The Distribution of Automated Teller Machine (ATM) in Calabar Metropolis, Cross River State, Nigeria

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Abstract: The study examined the distribution of automated teller machines in Calabar Metropolis in view of the Central Bank of Nigeria’s policy on cashless economy. Data were obtained from both primary and secondary sources using direct field measurement of ATM locations and enumeration of ATMs across the wards, questionnaire and National Population Commission records. The data were presented in tables and analyzed using geographical information systems and statistics. The result revealed a total of 134 ATMs, located across the Metropolis. It was discovered that while some areas had excess ATMs, many other places had deficits, making it difficult for customers to access ATMs services, except at some cost. It was discovered that there is a significant variation (F = (d.f. = 1, 400) = 27.472, p < 0.05) in the cost of transportation to the nearest ATM location across the 22 Wards in Calabar Metropolis. Again, the study revealed that ATMs are significantly clustered in the Metropolis with Max. D of 0.2459 > critical D of 0.136 and disproportionately distributed. It is recommended that more ATMs should be located near the people for easy access at minimal cost so as to enhance the Central Bank of Nigeria policy on cashless economy.

Keywords: Automated Teller Machine, spatial distribution, Calabar Metropolis, cashless economy

INTRODUCTION

At the core of any growing economy is the need to have a stable financial sector. One factor of a stable financial economy is the discouragement in direct cash transactions. This has been achieved by most developed nations where they have moved away from a cash based economy to a cashless one. The paradigm that brought such transformation in the economy of these advanced nations created the need for economic reformation policy in less developed nations such as Nigeria.

In line with global trends, the Central Bank of Nigeria (CBN) introduced a cashless policy to the Nigerian economy in 2011. The aim of the policy is to reduce the volume of physical cash in circulation, thereby encouraging the use of alternative electronic products and channels, such as the automated teller machine (ATM), point-of-service (POS), internet banking, and so on, for financial transactions. The cashless policy of the CBN further stipulates a daily cumulative free cash withdrawal limit of ₦150,000. However, withdrawals above the limits were to be charged as service fee. Similar limits also apply to cash lodgments. Other stipulations of the cashless policy have been discussed by Muyiwa, Tunmibi and Dewole [1].

Cashless policy has been of importance since the advancement of technology; facilitating funds transfer thereby reducing time wasted in banks, help low income earners to make financial transactions across long distances, reducing risk of carrying cash and avoiding bank charges at its lowest. In view of becoming one of the best economies in 2020, the CBN started implementing the cashless policy/banking in some major states/cities in Nigeria such as Lagos, Abuja, Kano, Port-Harcourt. The CBN and other stakeholders have asserted reduction in crime rates, political corruption, banking cost, and improvement on monetary policy on inflation and the overall growth and development of the economy of Nigeria as advantages associated with the implementation of the cashless policy. The implementation of this policies has since been extended to other parts of the country including Calabar.

One avenue of encouraging the cashless economy is through the automated teller machine (ATM). The distribution of the ATM’s is important in achieving the cashless policy. The ATM is an electronic computerized telecommunications device that allows financial institutions (e.g. bank or building society) customers to directly use a secure method of communication to access their bank accounts. ATMs should therefore be cited not only where they are accessible, but where they can be easily located by visitors. They should be placed where they will be little danger, with less congestion as much as possible.
In spite of the much talk about policy on cashless economy by the CBN, it is not clear if the banks are ready for it vis-à-vis the various channels (point of service: POS, ATM, Web, etc.) that are often used to implement the policy. Of particularly interest in this study is the distribution of the ATMs service, since it is the most commonly used and easily accessible of the available channels. It is not also clear if the distribution of the ATM is even, in terms of population distribution in Calabar Metropolis. Moreover the cost in terms of distance, incurred by customers to access an ATM from their residences has not been discussed in the available literature. These constitute the gap of which this study seeks to fill. In this study an attempt is made at analyzing the spatial distribution of automated teller machines (ATMs) in Calabar Metropolis and their accessibility in view of the cashless policy of the CBN.

Many studies have been conducted on location of facilities. However, only a few has been carried out on the location ATM. Munro, Deighton, and Leong [2] in their study on ATM banking and gaming theory found out that the best-located ATMs generate three to seven times more volumes of access than those in less-traveled locations. While volume is not the only criteria for determining productivity, lower volume ATMs in remote location can help meet service requirements or increase market share which is a demonstration of the potential to increase profitability. They therefore submitted that banks can create significant value by improving their lowest performing ATMs.

