

MAPPING AND SPATIAL ANALYSIS OF POLLING UNITS TO ENHANCE VOTING IN AKURE SOUTH, NIGERIA

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Abstract. Polling units are isolated places with significant structures established by the Independent National Electoral Commission in Nigeria to serve as registration centers and voting units. The study aimed at mapping and examining the spatial distribution of polling units to enhance the voting process in Akure South, Ondo State. Handheld-GPS map 76CSX was used in acquiring coordinates of the existing polling units. Queries were performed to examine the ownership of the polling unit premises and also determine polling units with over 500 registered voters. The result of the query shows that 276 out of the 302 polling units in the study area have over 500 voters. The distribution pattern of the polling units was determined using the average Nearest Neighbour Analysis. The result indicates clustered with R_n as 0.502292 and Z -value is -16.546600 less than 1. Geocoding was done to ease accessibility and navigation to polling units. A map depicting the polling units' locations and landmarks was produced using ArcGIS 10.6, and it was revealed that some polling units allocated for the study area fall into surrounding Local Governments. It is worthy to note that the results of this study should be adopted, as it would efficiently enhance the voting process.

Keywords: *mapping, spatial distribution, polling units, Nearest Neighbour Analysis*

Introduction

Election is definitely the foundation of democracy; this is related to the system by which the people of an area decide on individuals who will stand for them in government. This specific election happens to be able to fill up public offices with numerous levels of government whether it is federal, state or even local. Election is a significant characteristic inside a democratic system whereby the people should have their voices noticed as well as their viewpoints valuable in their leadership and in crucial decision generating whether that sort of government is almost always to be regarded as a democracy (Osabiya, 2014).

A polling system is a designated location in which qualified voters cast their votes on election time (Akinduro, 2015). They frequently work as registration centers throughout voters' registration. Polling units are exactly where voters cast their ballots on an election time. They are normally the location at which the votes will be counted as well as got into the formal outcomes sheet. Consequently, polling units have become the basic "units of analysis" for an individual or perhaps group seeking to evaluate the method along with its outcomes (OEDI Official Portal, 2019). Considering that the polling units are places reserved for voters in order to participate in elections, it is paramount to determine and map such essential regions as well as to indicate their proximity to voters. Siting polling units in close proximity to voters is going to enhance quick and easy procedure of election during voting (Chang, 2008).

In accordance with Dundas (2012), the problem of area of polling unit and proximity of voting terminals to voters is a great obstacle for huge territories with sparse

countryside population. The irregular siting of polling station within Nigeria happens to be recognized as an important barrier for a free, credible and fair election in Nigeria as location of polling units tend to be afflicted by people (clearly connected), high government officials, along with traditional rulers (Okosun, 2016). The appropriate location and accessibility of polling station, basically like educational service, health service and others, is a vital aspect associated with a well-developed political region, or perhaps any settlement as well as need to be sought by people in politics, communities plus viewpoint leaders (Okosun, 2016). Information regarding wherever polling units are situated along with different feature data is essential for appropriate planning, delivery and distribution of election materials, as well as enabling citizens to take part on an election day. For virtually any organizations, nonpartisan or even partisan, planning to observe the election, accessibility to information concerning polling stations ahead of an election day is essential to developing plans for observation. These are most effectively accomplished through Geographic information System (GIS) as a tool (Kanneh, 2015).

Digital mapping has today turn into an essential application in solving numerous environmental-based challenges. The techniques employed for generating electronic maps happen to be countless, depending on the grade of details needed, the utilization to which the map is going to be placed plus the resource of information (Bukhari and Muhammed, 2013). Geographic information Systems (GIS) happens to be an info technology which has discovered escalating application in public decision-making; especially when it comes to environmental designing and management, Human resource management, logistic planning and management. GIS can be described as a "system of computer software, hardware, data, and personnel to assist manipulate, analyze, and present information that is associated with a spatial location. GIS allows users to collate as well as evaluate information much more easily than is achievable with traditional analysis methods. With GIS, investigators are able to map, model, query, as well as examine huge amounts of information all held together within a single database (Tunceli and Collins, 2003).

