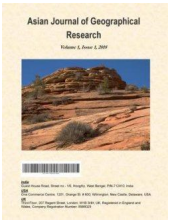

Asian Journal of Geographical Research

1(2): 1-9, 2018; Article no.AJGR.44625

Managing Filling Stations Spatial Database Using an Innovative GIS Tool – Case Study Afipko City in Nigeria

M. A. Emakoji[1*] and K. N. Otah[1]

[1]Department of Surveying and Geoinformatics, Akanu Ibiam Federal Polytechnic Unwana, Ebonyi State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author MAE produced the map, performed the spatial analysis. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJGR/2018/v1i229605
Editor(s):
(1) Dr. Xu Chong, Professor, Institute of GeologyChina Earthquake Administration, Beijing, China.
Reviewers:
(1) Mohamad Awad, Lebanese National Council for Scientific Research (CNRSL), Lebanon.
(2) Ogunyemi Samson Akintunde, Obafemi Awolowo University, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/28086

Original Research Article

Received 21st September 2018
Accepted 16th December 2018
Published 3rd January 2019

ABSTRACT

With the Nigeria economy and her citizens over reliance on crude oil and its refined products, the use of petrol, diesel and kerosene in fuelling of generators and automobiles or for domestic cooking becomes very essential. Hence, constant visit to filling stations is necessary at one time or the other. This has in turn enthused the siting of so many filling stations and one is forced to wonder if they all complied with the standards required for their establishment. The question of where to buy fuel and which filling station is sited short of the regulatory standards can be appropriately answered using Geographic Information System (GIS). This study focuses on analysing the location of filling stations within Afikpo, in Ebonyi State Nigeria against the laws/regulations guiding their establishment. The coordinates of the filling stations were acquired with a handheld Global Positioning System (GPS) receiver and plotted on a georeferenced map in ArcMap environment of ArcGIS 10.2 software. All the analyses were performed in the ArcMap environment using spatial analyst, spatial statistics and proximity tools available in the software. The findings revealed that the filling stations are spatially distributed in a dispersed pattern. The results of the analysis reveals that 44.4% of the filling stations did not meet the criteria of 15 meters minimum distance from the pump to the edge of the road.

**Corresponding author: E-mail: emakojimoses@yahoo.com;*

22.2% of the filling stations were sited too close (lesser than 100 meters) to a health care centre. 66.7 % % did not meet the criteria of 400 meter minimum distance to other stations when located on the same road side (with no road separation). This database created on filling stations provides a platform to help policy makers (regulatory agencies) in planning, management and effective monitoring/supervision. It is there recommended that the regulatory bodies should be proactive in the discharge of their duties.

Keywords: Database; filling station; GIS, map.

1. INTRODUCTION

A filling Station is a place where fuel and lubricants for motor vehicles are sold. They are commonly situated along major streets in Nigeria for many reasons such as easy accessibility, security e.t.c. According to Shikenan [1], there are three major products sold in Nigeria filling Station. There are: AGO-Automotive Gasoline Oil (Diesel), PMS-Premium Motor Spirit (Petroleum), DPK- Dual Purpose Kero (Kerosene). Despite the many researches on the use of biofuel from biotechnology and solar power e.t.c., as alternative power source, the use of petrol, diesel and kerosene in fuelling of generators and automobiles or for domestic cooking cannot be completely ruled out. Especially in a developing country like Nigeria, where epileptic power supply is the order of the day (notwithstanding the many efforts made by the federal government to improve power supply). Hence, constant visit to filling stations is necessary at one time or the other. There are other several reasons for the universal acceptance of petroleum based fuels. The fuel occurs in liquid forms, which made it easy and convenient to be transported through virtually all the fuel transportation modes including pipelines, trucks, tankers (land, water and air) etc.[2].

