# Evaluation of Crime Rate in Delta State: a Time Series Approach

Ideh, C. [1], Aronu, C. O.[2], and Bilesanmi A. O. [3]

[1, 2]Department of Statistics, Chukwuemeka Odumegwu Ojukwu University, Anambra State, Email: amaro4baya@yahoo.com
[3] Department of General Studies, Petroleum Training Institute, Effurum-Delta State, Nigeria

## ABSTRACT

*This study evaluates the crime rate in Delta State Nigeria from 2007 to 2016. The objective of this study is to ascertain the best model for estimating the trend of total crime, to test whether crime across the various zones in Delta State is the same and to determine the most committed crime in Delta State. The statistical tool used in this study were the trend analysis, Kwiatkowski-Phillips-Schmidt-Shin Test Statistic, measures of model Accuracy and Kruskal-Wallis test. The findings of the study showed that the Quadratic model was adequate for estimating total crime trend in Delta State. It was found that total crime has an creasing Quadratic trend across the observed period. The series was found to be stationary and the four years forecast revealed a decreasing crime trend from 2017 to 2020. It was found that crime across the zones were not statistically significant. Also, findings showed that stealing is one of the most committed crime in Asaba which this validates the alarming rate of poverty and hunger in the state and Nigeria in general.*

*Keywords: Crime Trend, Kidnapping, Quadratic Model, Stealing, Stationarity*

## 1.0 Introduction

The perception of the term crime varied greatly across geographical areas, socio-cultural and economic differences of societies as well as time lag. This kind of variations makes it difficult to universally define crime across regions of the world. What may be regarded as a crime in one region may not be a crime in another and changes over time. For instant, prostitution and homosexuality are crimes in many regions especially where religion dictates, while in many others, they are acts of promotion. A few decades ago, dumping toxic waste has not been classified as a crime but presently it is a serious crime and violation of laws in country like Nigeria (Ghani, 2017).

Crime analysis is an investigative tool, defined as the set of systematic, analytical processes that provide timely, pertinent information about crime patterns and crime-trend correlations. It uses crime data and police reports to study crime problems, including the characteristics of crime scenes, offenders and victims. Crime patterns are analyzed in terms of their socio-demographic, temporal and spatial qualities, and may be represented visually using graphs, tables and maps. (Richard and Lorraine, 2011).

The basic goal of crime analysis is to identify and produce the information required for making relevant decisions in distributing an appropriate quantity of resources to mitigate and control crimes. In addition, crime analysis can be used to appraise the effectiveness of crime prevention programmes, develop strategies

through research and help determine or define a problem (Canter, 2000).

Crime analysis can also inform policy and decision makers about the existing or anticipated consequences of interventions, polices, or working procedures (Boba, 2001). Therefore, crime analysis aims at identifying patterns and trends of a crime while the former aims at examining the association and identification of criminals with any criminal activity.

Nigeria is currently caught in the web of crime, manifesting in the upsurge of both violent and non-violent crimes. Most notable are the rising incidents of stealing, armed robbery, assassination and ransom-driven kidnapping, which are now ravaging the polity and spreading fears and anxieties about public safety. The objective of this study is to ascertain the best model for estimating the trend of total crime, to test whether crime across the various zones in Delta State is the same and to determine the most committed crime in Delta State.

## 2.0 Literature Review

Habibullah *et al.* (2013) defined crime as violation of 'property rights' where the focus was prioritized on crime against property. This will not give a comprehensive understanding on crime. Tretter (2013) posits that crimes can be established in corruption, rape, terrorist criminal activities, kidnapping, human trafficking, assault, vagrancy and failure to pay public tax, utility bills or transport, drugs and narcotics abuse, wanton environmental destruction and unauthorized dumping of toxic substances. On socio-cultural ethical perspectives, crime is viewed as violation of societal norms and values.

Tenibiaje (2010) sees crime as a 'deviant behaviour that violates prevailing norms, which may be cultural, social, political, psychological and economic conditions'. Usman *et al.*, (2012), described crime as a deviant act that is threatening moral behaviors and injurious to society. Moral decadence afflicts the personality of individual, his property and lessens trust among members of the society which may result to threat and fear.