Spatial distribution might signify patterns of underlying procedure. Incidents subjected to the influence of process which is similar have a tendency to conform with related locating pattern. Thus, research on spatial cluster might uncover information concerning the main geographical method which produces the spatial layout that might additionally assist the understanding of basic geographical process as well as its connection with the trend being investigation. Evaluation of points distributions, which is commonly called point pattern analysis is among the fundamental techniques in spatial analysis (Hatfield and Follett, 2008).

Elections in Nigeria have been faced with irregularities and delays since time immemorial, the 2019 general election was not left out. During the 2019 general election, it was recorded that elections commenced late in some polling units due to the inability of some ad hoc staff to easily identify their assigned polling units. It was recorded that some could not locate their newly assigned polling units. It was also reported that some officers went to a wrong polling unit after several attempts to locate their specific polling unit. In another example in Abuja, polling officers commenced elections in a different polling unit (NBA, 2019). According to (Jega, 2014), the structure of polling units created by the defunct National Electoral Commission of Nigeria (NECON) in 1996 has been used for the 1999, 2003, 2007, and 2011 general elections and polling units were congested on election days in 2011 and since then in

many parts of the country. Congestions of polling units and difficulties faced by voters and other active actors in elections in locating the polling units are major problems. Inappropriate delineation of constituency boundaries is also a problem. To avert these ugly occurrences that do mar the conduct of election in Akure South Local Government Area. Hence, the study aimed at carrying out mapping and examining the spatial distribution of polling units to enhance credible voting processes within the study area.

Study area

The study location is Akure South Local Government Area, Ondo State, Nigeria. Akure south has its headquarters within the state capital - Akure. It is located between latitude $7^{\circ}15'N$ and $7^{\circ}30'N$ and longitude $5^{\circ}15'E$ along with $5^{\circ}25'E$. It is bonded along the north east by Akure North Local Government Area, in the North West by Ifedore Local Government Area, as well as in the south by Idanre Local Government Area. It has an area of 331km² in addition to a population of 353,211 at the 2006 normal census along with an annual growth rate of 3.03 % (Nigeria Data Portal, 2006). It is approximately 250 meters above the sea level with a landmass addressing an area of 331 square kilometers. Out of the entire Two hundred and three (203) wards along with 3,009 polling units in Ondo State, electoral numbers have it that there are 11Wards (Registration Areas) plus 302 Polling Units in Akure South Local Government Area (LGA). The study location map is shown in *Figure 1(a), (b), (c)*.

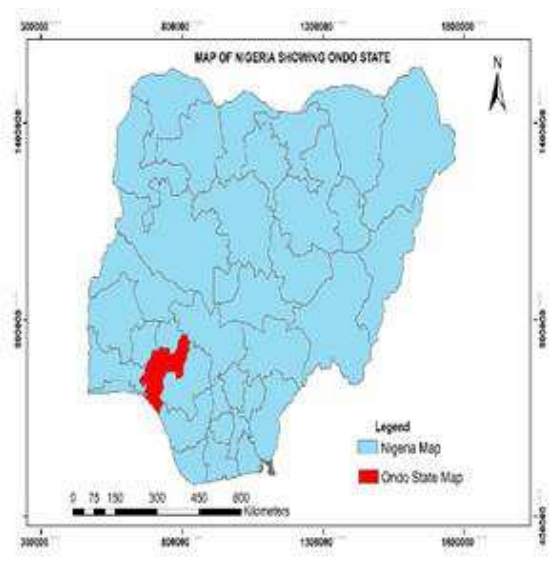


Figure 1(a). Map of Nigeria showing Ondo State.

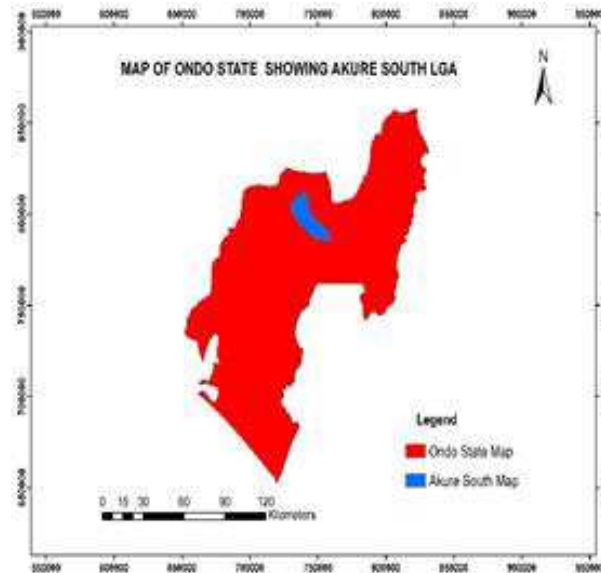


Figure 1(b). Map of Ondo State showing Akure South LGA.