Filling station is a significant contributor to traffic problems like 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 and so on [3]. There are many aspects to consider when storing petroleum products at petrol filling stations. Due to the close interaction with the public, it is important that the necessary controls are in place so that products such as petrol or diesel are stored, transferred and handled appropriately [4]. According to DPR [5], the following conditions must be met before storage and sales licence can be granted:

i A minimum of three (3) underground storage tanks (one each for PMS, DPK, and AGO.)
ii A minimum of three (3) dispensing pumps (one each for PMS, DPK and AGO)
iii Office building: Two (2) offices, sales room, toilet, lube bay/store (Optional)
iv Well concreted forecourt “IN/OUT” drive way inclusive
v Wall fence demarcating the station (minimum height of 1.5m high)
vi Good drainage Network
vii Safety facilities (Fire Extinguishers, Sand Buckets, strategic display of “NO SMOKING” warning signs.
viii Station Sign post/logo of company/outlet.
ix Standard canopy over PMS pumps (mandatory) with company name and logo boldly written.
x Standby Generator.
xi Accessible Potable water source.
xii Standard (51” x 30”) price bill board with changeable price mechanism

A Geographic Information System (GIS) is an automated information system for capturing, storing, analysing, displaying and managing data and associated attributes that are spatially referenced to the earth. GIS is a tool that allows users to create interactive queries (user created searches), analyse the spatial information, edit data, maps, and present results of all these operations [6]. The use of a GIS database provides a stored ‘intelligent’ record of the derived observations and accurately depicting their spatial location on a map.

A map is defined as a representation on a plane surface of the physical features, both natural and artificial, of some parts or whole of the earth’s surface at a given scale, by the use of signs and symbols with the method of orientation indicated. It is a means of conveying geographic information. Maps are universal medium for communication, easily understood and appreciated by most people regardless of language or culture [7].

A review of some related literatures was done to understand the extent of research/study made so

far. In the work of Mohammed, Musa, and Jeb [8], GIS-Based Analysis of the Location of Filling Stations in Metropolitan Kano against the Physical Planning Standards set by Department of Petroleum Resource, DPR (2007) and Kano Urban Planning and Development Agency, KNUPDA (2013) was done in which most filling stations were seen to fall short of the criteria of 400meter minimum distance to other stations where located on same road side and when not separated by any road or street. However, most of the filling stations satisfied the minimum requirement of 15 m distance from the road as well the criteria of 100m from the health care facilities [8].

Another study by Dogara [9] analysed the location of filling stations in Kaduna Metropolis against the physical planning standards set by Department of Petroleum Resource (DPR) and Kaduna Urban Planning and Development Agency (KASUPDA). In their findings, some filling stations did not meet the minimum distance of 100 meter from the health care facilities as well as the criteria of 400 meter minimum distance to other stations where located on same road side.

Ogunyemi et al. [10] examined the spatial pattern of petrol service station using nearest neighbour analysis, the inventory of service stations in terms of marketing official rank and mapping of petrol service stations with a view to providing a framework for the safety of citizen from fire hazards and to protect the immediate environment from fire menace. The findings revealed three major spatial distributions which are; dispersed pattern, random pattern, and clustered pattern.

Oloko-oba Mustapha et al. [11] used geospatial techniques to determine the distribution pattern and asses the level of conformity of the filling stations against the physical planning standards by the regulating bodies. In his findings, the filling stations formed a clustered pattern of distribution, while many fillings stations met with 15 m distance from the edge of the road, while almost all the filling stations violated the 400 m distance apart between filling stations as well as the 2 km radius of four stations.

The aim of this study is to carry out spatial analysis of the distribution and location of filling stations within Afikpo metropolis using GIS techniques with a view to investigating the level of compliance of these filling stations with the regulations guiding their establishment. The objectives will therefore be to produce a digital map of Afikpo showing the spatial distribution of filling stations within the area, create a database for the filling stations and carry out selected queries. With the problem of indiscriminate location of filling stations taking place almost in every cities in Nigerian, Spatial analysis of the location and distribution of filling stations will help to point out operators who may have fallen short of the standard required. Hence, the study is will provide the necessary information on filling stations within the area and help policy makers (regulatory agencies) in planning, management and effective monitoring/supervision as a guide for tourist or visitors, as a base and reference for further research work.

2. MATERIALS AND METHODOLOGY

2.1 Study Area

Afikpo (Ehugbo) is the second largest town in Ebonyi State, Nigeria. The population is approximately half a million people and growing. The local language (Okwu Ehugbo) is a dialect of Igbo, which is the common language among the five south eastern states (Abia, Anambra, Ebonyi, Enugu and Imo states) of Nigeria [12]. It lies between Latitude 7º 55' 17.4"N – 7º 56' 35.4"N and Longitude 5º 53' 12"E – 5º 53' 59.4"E. It is bounded to the north by the town of Akpoha, to the south by Unwana and Edda in Ubeyi and Afikpo South Local Government Areas respectively, to the East by the Cross River and to the West by Amasiri. Afikpo spans an area approximately 164 square kilometers in size [13].