Alhaffa and Abdual [3] argued that ATMs are critical to the success of any financial institution. The observe that many bank customers list the location of ATMs as one of their most important factor for their choice of a financial institution. Following this reason, they recommended that banks should locate ATMs nearer to their expected customers so as to attract patronage. An alternative spatial model was examined by McAndrews [4] to find out banks’ equilibrium choices of foreign fees and surcharges. The assumption was that customers had random itineraries around a circular city. They experienced random needs for cash and were unaware of the locations of their own bank’s ATMs.

Several studies reveal that there exist relationships between service centres and population density [5]. Eni and Abua [6] also observed that economic activities of an area are influenced by the population and the nature of the environment. Hence, they argued that the higher the population, the more the economic activities in that area. Accordingly, the central place theory [7], which supports the fact that service point could be distributed rationally according to the size, spacing or distance and population to be served applies in this study.

In the light of the above, this study examined the spatial distribution of automated teller machines in Calabar Metropolis in consideration of government policy on cashless economy. Specific objectives of the study included: to map ATM locations with the use of Geographic Information Systems (GIS); to assess the relationship between population density and ATM distribution, and to evaluate the distance in terms of cost, that customers cover to find an ATM.

CONCEPTUAL FRAMEWORK

There was a marked increase in the use of point pattern analysis in the 1950s and early 1960s [8, 9]. However, there a renewed interest in the statistical analysis of point patterns [10]. This is due mainly to developments in geographical information systems (GIS) [11]. Gatrell et al [10] have reviewed many of the GIS tools that have been developed for the analysis of point data. Point pattern analysis have been adopted in several studies including health and epidemiology [10], crime location, locating archaeological sites and landforms [12, 13], urban studies, including location of shops and retail outlets, settlement distribution, and so on [9].

Four kinds of spatial data are identified in literature – points, lines, polygons and surfaces. However, the simplest of the four is point or point patterns [12], though not in terms of analysis. A point pattern basically consist of a set of locations in a demarcated study area at which objects of interest have been recorded [10].

O’Sullivan and Unwin [12] submit that point pattern analysis involves two main activities. Firstly, the description of the patterns made by point event and, secondly, the test whether or not the events are random or concentrated (clustered) within particular location(s). The simplest theoretical model for analysis of point pattern is the complete spatial randomness (CSR). With the CSR, events are distributed independently based on a uniformed probability distribution over the study region. The CSR seeks to answer the question, whether the observed distribution display any systematic spatial pattern or there is a departure from randomness by way of clustering or regularity.

Point pattern analysis are based on two interrelated approaches of ‘point density’ and ‘point interaction’ [10]. These two approaches are also related to two distinct aspects of spatial patterns known as the first-order and second-order effects [12]. First-order effects relate with variations in the intensity of the
process across space. They are estimated as observed spatial density of events, shown as clear variations across space in the occurrence of the event per unit area. Practically, they allow one to make a distinction between high, low and varying intensity. Second-order effects, on the other hand, are due to interactions between locations and are expressed in terms of reduced or increased distances between nearby events. With second-order effects, one can distinguish between regular and clustered patterns.

Furthermore, measurement of variations in the first- and second-order properties in point pattern can be density-based or distance-based. Density-based measures include the use of density maps [14], quadrat analysis [12], Poisson distribution [14] and kernel estimation [15]. Each of these measures have their advantages and disadvantages. Their discussions are beyond the scope of the present paper.

Similarly, distance-based measures include the simple nearest-neighbour distance [14], with its various extensions, including the G and F functions [12]. However, the major shortcoming of the nearest-neighbour distance and its extensions is that of measuring only the nearest neighbour for each event in the pattern [12]. Moreover, with closely clustered points, G increases at short distances, but if points are evenly spaced, G will increase slowly up the range of distances at which most events are spaced before it begins to increase rapidly. The K-function, better known as the Ripley's K-function [15], and the improved K-function known as the L-function [16] provide better alternatives to the nearest neighbour distance. Zhang et al [17] adopted the Ripley's L for the analysis of the spatial distribution of Picea schrenkiana. The Ripley's K-function, is presently the most important technique for the analysis of spatial distribution patterns of populations [17].

METHOD OF STUDY

Study area

This study was carried out in Calabar Metropolis. Calabar is the headquarters of Cross River State, located in the south-south geo-political zone of Nigeria. It has an area of about 604 sq km and a projected population of 454,947 persons as at 2015. Calabar Metropolis lies within Longitudes 8° 20' E and 8° 40' E, and Latitudes 4° 50' N and 5° 05' N (Figs. 1 & 2). It is bounded in the North by Odukpani Local Government Area and in the North-East by the Great Kwa River. Southern shores are bounded by the Atlantic Ocean and on the west by the Calabar River [18-20]. It comprises two local government areas; Calabar Municipality and Calabar South.