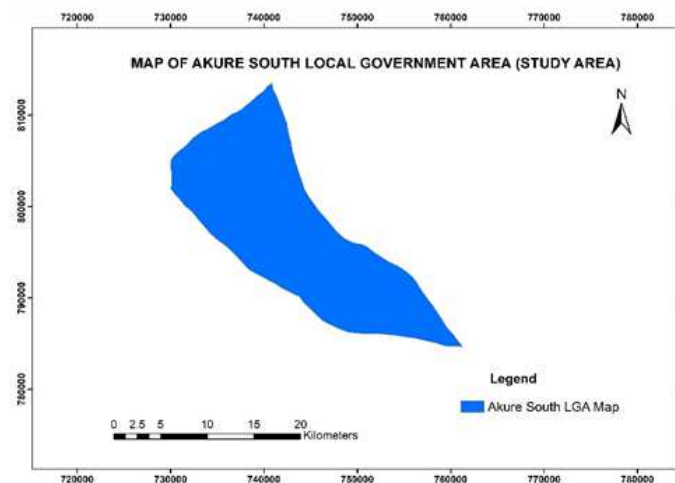


Figure 1(c). Map of Akure South Local Government area.

Materials and Methods

Both primary and secondary data was used for this study. The primary data are the coordinates of present polling units, observed from field work through the Germin 76csx Handheld GPS. The total number of 302 pair of coordinates acquired utilizing Handheld GPS was downloaded into the computer system to attain the coordinates (X, Y) of the polling units in MINNA UTM 31N coordinate feature. The data was after that exported into ArcGIS 10.6 through Microsoft Excel for onward processing. The secondary data and attribute information including figures of registered voters in every polling unit, polling units' titles were collected from the Independent National Electoral Commission (INEC) office in the study area (Independent National Electoral Commission Nigeria Official Portal, 2019). Information about the ownership of the polling units' premises were gathered during field observation to complement the data extracted from Independent National Electoral Commission. The spatial location of the polling units was shown in ArcMap environment. The downloaded two-dimensional

locations of the polling units and prominent adjoining features, already positioned within tabular structure inside excel, was brought into ArcMap by using Arc catalogue to visually present them in their correct spatial locations. The assessment performed through the analysis include spatial statistics assessment (Average Nearest Neighbor Analysis), to identify the distribution pattern of the polling units in the research area; single criteria query was performed to figure out all of the polling units with more than 500 registered voters; as well as geocoding was carried out on a web map to improve accessibility to these polling units. *Figure 2* shows the flow chart of the methodology implemented in this study.

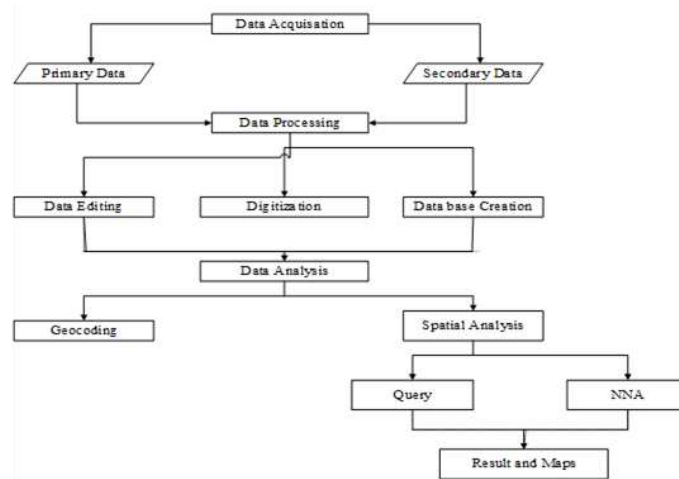


Figure 2. Methodology flow chart.