2.2 Method

A topographic map covering the study area (Afikpo N.E, Sheet 313NE at scale 1:50,000) was obtained from the Office of the Surveyor General of the Federation (OSGOF) Abuja Nigeria, to serve as the base map. This topographic map was scanned using a scanner in order to allow the map to be imported into a Computer (with software ArcGIS 10.2 installed on it). The raster image (Scanned map) was imported into the ArcGIS environment from where different layers were created using the ArcCatalog, it was Georeferenced and thereafter digitised using the ArcMap.

The names of the various filling stations within Afipko metropolis were obtained from the

Department of Petroleum Resources (DPR) and verified on site. A Handheld Global positioning System (GPS) receiver (Garmin 76), was used to acquire the location coordinates of the filling station and also the coordinates of some points of interest for the purpose of map updating, owing to the fact that the base map used was produce some years ago (produced by the British Government's Ministry of Overseas Development, Directorate of Overseas Survey 1965) there was the need to update the map. These coordinates were plotted in ArcMap of ArcGIS software (through 'add XY data'). The spatial and their attribute data (filling station names and coordinates, as well as number of pumps per product) obtained were first entered in Microsoft Excel (2013) software to create a simple database and was exported to ArcMap environment of ArcGIS. This data was thereafter converted to shape file and used to perform all the required analysis. A logical flow chart of analytical operations within a GIS Framework is shown in Fig. 1 as relating to the design of spatial database. Different symbolization was used to map out the filling. A map showing the distribution of the filling stations was produced and different queries were created.

Some analysis were carried out in ArcMAp environment of ArcGIS software using the proximity analyst of the ArcToolbox, to determine the level of compliance of these filling stations with the laws (DPR Guidelines for Approval of Construct and Operation). A buffer was created at 15 m to check if any pump (within any filling station) was cited less than 15 meters from the edge of the road. Another buffer was created at 100 meters to check if any filling station was cited less than 100 meters from any public place (hospital). Also, a buffer of 400 meters was created to check if any filling station fell short of the 400 meter minimum distance from another filling station (if both filling station were located on same road side).