Calabar Metropolis is generally acclaimed as one of the leading tourism destinations in Nigeria because of its numerous tourism hotspots within the City. There are several financial institutions in Calabar Metropolis including the Calabar Branch Office of the Central bank of Nigeria, commercial banks, microfinance banks, etc. The banks seem to be located along major routes in the City including Murtala Mohammed Highway, Calabar Road, Mary Slessor Avenue, Eta Agbo Road and Ndidem Usang Iso Road.
Method of data collection

Data for this study were collected from both primary and secondary sources. Primarily, data were collected on geographic locations of ATM stations using the geographic positional system (GPS) and counting the number of ATMs at each station in the study area. Data were also obtained through the use of questionnaire with a minimum sample size of 400 based on Yamene [21] formula for determination of minimum sample size. Secondarily, population data were from the National Population Commission. Esri shape files containing boundaries of the 22 political wards (10 for Calabar Municipality and 12 for Calabar South L. G. A.) in the study were obtained from the Geographical Information Systems Unit, Department of Geography and Environmental Science, University of Calabar, Calabar. Table 1 shows data on population distribution, number of ATMs and proportionate minimum sample size for each ward in Calabar Metropolis.

| Calabar Metropolis | Population by wards* | Proportionate sample** | No of ATMs** | Population Density** |
|--------------------|-----------------------|------------------------|--------------|---------------------|
| Calabar Municipality |                      |                        |              |                     |
| Ward 1             | 62391                 | 55                     | 12           | 0.01292             |
| Ward 2             | 11797                 | 10                     | 14           | 0.00145             |
| Ward 3             | 13867                 | 12                     | 0            | 0.0006              |
| Ward 4             | 15806                 | 14                     | 0            | 0.00082             |
| Ward 5             | 10231                 | 9                      | 6            | 0.00114             |
| Ward 6             | 24634                 | 22                     | 12           | 0.00271             |
| Ward 7             | 10537                 | 9                      | 16           | 0.00294             |
| Ward 8             | 30599                 | 27                     | 4            | 0.00105             |
| Ward 9             | 15222                 | 13                     | 2            | 0.00052             |
| Ward 10            | 14313                 | 13                     | 0            | 0.0015              |
| Calabar South L. G. A. |                  |                        |              |                     |
| Ward 1             | 13530                 | 12                     | 35           | 0.15535             |
| Ward 2             | 17189                 | 15                     | 12           | 0.0774              |
| Ward 3             | 22100                 | 19                     | 0            | 0.12752             |
| Ward 4             | 18416                 | 16                     | 0            | 0.03789             |
| Ward 5             | 18637                 | 16                     | 1            | 0.07085             |
| Ward 6             | 24555                 | 22                     | 6            | 0.21352             |
| Ward 7             | 14733                 | 13                     | 7            | 0.03978             |
| Ward 8             | 11197                 | 10                     | 0            | 0.01138             |
| Ward 9             | 36489                 | 32                     | 3            | 0.0629              |
| Ward 10            | 12278                 | 14                     | 0            | 0.0016              |
| Ward 11            | 20823                 | 18                     | 3            | 0.00017             |
| Ward 12            | 35605                 | 31                     | 2            | 0.00012             |
| Total              | 454947                | 402                    | 134          |                     |

Sources: * National Population Commission, ** Authors’ fieldwork and compilation

Techniques of data analysis

Data obtained in this study were analysed mostly within the GIS. The Splancs package in the R-program, ArcGIS 10.1 and IBM SPSS version 22 served as the major packages for the analysis. In analysing the spatial distribution of ATM points in the study area, both the first- and second-order effects were examined. First-order intensity was examined using density-based measures which included the use of dot-density maps, quadrat analysis and Poisson distribution and kernel estimation. Second-order intensity was examined using the simple nearest-neighbour distance and its various extensions, including the G function and the alternative K-function and L-function.

Three hypotheses were stated for testing in this study. There are:

**Hypothesis 1**

H0: There is no significant difference between the distribution of ATMs and a random distribution in Calabar Metropolis.

H1: There is a significant difference between the distribution of ATMs and a random distribution in Calabar Metropolis.

**Hypothesis 2**

H0: There is no significant relationship between the number of ATMs and population density in Calabar Metropolis.

H1: There is a significant relationship between the number of ATMs and population density in Calabar Metropolis.

**Hypothesis 3**

H0: There is no significant variation in the cost of transportation by bank customers to ATM stations across the various residential districts in Calabar Metropolis.
H1: There is a significant variation in the cost of transportation by bank customers to ATM stations across the various residential districts in Calabar Metropolis.