Data quality

The standard of data applied to any surveying work is often based on the validity and reliability of this kind of data. The validity of the data is assessed through the accuracy on the instrument utilized as well as the reliability of the information is discovered with the precision of the data. As a result, it is able to be agreed that the instrument used for data assortment is dependable along with being an individual to perform the observation has the necessary knowledge to undertake the field work (Idowu, 2005). The data applied to this particular project was acquired with utmost attention to be certain of precision and accuracy. The quality of the locational information can be based within the instrument applied to obtain the information that is hand-held GPS (Garmin map 76csx). Throughout data acquisition, hand-held GPS was permitted to acquire a minimum of 5 to 7 satellites and the weather is clear before acquiring the coordinates of the points.

Results and Discussion

Analyses of the data collected are presented and stated in this section. The results and findings of this project were presented in charts, figures and maps and they are explicitly discussed. The extract of the data obtained were shown in tabular form in *Table 1*.

Table 1. Extract of coordinates obtained for the polling units in Akure South LGA.

S/N	PU_RA	PU_CODE	PU_NAME	Easting	Northing
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1	01 – Aponmu	1	Lisa Camp	733617	802842
2	01 – Aponmu	2	Oke Agbe Camp; Infront of Oluwunmi’s House	732278	803133
3	01 – Aponmu	3	Ita Oniyani/Adun	731130	803896
4	01 – Aponmu	4	Ago Obe; Infront of Obe’s House	727803	800028
5	01 – Aponmu	5	Mile 13	726720	798326
6	01 – Aponmu	6	Aladodo Camp	729124	802852
7	01 – Aponmu	7	Olokuta	731970	799844
8	01 – Aponmu	8	Opa Iwoye	733581	800158
9	01 – Aponmu	9	Iwoye Camp	733731	797912
10	01 – Aponmu	10	Aponmu	728103	800476

GPS points visualization

The spatial location of the polling units and prominent adjoining landmarks were displayed in Arcmap environment. The result is a map shown in *Figure 3*.

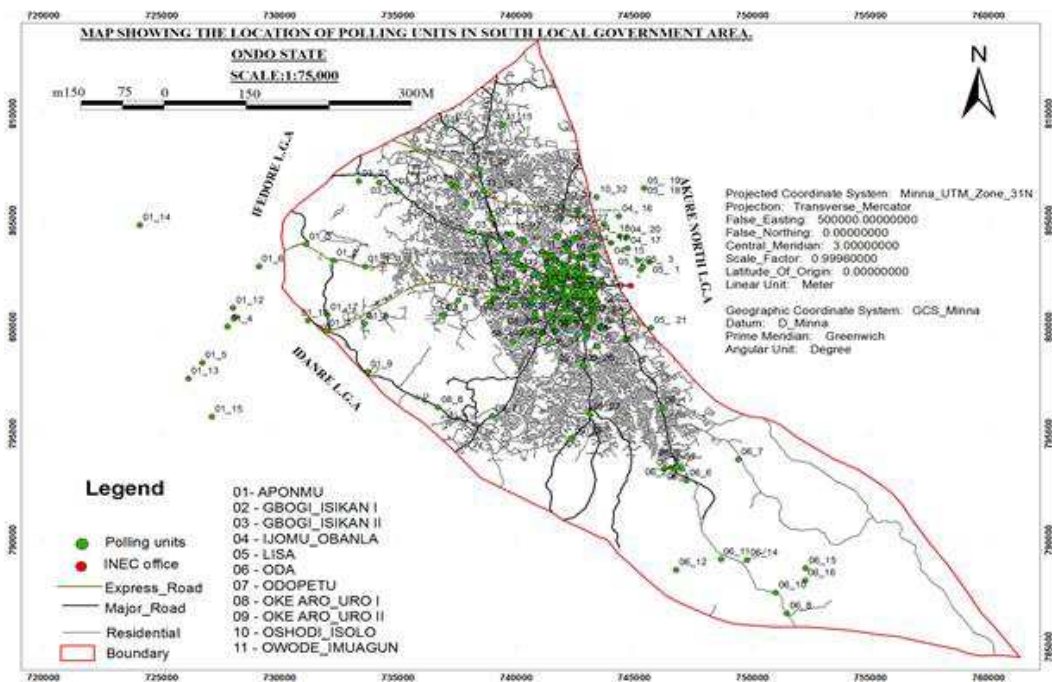


Figure 3. Map depicting the polling units’ locations and landmarks.