Ojiako *et al.,* (2016) modelled crime patterns in Anaocha L.G.A, Anambra state using GIS approach. Methodology adopted included the acquisition of GPS coordinates of crime locations, attribute data and analogue map of Anaocha L.G.A which was scanned and digitized amongst others. The GPS coordinates of the crime locations were imported into ArcGIS environment and a database was designed. The results showed that about 96.5% crimes in the area were committed by males, about 30.7% crimes resulted in more than one casualty, 18 out of 88 crimes were shoplifting, out of 88 crimes there were just two cases of kidnapping. The result of the research paper serves as a decision support system in managing crime within Anaocha L.G.A of Anambra State, Security agencies like Vigilantes should complement the efforts of the police in checking crimes especially in areas with no police posts or police station amongst other recommendations. Ahmed (2012) examined the pattern of crime distribution in Osun State Nigeria, over a period of fifteen years (1985-2000).The study focuses attention on criminal activities as affecting the live ability of residents of urban centers in the state. The investigation was carried out using ten selected local government areas that are notorious as black-spots crime area in the State. Five hundred Household-heads were administered questionnaires to solicit for

information on type of crimes commonly perpetrated in their neighborhoods as well as these crimes' causes, impacts, and coping mechanisms that sustained them. Factor analysis and Multiple regression statistical methods were used to reduce bulky data collected from primary and secondary sources into manageable standard. Relationship between variables as means of rewriting the data to show differential patterns was established. Results indicated that most residents in the area of study exhibited a significant higher-level of fears, but still want to remain in their cultural homes. Suggestions were put forward on policy measures that can sustain future planning of urban centers in the state to conform to modern city of the world. Yelwa and Bello (2012) complemented Geographical Information System (GIS) with multivariate cluster analysis in assessing property crime in the LGAs of Katsina State, Nigeria. The cluster analysis has combined all the crimes at a time for analysis. Katsina and Funtua LGAs have the higher concentrations of all the property crimes in the state, while the Local Government Areas with the lower concentrations of the property crimes are Ingawa, Musawa, Kaita, Dutsi, Kurfi, Kafur, Kankara, Sandamu, Jibia, Mani, Safana, Sabuwa, Kankia and Matazu LGAs. Also robbery was found to be relatively higher in Bakori, Mslumfashi and Danmusa LGA. Theft and stealing are prevalent in Dutsinma, Faskari, Baure and Daura LGAs. The study concluded that although, the techniques of GIS and cluster analysis are different, the latter has complemented the former in analyzing property crime in Katsina State. Oyinloye *et al.,* (2017) utilized the Geographic Information System technology to access the spatial distribution of crime in selected communities in Akure and also examined the characteristics of respondents in the

study area through the administration of a structured questionnaire to 250 respondents that constitute 1.1% of the total population in the selected communities due to homogenous characteristics. Empirical analysis shows that over 60% are not employed by government while the average monthly income is less than N18,000.00. GIS analysis shows that theft and battery are the major crimes and these are mostly concentrated in areas with poor building conditions.

Olajuyigbe *et al.,* (2015) investigated the level and spatial analysis of crime occurrence in Akure, Nigeria with a view to promoting security in the city. The responses were obtained from administered copies of the questionnaire. The crime data were analyzed using spatial analysis technique in ArcGIS 10, Global Mapper 13 and CrimeStat III. Overlays operations were carried out to evolve crime maps. The study found that the main road network that traverses Akure Metropolis, provides easy access and exit to criminals, and constitutes a dominant axis of crime events as facilities located along the road usually experience armed robbery attack or burglary. Again, crime hotspots are more prevalent in the city core. In view of the efficacy of GIS technique as a tool for detecting crime pattern, occurrence and prediction, the study advocates the development of all inclusive crime database system and training of security agents in the use of information technology to improve intelligence gathering capabilities in a bid to combat crimes in Akure metropolis in particular and Nigeria in general.

Osuji, *et al* (2015) determined variables that are crime prone in Southeastern Nigeria over a 10 year study period using Principal Component Analysis (PCA)