Hypothesis 1 was tested based on the complete spatial randomness in the data set. This was because, as argued earlier in the paper, the CSR is the simplest theoretical model for spatial point pattern analysis. On the other hand, hypotheses 2 and 3 were tested using the Spearman’s Ranked-Order Correlation and the one-way analysis of variance respectively. The results and discussions are found in the next section.

RESULTS AND DISCUSSION

Table 2 shows data on the location of ATM stations in Calabar Metropolis. It reveals the coordinates of the stations in Eastings and Northings using a projected coordinate system, UTM zone 32 N (Fig. 3).

| S/N | NAME & ADDRESS OF ATMS          | Eastings | Northings | No of ATMS |
|-----|---------------------------------|----------|-----------|------------|
| 1   | Microfinance ATM Unical         | 427096.8 | 547569.6  | 1          |
| 2   | Microfinance ATM Unical Malabor | 427500.0 | 546764.7  | 1          |
| 3   | Diamond Bank ATM CRGIS          | 425405.3 | 549367.6  | 1          |
| 4   | Heritage Bank ATM Highway       | 425405.3 | 549367.6  | 1          |
| 5   | Fidelity Bank ATM Highway       | 425658.1 | 549582.4  | 3          |
| 6   | ECO Bank ATM Highway            | 425704.2 | 549637.6  | 2          |
| 7   | Keystone Bank ATM Highway       | 425716.6 | 549775.7  | 6          |
| 8   | ECO Bank ATM Highway            | 425815.2 | 550233.1  | 1          |
| 9   | Standard Chartered Highway      | 425938.9 | 550306.7  | 1          |
| 10  | WEMA Bank ATM Highway           | 426047.5 | 551022.2  | 4          |
| 11  | Zenith Bank ATM Highway         | 426047.5 | 551022.2  | 4          |
| 12  | Skye Bank ATM                   | 425985.9 | 550988.4  | 2          |
| 13  | Sterling Bank ATM               | 425816.2 | 551086.9  | 4          |
| 14  | First Bank ATM MCC              | 426133.5 | 552380.2  | 4          |
| 15  | UBA ATM In Pyramids Hotel       | 426235.2 | 553957.5  | 2          |
| 16  | GTBank ATM At Axari Hotel        | 426103.0 | 554105.0  | 1          |
| 17  | First Bank ATM 8miles           | 428214.9 | 559736.1  | 2          |
| 18  | Stanbic IBTC ATM Calabar Road   | 424957.2 | 548035.5  | 2          |
| 19  | Skye Bank ATM                   | 424750.9 | 547946.6  | 1          |
| 20  | Union Bank ATM Calabar Road     | 424849.8 | 548296.6  | 3          |
| 21  | First Bank ATM Calabar Road     | 424809.1 | 548321.1  | 8          |
| 22  | UBA ATM 1 Calabar Road          | 424933.1 | 548348.7  | 2          |
| 23  | UBA ATM 2 Calabar Road Opp.     | 424908.5 | 548358.5  | 6          |
| 24  | FCMB ATM Calabar Road           | 424957.7 | 548428.4  | 3          |
| 25  | UBA ATM At E3 Restaurant        | 425013.3 | 548499.0  | 3          |
| 26  | Access Bank ATM Calabar Road    | 425025.7 | 548600.4  | 3          |
| 27  | GTBank ATM                      | 425804.1 | 548538.9  | 3          |
| 28  | Heritage Bank ATM Calabar Road  | 425108.8 | 548603.4  | 1          |
| 29  | Eco Bank ATM Calabar Road       | 425173.2 | 548277.3  | 5          |
| 30  | Access Bank ATM Calabar Road    | 425367.1 | 548157.9  | 2          |
| 31  | Zenith Bank ATM Mary Slessor    | 425561.1 | 548123.8  | 3          |
| 32  | First Bank ATM Marian Road      | 427227.2 | 551205.2  | 7          |
| 33  | Diamond Bank ATM Marian Road    | 427255.2 | 551472.3  | 5          |
| 34  | Unity Bank ATM                  | 426961.3 | 550143.0  | 1          |
| 35  | Stanbic IBTC Bank ATM           | 426843.8 | 549725.5  | 2          |
| 36  | ATM Point At GLO Office         | 426739.4 | 549667.3  | 2          |
| 37  | Eco Bank ATM Etta Agbo          | 426878.8 | 547821.6  | 7          |
| 38  | First Bank ATM Etta Agbo        | 427168.1 | 547511.2  | 2          |
| 39  | Fidelity Bank ATM Etta Agbo Road| 426850.7 | 547453.2  | 5          |
| 40  | Diamond Bank ATM Mayne Avenue/Palm Street | 425362.4 | 546356.5  | 2          |
| 41  | First Bank ATM Mayne Avenue     | 424798.4 | 546233.1  | 5          |
| 42  | Zenith Bank ATM Chamley Street  | 424291.1 | 547179.4  | 2          |
| 43  | First Bank ATM By Ambo Street   | 424025.0 | 545819.3  | 1          |
| 44  | First Bank ATM 56 Mbukpa Street | 424341.8 | 545416.7  | 2          |
| 45  | Union Bank ATM                  | 427137.2 | 547379.2  | 2          |
| 46  | ECO Bank ATM Akim Area          | 427569.4 | 548432.0  | 3          |
| 47  | FCMB ATM                        | 426943.4 | 547680.3  | 3          |
| 48  | Skye Bank ATM                   | 426678.0 | 546712.4  | 2          |
| 49  | First Bank ATM                  | 424327.2 | 546252.0  | 1          |
| 50  | UBA ATM (Ekondo Bank)           | 424836.6 | 547390.0  | 1          |