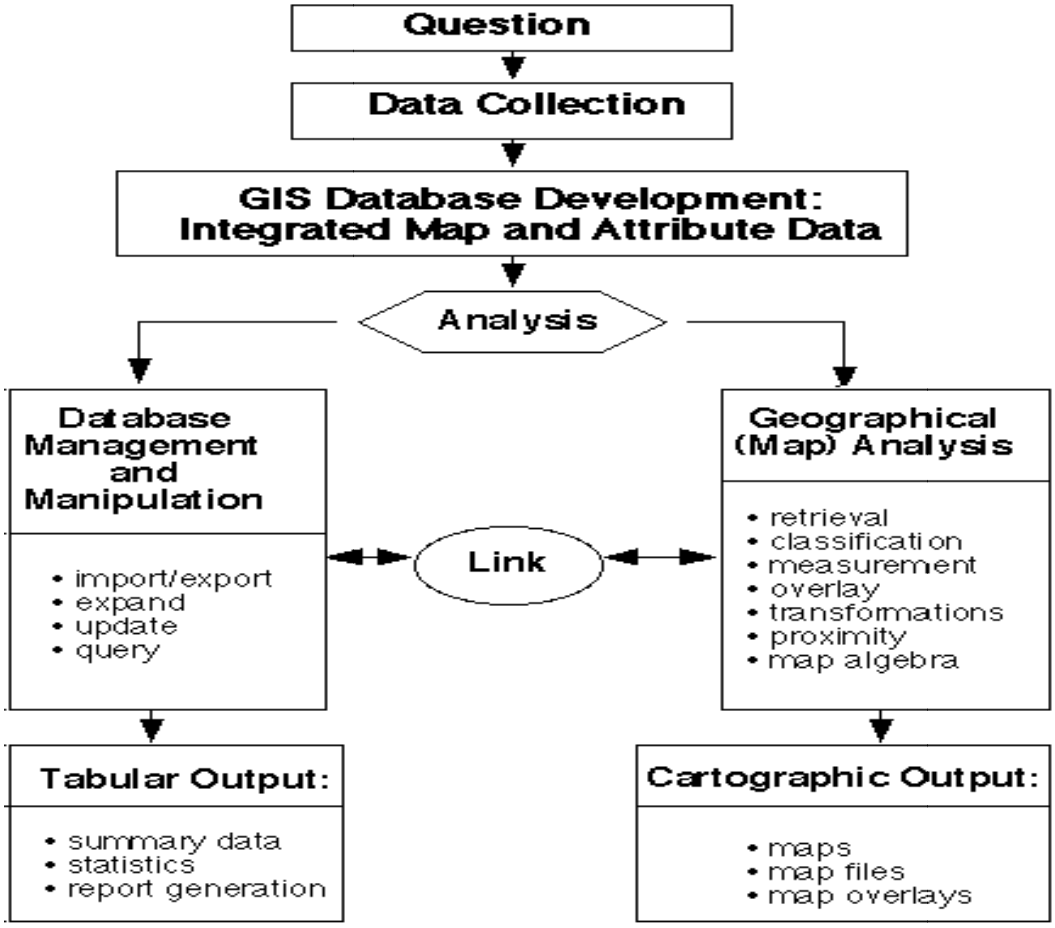

Fig. 1. Logical Flow Chart of Analytical Operations within a GIS Framework [14]

3. RESULTS AND ANALYSIS

The study revealed that there are nine (9) independent marketers (filling stations) within Afikpo metropolis with no major marketer within the area. The pattern of distribution of the filling stations was the dispersed pattern which may have been caused by the road network pattern as well as the residential area available within. The list of the independent marketers with the location coordinates is shown in the Table 1. The number of pumps for each filling station is shown in Fig. 2, with Ebiri Nig. Ltd and Precious Codoris Global Ltd having the highest number of four (4) petrol pumps, followed by Jekwu Oil Ltd with three (3) petrol pumps, while Tongadas Investment Nig. Ltd, D.A. Ugwu and Sons, Vita mater oil Ltd, Ibeson Petroleum Ltd, Concept Petroleum Ltd, and San Savanah oil Ltd, have two (2) petrol pumps each. The spatial distribution of the filling stations is shown in Fig. 3. Some queries were also created an example of such queries (shown in Fig. 4) was to determine the filling stations without a kerosene pump. Result of a query showing filling stations with more than two (2) Petrol pumps is shown in Fig. 5.

The results of the buffer analysis reveals that 44.4% of the filling stations did not meet the criteria of 15 meters minimum distance from the pump to the edge of the road. 22.2% of the filling stations were cited too close (lesser than 100 meters) to a health care centre. 66.7% % did not meet the criteria of 400 meter minimum distance to other stations when located on the same road side (with no road separation). The result of the 400 meter buffer is shown in Fig. 6.

Table 1. List of the Independent Marketers within Afikpo Metropolis

S/N	Names	Easting (m)	Northing (m)	Petrol Pump	Kerosene Pump	Diesel Pump
1	Tongadas Investment Nig. Ltd	382329.710	650526.599	2	1	0
2	D.A. Ugwu and Sons	382257.497	650556.688	2	1	1
3	Jekwu Oil Ltd	381629.601	651112.756	3	1	1
4	Ebiri Nig. Ltd	381274.254	651101.623	4	1	1
5	Precious Codoris Global Ltd	380536.409	648992.062	4	1	1
6	Vita mater oil Ltd	383707.784	651507.499	2	1	1
7	Ibeson Petroleum Ltd	382432.013	650097.318	2	1	1
8	Concept Petroleum Ltd	382311.474	649894.914	2	1	1
9	San Savanah oil Ltd	382937.507	651314.93	2	0	0

