconstruction	499435	761168
32	UNDER CONSTRUCTION 2	Owode – Ibese Road	Underconstruction	499561	761564
32	UNDER CONSTRUCTION 3	Owode – Ibese Road	Underconstruction	499580	761349
34	UNDER CONSTRUCTION 4	Owode – Ibese Road	Underconstruction	501006	762580

Figure 1: Spatial Locations of Petrol Filling Stations in Ilaro Town



Conformity of the Petrol Filling Stations with Planning Standards

Survey and application of GIS in determining the conformity of the petrol filling stations with planning standards relied on the Ogun State Urban and Regional Planning Law of 2010 and DPR guidelines of 2007 for approving petrol filling stations. The result of survey and ArcMap queries shown in table 2 indicates that with respect to threshold land size of 1188m^2,just 14 (41.18%) of the filling stations can be said to be in compliance. As far as the setback standard of 9 meters from road is concerned, just 6 petrol filling stations, representing 17.65 %,can be said to be in conformity. 17 (50%) of the petrol filling stations have their nearest neighbor filling station on either side of the road locating outside the radius of 300 meters. While 11(32.35%) of the petrol filling stations comply with the minimum setback of 100 meters from places of worship,16 (47.06%) comply with the minimum setback of 100 meters from schools, and 29 (85.29%) comply with the minimum setback of 100 meters from places of hospitals. Further, while 26(76.47%) of the petrol filling stations are located in developed milieus, 2(5.88%) are located in developing areas, and 6(17.64%) are sited in underdeveloped areas. Table 3 shows that Papa-Polytechnic Junction, a major road, carries the highest density(4.91 Km^{-1})expressed in terms of number of filling stations per kilometer , with the 16 petrol filling stations congesting a road of 3.26km stretch . This is followed by Owode-Ibese Road ,a major road, which carries the density of 2.68 Km^{-1} with 8 petrol filling stations dotting its 2.99 kilometer length; Old Garage road, a minor road ,which has the density of 2.1 Km^{-1} with 1 filling station locating on its 0.48

kilometer; Tunde Ibikunle Road ,a major road, which carries the density of 1.57 Km^{-1} , with 5 filling stations locating on its 3.193 kilometer length; Gbogidi Road, a minor road, with a density of 0.74 $Km^{-1,}$ with 2 filling stations locating on its length of 2.69 kilometers; Poly-Oja-Odan road , a major road, which carries a density of 0.57 Km^{-1},and have just one filling station locating on its stretch of 1.76 kilometer; and Atewolara road, a minor road, which carries a density of 0.39 Km^{-1} ,equally with one filling station locating on its extent of 2.58 kilometer.

Table 2: Profile of Petrol Filling Stations with Respect to Planning Standards

S/N	Name Of Filling Station	Compliance with Minimum Size Standard (1188m^2)	Compliance with minimum setback of 9 meters from road	Compliance with minimum setback of 300 meters from nearest neighbor filling station on either side of the road	Compliance with minimum setback of 100 meters for Places Of Worship	Compliance with minimum setback of 100 meters for Schools	Compliance with minimum setback of 100 meters for Hospitals	Level Of Development of the Area	
1	Honeywell	No	No	No	Yes	No	Yes	Developing	
2	Johnfolu	No	No	No	Yes	No	No	Developed	
3	Kareem	Yes	No	Yes	Yes	Yes	No	Developed	
4	AP	No	No	No	No	Yes	Yes	Developed	
5	Wellstead	Yes	Yes	Yes	No	No	Yes	Developed	
6	Himbab	No	No	Yes	Yes	No	Yes	Developed	
7	Ifotech	No	No	No	No	No	Yes	Developed	
8	Abital	Yes	No	No	No	Yes	Yes	Developed	
9	Gaboma	Yes	No	No	No	Yes	Yes	Developed	
10	Olufela	Yes	No	No	Yes	Yes	Yes	Developed	
11	Awo	Yes	No	No	Yes	No	Yes	Developed	
12	Buksol	No	No	No	No	Yes	No	Developed	
13	Toyse	No	No	No	No	Yes	No	Developed	
14	Total	Yes	Yes	No	No	Yes	No	Developed	
15	Conoil	Yes	Yes	No	No	No	Yes	Developed	
16	Afariogun	No	No	Yes	No	Yes	Yes	Under – Developed	
17	Kaolas	Yes	Yes	Yes	No	Yes	Yes	Under –	