Source: Authors’ fieldwork (2016)
The approximate time that respondents take to walk from their homes to the nearest ATM location is shown in Table 3. The table reveals that 62.1 per cent of respondents walk more than 30 minutes to get to the nearest ATM point while 23 per cent walk less than 10 minutes to reach the nearest station to their homes.

Table 3: Approximate distance walk to ATM

| Frequency | Percent | Cumulative Percent |
|-----------|---------|--------------------|
| <10min    | 77      | 23.0               |
| 10-20min  | 45      | 13.4               |
| 21-30min  | 5       | 1.5                |
| >30min    | 208     | 62.1               |
| Total     | 335     | 100.0              |

Source: Authors’ fieldwork (2016)

Table 4 shows some of the challenges encountered by users of ATMs in Calabar Metropolis. It reveals that 50.5 per cent of the respondents experienced long queue at ATM locations. 38.3 per cent says it is the problem of insufficient funds while 11.2 per cent complained of ATM being out of order/ non-availability of network for transmission.

Table 4: Challenges faced when using ATM

| Challenge                                | Frequency | Percent | Cumulative Percent |
|------------------------------------------|-----------|---------|--------------------|
| Insufficient ATM stations                | 155       | 38.56   | 38.56              |
| Long queue/time wasting                  | 196       | 48.76   | 87.32              |
| ATMs out of order/no network for transaction | 51       | 12.68   | 100.0              |
| Total                                    | 402       | 100.0   |                     |

Source: Authors’ fieldwork (2016).

Table 5 shows a cross tabulation of the cost customers pay to locate nearest ATM to their residence across Calabar Metropolis. About 19 per cent of respondents do not need to pay for transportation to the nearest ATM station, 61 per cent pay at least ₦50 to get to the nearest station, 16 per cent pay up to ₦100 while less than 4 per cent pay up to ₦150.

Table 5: Transportation cost to ATM

| Challenge                        | Frequency | Percent | Cumulative Percent |
|----------------------------------|-----------|---------|--------------------|
| No payment                       | 65        | 19.07   |                    |
| ₦50 to ₦100                      | 242       | 73.23   | 73.23              |
| ₦100 to ₦150                     | 34        | 10.20   | 83.43              |
| ₦150 to 174                      | 1         | 0.30    | 83.73              |
| Total                            | 338       | 100.0   |                     |
Table 5: Frequency distribution of cost of transportation to locate nearest ATM in Calabar Metropolis

| Cost   | LGA          | Calabar Municipality | Calabar South | Frequency | Percentage |
|--------|--------------|----------------------|---------------|-----------|------------|
| ₦0.00  | 58           | 20                   | 78            |           | 19.40      |
| ₦50.00 | 102          | 143                  | 245           |           | 60.95      |
| ₦100.00| 19           | 47                   | 66            |           | 16.42      |
| ₦150.00| 5            | 8                    | 13            |           | 3.23       |
| Total  | 184          | 218                  | 402           |           |            |

Source: Authors’ fieldwork (2016).

Distribution of ATM

The distribution of point data can be discussed under first-order and second-order effects. The discussion in this section follows this pattern.

First-order effects

In examining in possible variation of ATM point density over the Calabar Metropolis, the dot-density map (Fig. 4) reveals the stations seems to be more in the southern part than in the northern section of the study area. However, this impression is subjective. As Bailey and Gattrell [14] and O’Sullivan and Unwin [12] argue, this impression depends on the cartographic technique involved.