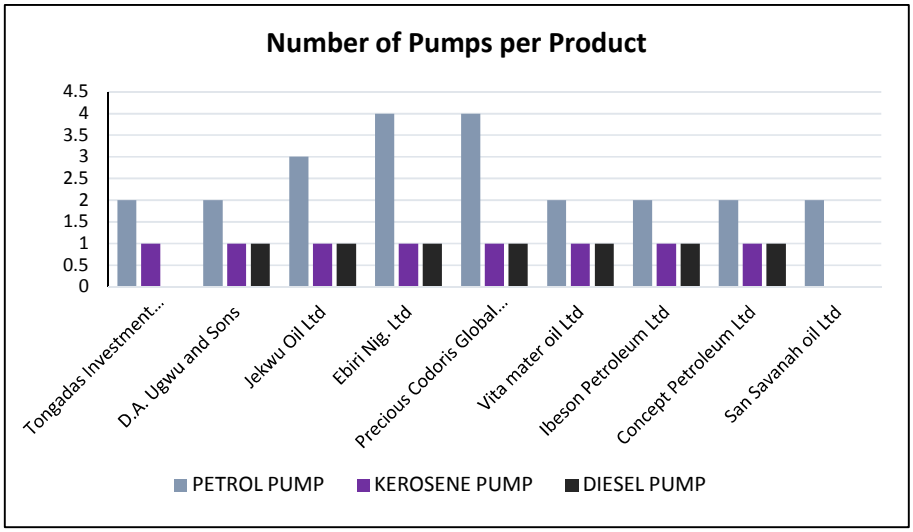

Fig. 2. Chat showing independent marketers within Afikpo metropolis

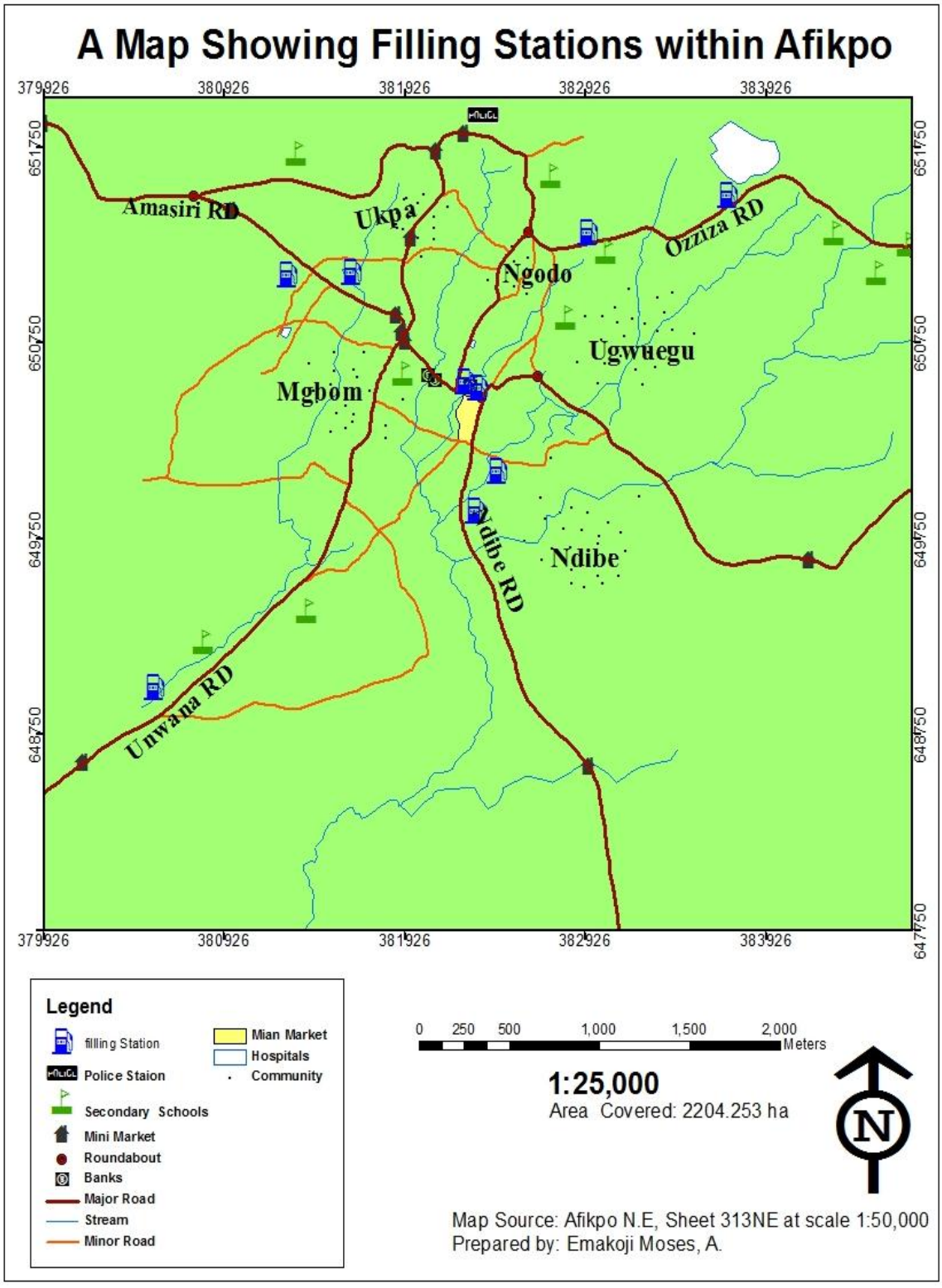