The visualization of these points on ArcMap reveals that twenty-five (25) of the polling units allotted to Akure South LGA by INEC fall outside the boundary of Akure South, into the adjoining local governments. These polling units are located in Ward 1, 4, 5, 6, and 10. Information about these polling units that fall outside the boundary are given in *Table 2*.

Table 2. Information about polling units that fall outside the boundary of Akure South LGA.

S/N	PU_RA	PU_CODE	PU_NAME	Easting	Northing	No. of regd. voters
1	01 – Aponmu	4	Ago obe_in front of obe's house	727803	800028	372
2	01 – Aponmu	5	Mile 13	726720	798326	94

3	01 – Aponmu	6	Aladodo camp	729124	802852	480
4	01 – Aponmu	10	Aponmu	728103	800476	629
5	01 – Aponmu	11	Aponmu	728135	800473	552
6	01 – Aponmu	12	Ago akure	728019	800911	392
7	01 – Aponmu	13	Ajgunle	726130	797584	180
8	01 – Aponmu	14	Pilot sawmill	724075	804788	68
9	01 – Aponmu	15	Ago mattew	727125	795807	105
10	01 – Aponmu	16	Akobo	731202	800307	94
11	04_Ijomu_Ob anla	10	Osisi quarters - ola jombo house	743745	804842	1279
12	04_Ijomu_Ob anla	15	Ijapo - ijapo high sch	744021	803945	1202
13	04_Ijomu_Ob anla	16	Ijapo - flagship hotel	744373	805200	2261
14	04_Ijomu_Ob anla	17	Ijapo - recreation centre	744725	803697	1058
15	04_Ijomu_Ob anla	18	Ijapo - cosmic hotels	744406	804274	979
16	04_Ijomu_Ob anla	19	Ado road- testing ground	745168	803136	1481
17	04_Ijomu_Ob anla	20	Ado road- ap filling station	744708	804228	1229
18	05- Lisa	1	Ago ireti	745660	803065	1130
19	05- Lisa	2	Ago ireti - mobil p.s	745288	802695	942
20	05- Lisa	3	Beside mobil, oba ile	745375	802804	1127
21	05- Lisa	18	Alagbaka pry sch I	745424	806513	1510
22	05- Lisa	19	Alagbaka pry sch II	745424	806513	1218
23	05- Lisa	21	School of nursing	745715	799973	1232
24	06-Oda	9	Osic langbodo camp II lamgbodo camp	755678	783299	180
25	10_Oshodi_Is holo	32	Okesi, at okesi village	743422	806098	1541

Ownership of polling unit premises

In a press conference made by INEC, through the then INEC chairman, Prof. Attahiru Jega, in the build up to the 2015 general election: “one of the objectives of restructuring the existing polling units was relocating the PUs from “in-front of” private houses, and such other unsuitable places, to public buildings or where this is not possible, to public open spaces where tents can be provided.” The ownership of the polling unit premises in the study area was examined in order to verify the effectiveness of the decision of INEC in reconfiguration of the structure of polling units in Nigeria. Ownership of polling unit premises across the LGA can be categorized into government/public and private. The result of the analysis of the ownership of the polling unit premises is shown in *Table 3*.

Table 3. Showing the percentage of ownership of polling unit premises.

Ownership of polling unit premises	Number of polling unit	Percentage (%)
Private	228	75
Government	74	25
Total	302	100

The government owned polling unit premises are public places such as schools, market squares, and town halls, while the private owned polling unit premises are

residential buildings, private shops etc. Out of the 302 polling units in Akure South, the polling unit premises owned by the government was found to be 74, accounting for 25% while the private owned polling unit premise was found to be 228, accounting for 75% as presented in *Table 3*. The above analysis and results therefore shows that the decision by INEC to relocate polling units from private houses to public places was not effective in the study area. As such, citing polling units in residential buildings and private places may influence voters' decision.

Single criteria queries

A single criteria query was carried out to determine all the polling units with over 500 registered voters. This condition is used to retrieve the required information from the database. This entails selection by attributes: `SELECT* "NO_REG_VOT" >500`. The results showed that 276 polling units out of the total 302 have registered voters of above 500. This contradicts the maximum number of registered voters (of 500) per polling unit in Nigeria set by the Independent National Electoral Commission.