Fig-4: Dot-density map of ATM in Calabar Metropolis

Results of further examination of the first-order effect using quadrat analysis based on a 10 X 10 quadrat is shown in Fig. 5. This result has been summarized as observed frequency in Table 6. Of the total of 100 quadrats, 80 did not have any ATM station, 11 had one ATM station each, 3 had two ATM stations while 1 had three stations. Again, 4 quadrats had four ATM stations each while 1 quadrat had 12 stations.

Fig-5: 10 X 10 quadrat of ATM distribution in Calabar Metropolis
It has been argued [12] that a useful model for predicting the pattern generated by a spatial process is the Poisson distribution, since it represents the distribution of the number of randomly generated points that are found in a given area. The expected frequencies of ATM based on Poisson distribution are also presented in Table 6. Fig. 6 is the modelled frequency distribution.

Table 6: Frequency distribution of ATM in Calabar Metropolis based on a 10 X 10 quadrat

| No. of ATM | No. of quadrats | Observed frequency | P (x) | Expected frequency |
|------------|-----------------|--------------------|-------|--------------------|
| 0          | 80              | 0.5534             | 55.43 |
| 1          | 11              | 0.3271             | 32.71 |
| 2          | 3               | 0.0965             | 9.65  |
| 3          | 1               | 0.0190             | 1.90  |
| 4          | 4               | 0.0028             | 0.28  |
| 5          | 0               | 0.0003             | 0.03  |
| 6          | 0               | 0.0000             | 0.00  |
| 7          | 0               | 0.0000             | 0.00  |
| 8          | 0               | 0.0000             | 0.00  |
| 9          | 0               | 0.0000             | 0.00  |
| 10         | 0               | 0.0000             | 0.00  |
| 11         | 0               | 0.0000             | 0.00  |
| 12         | 1               | 0.0000             | 0.00  |

Source: Authors’ analysis (2016)

Fig-6: Modelled frequency distribution of ATM stations in Calabar Metropolis

The result of the ‘goodness-of-fit’ test of the distribution based on Kolmogorov-Smirnov D test reveals the observed and predicted proportions shown in Table 7. The cumulative proportions are presented in Table 8.

Table 7: The observed and predicted proportion of ATM distribution in Calabar Metropolis

| K | Number of quadrats | Observed proportion | Expected proportion |
|---|--------------------|---------------------|---------------------|
| 0 | 80                 | 0.80                | 0.5534              |
| 1 | 11                 | 0.11                | 0.3271              |
| 2 | 3                  | 0.03                | 0.0965              |
| 3 | 1                  | 0.01                | 0.0190              |
| 4 | 4                  | 0.04                | 0.0028              |
| 5 | 0                  | 0.00                | 0.0003              |
| 6 | 0                  | 0.00                | 0.0000              |
| 7 | 0                  | 0.00                | 0.0000              |
| 8 | 0                  | 0.00                | 0.0000              |
| 9 | 0                  | 0.00                | 0.0000              |
| 10| 0                  | 0.00                | 0.0000              |
| 11| 0                  | 0.00                | 0.0000              |
| 12| 1                  | 0.01                | 0.0000              |

Source: Authors’ statistical analysis (2016)
Table 8: Cumulative proportions

| K | Number of quadrats | Observed proportion | Expected proportion |
|---|------------------|---------------------|---------------------|
| 0 | 0.80             | 0.5543              | 0.2459              |
| 1 | 0.91             | 0.8814              | 0.0286              |
| 2 | 0.94             | 0.9779              | 0.0379              |
| 3 | 0.95             | 0.9969              | 0.0469              |
| 4 | 0.99             | 0.9997              | 0.0097              |
| 5 | 0.99             | 1.000               | 0.01                |
| 6 | 0.99             | 1.000               | 0.01                |
| 7 | 0.99             | 1.000               | 0.01                |
| 8 | 0.99             | 1.000               | 0.01                |
| 9 | 0.99             | 1.000               | 0.01                |
| 10| 0.99             | 1.000               | 0.01                |
| 11| 0.99             | 1.000               | 0.01                |
| 12| 1.00             | 1.000               | 0.00                |

Source: Authors’ statistical analysis (2016)

In testing hypothesis 1, Table 8 reveals that Max D = 0.2459. At the 0.05 significance level,

\[
\text{Critical D} = \frac{1.36}{\sqrt{N}} = \frac{1.36}{10} = 0.136
\]

Since Max. D of 0.2459 > critical D of 0.136, Ho was rejected.

Hence, the distribution of ATM in Calabar Metropolis is not random. There is therefore a pattern in the distribution of ATM in Calabar Metropolis.