Fig. 3. Spatial distribution of filling stations within Afikpo metropolis

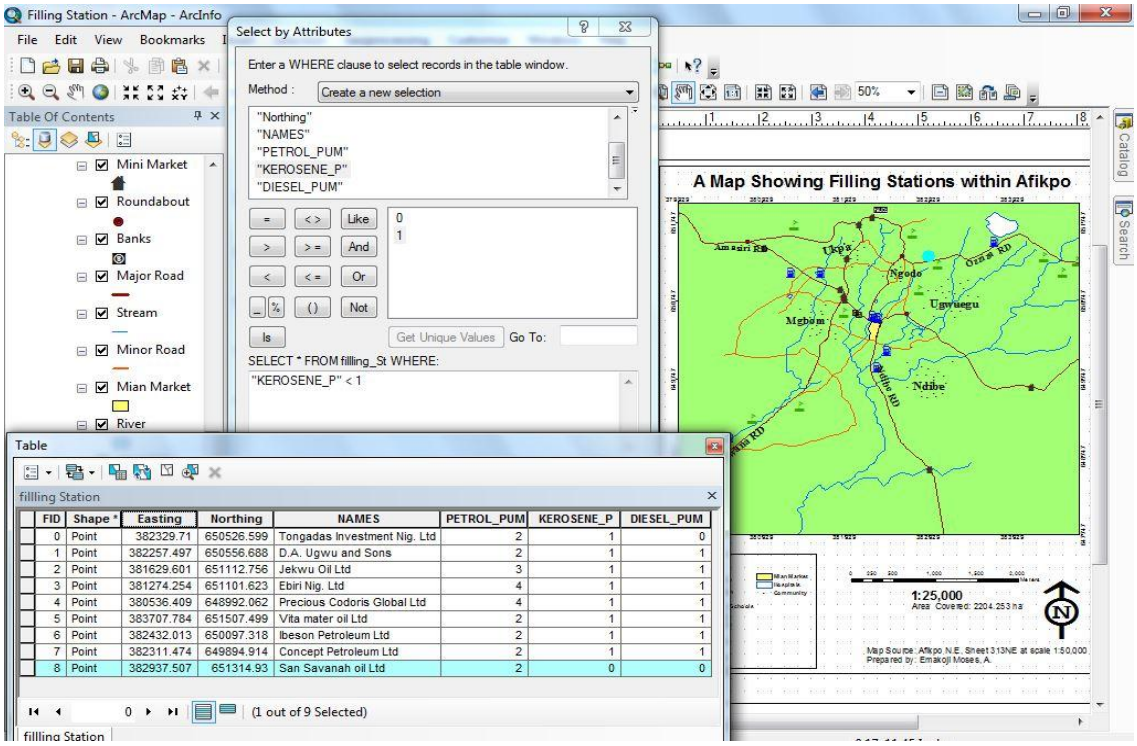

Fig. 4. Result of query showing filling stations