								Developed	
18	Elak	Yes	Yes	No	No	Yes	Yes	Under – Developed	
19	Total2	No	No	Yes	No	No	Yes	Developed	
20	Fabson	No	No	Yes	No	No	Yes	Developed	
21	Elak 2	Yes	No	Yes	No	No	Yes	Developed	
22	Ascon	No	No	Yes	No	No	Yes	Developed	
23	Arolat	Yes	Yes	Yes	No	No	Yes	Developed	
24	Atinsola	Yes	No	Yes	No	Yes	Yes	Developed	
25	Himra	No	No	Yes	Yes	No	Yes	Developed	
26	Arolat2	No	No	Yes	Yes	Yes	Yes	Developed	
27	Macglobus	Yes	No	Yes	Yes	No	Yes	Developing	
28	Ultimate	No	No	Yes	Yes	Yes	Yes	Under – Developed	
29	Joaks	No	No	Yes	No	Yes	Yes	Under – Developed	
30	Talkeem	No	No	Yes	No	Yes	Yes	Under – Developed	
31	Under Construction 1	No	No	No	Yes	No	Yes	Developed	
32	Under Construction 2	No	No	No	No	No	Yes	Developed	
33	Under Construction 3	No	No	No	No	No	Yes	Developed	
34	Under Construction 4	No	No	No	No	No	Yes	Developed	

Table 3: Density of Petrol Service Stations by Roads

S/N	Name Of Road	Length (Km)	Number Of Pfs	Density
1	Papa -Polytechnic Junction Road	3.26	16	4.91
2	Owode – Ibese Road	2.99	8	2.68

3	Atewolara Road	2.58	1	0.39
4	Polytechnic – Oja – Odan Road	1.76	1	0.57
5	TundeIbikunle Road	3.193	5	1.57
6	Old Garage-OkeEla	0.48	1	2.1
7	Gbogidi	2.69	2	0.74

Where density per road = number of petrol service stations ÷ length of road

Table 4: Distribution Of Petrol Service Stations By Road

S/N	Road	Type Of Road	Number Of Stations	%
1	Papa -Polytechnic Junction Road	Major	16	47.1
2	Owode – Ibese	Major	8	23.5
3	Atewolara	Minor	1	2.94
4	Polytechnic – Oja – Odan	Major	1	2.94
5	TundeIbikunle	Major	5	14.71
6	Old Garage-Oke–Ela	Minor	1	2.94
7	Gbogidi	Minor	2	5.88

Distributional Pattern of the Petrol Filling Stations

The Nearest Neighbour Analysis was carried out in respect of the 34 petrol filling facilities locating in the 106 square kilometer of Ilaro town, and with mean nearest neighborhood distance of 0.29 km. With the Rn value of 0.33, the locational pattern can be said to tend towards clustering. This is obvious in the high density expressed as number of filling stations per kilometer in major road corridors of Ilaro settlement, as shown in table 3. It is equally corroborated by the finding in table 1 that 17 (50%) of the petrol filling stations have their nearest neighbor filling station on either side of the road locating outside the recommended radius of 300 meters . With the facility per population contained in DPR guideline of 2007, which stipulates that one petrol filling station should serve 5000 population, the total number of petrol filling stations that should optimally serve Ilaro's population of 68,617 is 14. The present population of 34 filling stations suggests an undue clustering. It is equally noteworthy that the clustering is apparently more expressed in the developed areas of Ilaro settlement. On the basis of the foregoing, the null hypothesis stated in respect of this study that the locational pattern of petrol stations within Ilaro is not regular and evenly spatially distributed is hereby accepted.

Conclusion and Recommendations

From the foregoing it is evident that if all parameters for assessing the locational appropriateness of petrol filling stations are critically considered ,none of the petrol filling stations in the study area is worthy of town planning approval. Their pattern of development and functionality is therefore an indictment on the Agency responsible for managing spaces in the study area. The study recommends that a moratorium on the approval of petrol filling stations within the fully developed road corridors within the study area, as it is evident the existing petrol filling stations have greatly flouted planning standards in their location. Certain standards discrepancies were commonplace in the course of this study. For instance while DPR standard recommends a setback of 15 meters from road, the Ogun State Urban and Regional Planning law of 2010 recommends a setback of 9 meters. The study deems imperative the reconciliation of such discrepancies by the regulatory authorities. Moreover, it recommends the need for an audit of approval carried out in respect of petrol filling stations in the study area, by Ogun State Ministry of Urban and Regional Planning. It recommends the need for more proactiveness and effectiveness in the development control activities of the planning authority, under whose jurisdiction, the study area falls into.

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