**Second-order effects**

Investigation of second order effects was carried out to determine if locations of ATM form local clusters and, if so, how tightly packed the clusters are. The graph of the nearest-neighbour cumulative empirical probability distribution function G(w),is shown in 8. The nearest neighbour function allows one to model the interdependency between ATM points.

In the present study, it can be observed that the graph in Fig. 8 climbs very steeply between the distance of 0 and about 250m. This is an indication of clustering. Between 250 and 300m, the line on the graph slows down briefly before climbing fast again at a distance of about 300m until at about 700m where it begins to remain relatively stable over the remaining distance in the study area. The implication is that there are more ATM locations that are nearer to each other than those that are afar off. But the nearest-neighbour analysis has a disadvantage that they only measure the nearest neighbour for each event in the pattern [12].

The K-function and the L-function were used to overcome the disadvantage of the G-function. A comparison of the K-function with the CSR model revealed that at a distance of about 50m, the K-function deviate from the CSR.
Relationship between ATM locations and population density

Table 9 shows the result of the Spearman’s Ranked-order correlation analysis (rho) between number of ATM and population density of wards in Calabar Metropolis.

![Fig-9: K-function graph (black) for ATM distribution with the estimated CSR model (red)](http://saspjournals.com/sjebm)

![Fig-10: L-function for ATM distribution with CSR model at 99 simulations](http://saspjournals.com/sjebm)

Table 9: Results of Correlation analysis

|                  | Number of ATM per ward | Population density per ward |
|------------------|------------------------|-----------------------------|
| Spearman’s rho   |                        |                             |
| Number of ATM per ward | Correlation Coefficient | 1.000                       |
|                   | Sig. (2-tailed)         | .197                        |
|                   | N                      | 22                          |
| Population density per ward | Correlation Coefficient | .197                        |
|                   | Sig. (2-tailed)         | .379                        |
|                   | N                      | 22                          |

Source: Authors’ statistical analysis (2016)

From Table 9, the result, rho = 0.197, indicates that there is a weak positive relationship between number of ATM and population density in Calabar Metropolis. In testing hypothesis 2, the result is however not significant, since p = 0.379 which is > 0.05. The null hypothesis was therefore retained. The implication is that the available ATM stations are not commensurate with the population in the study area.

Variations in cost of transportation to ATM locations in Calabar Metropolis

The results of the one-way analysis of variance are presented in Tables 10 -12. From the results in Table 10, it was observed that there is a significant variation (since F = (d.f. = 1, 400) = 27.472, p < 0.05) in the cost of transportation to the nearest ATM location across the 22 Wards in Calabar Metropolis. Hence, we do not have enough evidence to retain hypothesis 3.

Table 10: Results of ANOVA

|                  | Sum of Squares | df | Mean Square | F     | Sig. |
|------------------|----------------|----|-------------|-------|------|
| Between Groups   | 31411.853      | 1  | 31411.853   | 27.472| .000 |
| Within Groups    | 457369.241     | 400| 1143.423    |       |      |
| Total            | 488781.095     | 401|             |       |      |

Source: Authors’ statistical analysis (2016)
From the result in Table 11, it is observed that people generally pay more to be able to assess ATMs in Calabar South Local Government Area ($x = 59.86$) than in Calabar Municipality ($X = 42.12$). However, there is the need to locate more ATMs in Calabar Metropolis to alleviate the cost burden on the people. Moreover, certain wards would require more ATM locations than others if the cost of transportation must be minimized. For instance, more ATMs would be needed in Ward 3, 4, 9 and 10 with a mean transport cost of in excess of N50.00 for one part of the movement. (Table 12). For Calabar South Local Government Area, except for Wards 5, 6 and 7, residents in every other Wards pay in excess of N50.00 to be able to access the nearest ATM. Hence, the need to increase the number of ATM locations in these areas. Fig. 11 shows the mean cost plots for all the wards while Fig 12 shows variations in the number of ATM across the wards in Calabar metropolis.

### Table 11: Descriptive statistics on cost of transportation across the two LGA’s in Calabar Metropolis

|               | N  | Mean  | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | Minimum | Maximum |
|---------------|----|-------|----------------|------------|---------------------------------|---------|---------|
| Calabar Municipality | 184 | 42.1196 | 35.53443 | 2.61963 | 36.9510 to 47.2881 | .00 | 150.00 |
| Calabar South | 218 | 59.8624 | 32.29300 | 2.18716 | 55.5516 to 64.1732 | .00 | 150.00 |
| Total | 402 | 51.7413 | 34.91283 | 1.74129 | 48.3181 to 55.1645 | .00 | 150.00 |

Source: Authors’ statistical analysis (2016)