without a kerosene pump

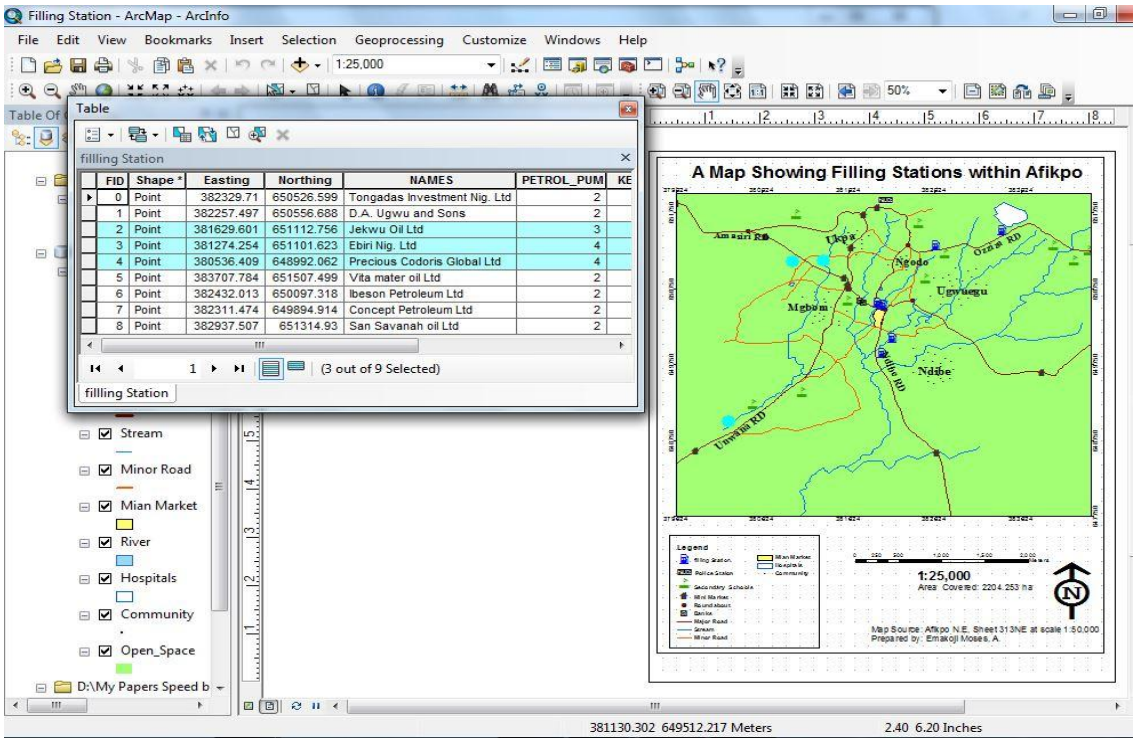

Fig. 5. Result of query showing filling stations with more than two (2) Petrol pumps