According to INEC (2019), "the location of polling units does not include places of worship, palaces of traditional rulers and private homes." Query was carried out to check if there were polling units located in palaces of traditional rulers. The result of the query showed that four (4) polling units in the study area are located in front of palaces of three different traditional rulers namely Iralepo Palace (2 polling units), Olukoyi Palace (1 polling unit), and Osolo Palace (1 polling unit), which are polling unit code 33 and 34 in Igbogi/Isikan I RA; polling unit code 19 in Oshodi/Isolo RA; and 22 in Oshodi/Isolo RA respectively.

Nearest Neighbour Analysis

To determine the distribution pattern of polling units in the study area, the Average Nearest Neighbour tool on ArcMap10.6 was used to statistically determine the existing pattern of distribution as to whether the distribution is regular, random or cluster in the study area. The Average Nearest Neighbour tool measures the distance between each feature centroid and its nearest neighbour's centroid location. It then averages all these nearest neighbour distances. The model indicates the degree to which any observed distribution deviates from what may be expected Nearest Neighbour Analysis (NNA) was used to determine the location pattern of the polling units. The statistics is given by;

NNS= Nearest Neighbor Statistics;

$$R_n = \frac{D_m}{D_e} \quad (\text{Eq. 1})$$

D_m = Observed mean distance in areas under consideration.

D_e = Expected mean distance

$$D_e = \frac{1}{2\sqrt{P}} \quad (\text{Eq. 2})$$

where P= density of points in A, i.e., number of points per unit area.

i.e. $P = \frac{n}{A}$

$$R_n = 2D_m \sqrt{\frac{n}{A}} = 2D\sqrt{P} \quad (\text{Eq. 3})$$

$$R_n = 2 \frac{d\sqrt{n}}{a} \quad (\text{Eq. 4})$$

where: R_n = the nearest neighbor index, a = the size of the study area, d = the mean distance between polling units n = the number of Polling units.

The R_n values range from 0 (when there is no distance at all) to 2.15 (when polling units have a minimum spacing and regularly distributed). $R_n = 0$: the distribution of points is clustered. $R_n = 1$: the distribution of points is random. $R_n = 2.15$: the distribution of points is regular/dispersed. Using the Spatial Statistic tool in ArcGIS, the nearest neighbor computed result is 0.502292 (Table 4), which thus indicates that the general distribution of polling units in Akure south is clustered in pattern. Nearest neighbor index (R_n) value is less than 1 and Z-value is -16.546600. The implication of the negative Z score indicates clustering (Figure 4).

Table 4. The Result of Nearest Neighbour Analysis in the Distribution polling units in Akure South L.G.A.

Study area	Observed mean distanced (m)	Expected mean distance (m)	Nearest Neighbour ratio (R_n)	Z-score	P-value
Akure south	379.4180	755.3730	0.502292	-16.546600	0.000000

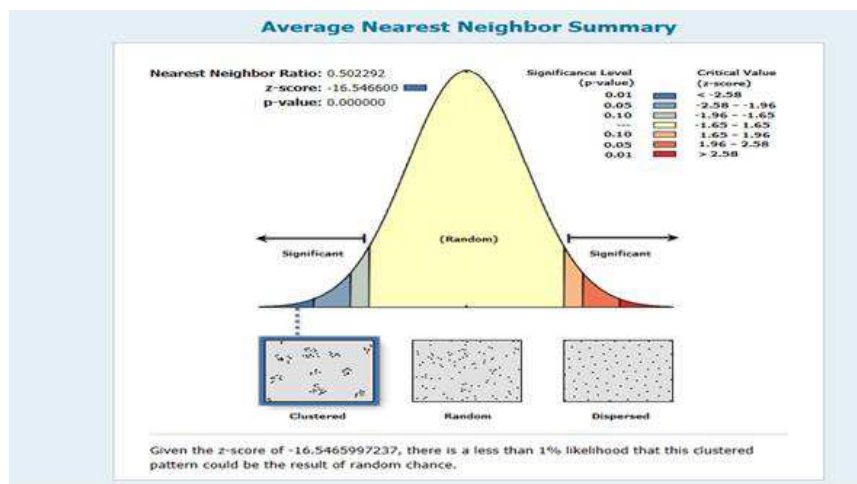


Figure 4. NNA of polling units in Akure South Local Government Area.