### Table 12: Descriptive statistics on cost of transportation across the 22 ward in Calabar Metropolis

|               | N  | Mean  | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | Minimum | Maximum |
|---------------|----|-------|----------------|------------|---------------------------------|---------|---------|
| Cal Mun 1 | 55 | 20.9091 | 24.89033 | 3.35621 | 14.1803 to 27.6379 | .00 | 50.00 |
| Cal Mun 2 | 10 | 25.0000 | 26.35231 | 8.33333 | 16.0845 to 34.9156 | .00 | 50.00 |
| Cal Mun 3 | 12 | 58.3333 | 55.73204 | 8.18716 | 40.1365 to 76.5291 | .00 | 150.00 |
| Cal Mun 4 | 14 | 85.7143 | 30.56249 | 6.18716 | 68.0680 to 103.3605 | 50.00 | 150.00 |
| Cal Mun 5 | 9 | 38.8889 | 22.04793 | 7.34931 | 22.9414 to 54.8364 | .00 | 50.00 |
| Cal Mun 6 | 22 | 27.2727 | 25.48236 | 5.43286 | 15.9745 to 38.5710 | .00 | 50.00 |
| Cal Mun 7 | 9 | 44.4444 | 16.66667 | 5.55556 | 31.6333 to 57.2556 | .00 | 50.00 |
| Cal S 8 | 27 | 46.2963 | 23.72084 | 4.56508 | 36.9126 to 55.6799 | .00 | 100.00 |
| Cal Mun 8 | 13 | 57.6923 | 18.77669 | 5.20772 | 46.3457 to 69.0389 | 50.00 | 100.00 |
| Cal Mun 10 | 13 | 84.6154 | 37.55338 | 10.41543 | 61.9221 to 107.3087 | 50.00 | 150.00 |
| Cal S 1 | 12 | 54.1667 | 14.43376 | 4.16667 | 44.9959 to 63.3374 | 50.00 | 100.00 |
| Cal S 2 | 15 | 53.3333 | 22.88689 | 5.90937 | 40.6590 to 66.0077 | .00 | 100.00 |
| Cal S 3 | 19 | 86.8421 | 36.67464 | 8.41374 | 69.1655 to 104.5187 | 50.00 | 150.00 |
| Cal S 4 | 16 | 78.1250 | 31.45764 | 7.86441 | 61.3624 to 94.8876 | 50.00 | 150.00 |
| Cal S 5 | 16 | 50.0000 | 36.51484 | 9.12871 | 30.5426 to 69.4574 | .00 | 100.00 |
| Cal S 6 | 22 | 38.6364 | 21.44660 | 4.57243 | 29.1275 to 48.1453 | .00 | 50.00 |
| Cal S 7 | 13 | 38.4615 | 21.92645 | 6.08130 | 25.2115 to 51.7116 | .00 | 50.00 |
| Cal S 8 | 10 | 75.0000 | 35.35534 | 11.18034 | 49.7083 to 100.2917 | 50.00 | 150.00 |
| Cal S 9 | 32 | 51.5625 | 29.74183 | 5.25766 | 40.8394 to 62.2856 | .00 | 100.00 |
| Cal S 10 | 14 | 78.5714 | 46.88072 | 12.52940 | 51.5033 to 105.6396 | .00 | 150.00 |
| Cal S 11 | 18 | 66.6667 | 29.70443 | 7.00410 | 51.8950 to 81.4383 | .00 | 100.00 |
| Cal S 12 | 31 | 59.6774 | 20.08048 | 3.60656 | 52.3118 to 67.0430 | 50.00 | 100.00 |
| Total | 402 | 51.7413 | 34.91283 | 1.74129 | 48.3181 to 55.1645 | .00 | 150.00 |

Source: Authors’ statistical analysis (2016)
CONCLUSIONS
From the above results and discussions, it was concluded that ATM locations in Calabar Metropolis is significantly clustered, with some areas being overserved while other are underserved. This clustering, however, may be as a result of the clustering of bank locations themselves. Many banks would not want to locate their ATMs outside their banking premises for security reasons.

Also, there is no significant relationship between number of ATMs and population density in Calabar Metropolis. Again, significant variations exist in the cost of transportation from residence of ATM users to the nearest ATM location. In some cases, ATM users pay up to ₦150.00 to get to the nearest ATM station. This is not economical. Furthermore, ATM users experience a lot of challenges, ranging from insufficient ATM stations to long queue at ATM locations and poor network connections at ATM stations.

While the cashless policy of the CBN has come to stay, it is recommended that banks should
endeavour to make ATMs available to their customers, especially at the locations (wards) identified in this study. This would ease the problems faced by users, particularly transportation cost and time wastage at ATM locations.

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