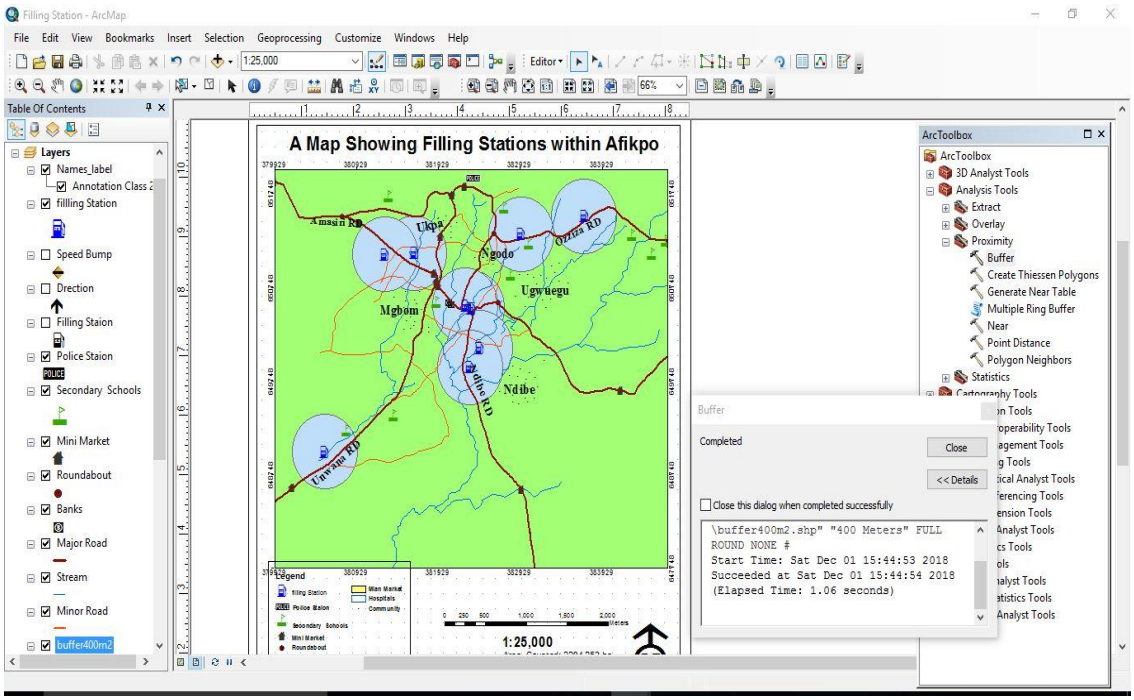

Fig. 6. A 400 meter minimum distance to other stations buffer result

4. CONCLUSION AND RECOMMENDATION

This study has further demonstrated the effectiveness of GIS to capture, store analyse and display and manage geographic and non-geographic related data. The database created will no doubt help to serve a base for further studies. It will also provide the necessary information on filling stations within the area and help policy makers (regulatory agencies) in planning, management and effective monitoring/supervision. It is there recommended that the regulatory bodies should be proactive in the discharge of their duties.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shikenan. Guide for running a filling station in Nigeria; 2011.
Available:http://www.shikenan.com/article-details/business-in-nigeria/guide-for-running-a-filling-station-in-nigeria
Accessed on 11th October 2017

2. Ohimain EI. The challenge of liquid transportation fuels in Nigeria and the emergence of the Nigerian automotive biofuel programme. Research Journal of Applied Sciences, Engineering and Technology. 2013;5(16):4058-4065

3. Ayodele SJ. Filling Station; 2011.
Available:http://www.scribd.com/doc/51589605/1/STATEMENT-OF-RESEARCH-PROBLEMS
Accessed on 15th October 2017

4. Energy institute. Filling stations; 2014.
Available:https://www.energyinst.org/technical/distribution-and-marketing/filling-stations
Accessed on 15th October 2014.

5. DPR. Guidelines for Approval to Construct and Operate Petroleum Products Filling Station; 2018.
Available:https://dpr.gov.ng/wp-content/uploads/2018/03/FILLING-STATION-GUIDELINES.pdf
Accessed on 18th September 2018

6. USDA. Geographic Information Systems; 2008.
Available:http://egsc.usgs.gov/isb/pubs/gis_poster/index.htm
Accessed on 13-2-10-2008

7. Sule, JO, Shebe MW, Bichi MA, Atiyong PB. Distribution of filling stations in Kaduna

metropolis. International Journal of Advanced Engineering Sciences and Technologies. 2011;1(7):110–121.

8. Mohammed MU, Musa IJ, Jeb DN. GIS-based analysis of the location of filling stations in Metropolitan Kano against the Physical Planning Standards. American Journal of Engineering Research. 2014; 9(3):147-158.
9. Dogara ST. GIS-Based locational analysis Of Petrol filling stations in Kaduna Metropolis. Science World Journal. 2017; 2(12).
10. Ogunyemi SA, Ajileye OO, Muibi KH, Alaga AT, Eguaroje OE, Samson SA, Omisore OO. Geo-information and distribution pattern of petrol service station in Sango – Ota Metropolis in Ado – Odo Ota Local Government Area, Ogun State, Nigeria. Asian Research Journal of Arts & Social Sciences. 2017;2(1).
DOI: 10.9734/ARJASS/2017/30048
11. Oloko-oba Mustapha O, Badru RA, Popoola OS, Alaga TA, Ogunyemi SA, Samson SA. Assessment of filling station in Ilorin, Kwara State, Nigeria Using Geospatial Techniques. International Journal of Scientific Research in Computer Science, Engineering and Information Technology. 2016;2(1):69-74.
12. Afikpoonline. About Afikpo; 2014.
Available:http://www.afikpoonline.com/about-afikpo/#
Accessed on 16th May 2016
13. Mbey G. Origin of Afikpo (Ehugbo); 2009.
Available at: Ebonyi online.
Available:http://www.ebonyionline.com/origin-of-afikpo-ehugbo/#
Accessed on 2nd June 2017
14. Agi WO. The distribution and analysis of secondary schools in Makurdi Metropolis; B.Sc. project Department of Geomatics Engineering, Ahmadu Bello University Zaria; 2009. (unpublished)

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/28086