The reason for the clustered distribution of the polling units in the area may be linked to the fact that polling units are concentrated mainly in the metropolis of the study area. This metropolis area houses the largest population of voters and by extension, the largest population of citizens in the local government, with this, it is evident that population is a key factor in facilitating the pattern of distribution of polling station as well as the creation of polling unit or decongestion of polling units. As the population increases and settlements begin to expand, there may be need to create more polling units.

Geocoding of polling units on google map

Geocoding is a process of assigning locations to addresses so that they can be placed as points on a map, similar to putting pins on a paper map, and analysed with other spatial data. The process assigns geographic coordinates to the original data, hence the name geocoding. The coordinates and attributes of these polling units are registered on Google map to enhance accessibility and navigation to polling units. The geocoding interface shows both the spatial and attributes information about the polling units including the pictorial view of the polling unit premises to enable electorate and others to easily identify the polling unit premises. The view of the geocoding interface is shown in *Figure 5*.

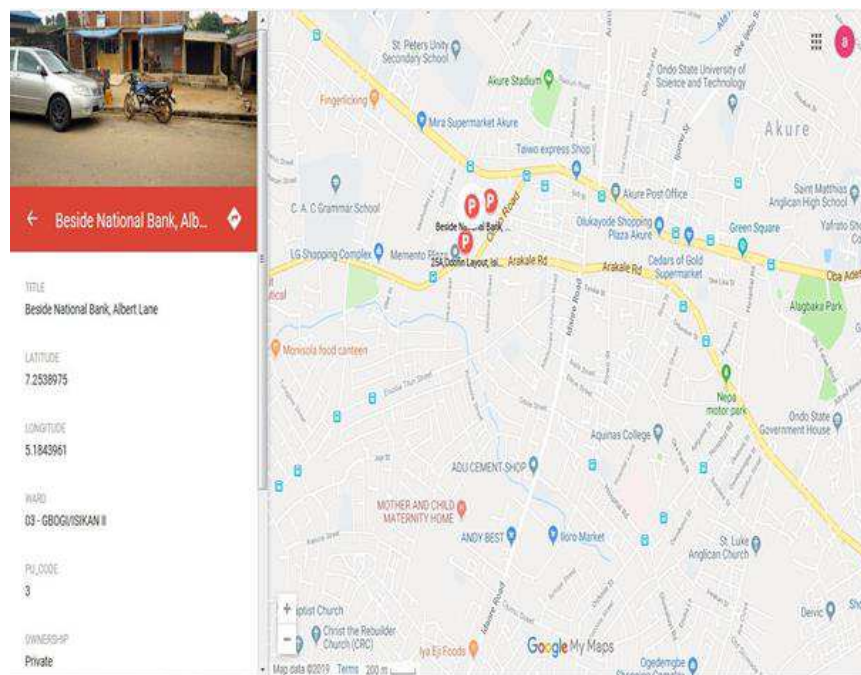


Figure 5. Location address of polling units on Google map.

Conclusion

This study integrates probability of adopting GPS and GIS in mapping and examining the spatial distribution of polling units. In this study, the approached adopted in data acquisition and analysis have been discussed extensively. This reveals that the total 302 polling units exist in the study area and twenty-five (25) of the polling units allotted to Akure South LGA by INEC fall outside the boundary of Akure South. Furthermore, out of the 302 polling units in Akure South, the polling unit premises owned by the government was found to be 74, which represents 25% while the private owned polling unit premise was found to be 228 accounting for 75% which contradict the decision by INEC to relocate polling units from private houses to public places. A total of 276 polling units out of the total 302 has registered voters of above 500 which contradict the maximum number of registered voters per polling unit in Nigeria. The inclusion of geo-coding in this study will enable the electoral, the electorate and the general public to easily identify these polling units anytime, anywhere so far, they are

connected to the internet. The performed query shows that four (4) polling units were located in front of two palace of traditional rulers. Nearest Neighbour Analysis carried out shows that the polling units within the study area were clustered. The study recommended that the results of this study should be adopted in other to enhance voting process in Akure South L.G.A., the political boundary of Akure South Local Government should be clearly and accurately be redefine/delineate, and there is need for continuous mapping and updating the database of these polling units.

Acknowledgement

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Conflict of interest

Authors confirmed there is no conflict of interest with any parties or organizations involved in this research study.

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