which is a Multivariate Statistical Technique that is use to reduce the dimensionality of a large number of interrelated crime variables while retaining as much of the information as possible. Data were collected on seven crime variables, from the data bank of National Bureau of Statistics (NBS). Moderate correlations were found to exist between sizeable number of crimes, two principal components was extracted using the screeplot, explaining 86.4% of the total variation in the dataset. The highest and most committed crime in the study region are Armed Robbery, Murder and Grievous Harm and Wounding. Balogun *et al* (2014) examined crime situation in Benin metropolis using questionnaire to elicit information from the public and the police. Their result shows that crime was on the rise and that the police are handicapped in managing it because of the obsolete methods and resources at their disposal. It also reveals that members of the public have no confidence in the police force as 80% do not report cases for fear of exposure of the informant to the criminal. In the light of these situations, the second part of the paper looked at the possibility of utilizing GIS for effective management of crime in Nigeria. This option was explored by showing the procedural method of creating 1) digital land use map showing the crime locations, 2) crime geo-spatial database, and 3) spatial analysis such as query and buffering using ILWIS and ArcGIS software and GPS. The result of buffering analysis shows crime hotspots, areas deficient in security outfit, areas of overlap and areas requiring constant police patrol. The study proved that GIS can give a better synoptic perspective to crime study, analysis, mapping, proactive decision making and prevention of crime. It however suggests that migrating from traditional method of crime management to GIS demands capacity building in the area of personnel, laboratory and facilities backed up with policy statement. Olajuyigbe *et al* (2016) focused on the application of Geographic Information Systems (GIS) as a tool for mapping out the area liable to crime in the core area of Akure, Nigeria. The study employs the use of secondary data from literatures, journals and crime incidence reports gotten from internet, archives and Nigeria Police Force (NPF) respectively. Both spatial and statistical analyses were carried out using the appropriate tools such as Neighborhood and Correlation Analysis, respectively. The study revealed that the transport route cutting through Akure metropolis is prone to crime activity. Finally, the study recommends that police officials should be trained on how to use GIS to fight crime.

## 3.0 Materials and Method

### 3.1 Nature and Source of data

The data is of secondary source. It was obtained from the crime records of the Nigerian Police Force Divisions in Asaba as well as police headquarters. The data set contains all reported crimes cases from the various zones in Asaba metropolis.

### 3.2 Area of Study

The area of study is Asaba the state capital of Delta State of Nigeria. Asaba is strategically located on the hill at the western edge of the River Niger. Delta State as one of the major oil producing states in Nigeria makes it an attraction of interest for employers and employees, and as such a hub for various tourist attraction, civil servants and known for its age long peace and tranquility thus making it a point of attraction for criminals.

### 3.3 Method of data analysis

### 3.3.1 Time Series Analysis

The study employed times series analysis. The analysis fitted the times series trend which was used in forecasting. The trend describes the long term general direction in which the graph of a time series appears to follow.

Here three trend models were compared in other to determine the best model in fitting the trend of crime in the study area.

1. **Linear model:**

   The linear model is given as:

   $$\hat{Y}_t = \hat{\alpha} + \hat{b}t \tag{1}$$

   Where: $\hat{Y}_t$ is estimate of the value of the trend for a given time period

   $$\hat{\alpha} = \frac{\sum y \sum t^2 - \sum t \sum ty}{n \sum t^2 - (\sum t)^2} \tag{2}$$

   is the intercept of the trend line on Y-axis

   $$\hat{b} = \frac{n \sum ty - \sum t \sum y}{n \sum t^2 - (\sum t)^2} \tag{3}$$

   is change in $Y_t$ per unit of time.

   t is the unit of time.

2. **Quadratic Model**

   The linear model is given as:

   $$\hat{Y}_t = \hat{\alpha} + \hat{b}_1 t + \hat{b}_2 t^2 \tag{4}$$

3. **Exponential Model**

The exponential model is also given as:

$$\hat{Y}_t = \hat{\alpha}\hat{b} \tag{5}$$

### 3.3.2 Measure of Accuracy in Trend Analysis

The comparison of the three models: linear, exponential and quadratic was assessed using the three accuracy measures found in Minitab output. The model with the least MAPE, MAD, and MSD becomes the best model. The accuracy measures are defined below.

(i)  **Mean Absolute Percentage Error (MAPE):** the mean absolute percentage error

   (MAPE), also known as mean absolute percentage deviation (MAPD), is a measure of prediction accuracy of a forecasting method in statistics, for example in trend estimation. It usually expresses accuracy as a percentage, and is defined by the formula:

**International Journal of Research**

Available at https://pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 22
November 2018

$$MAPE = \frac{100}{N} \sum_{i=1}^{N} \left| \frac{Y_t - \hat{Y}_t}{Y_t} \right| \qquad (6)$$

Where: $Y_t$ is the actual time series data

$\hat{Y}_t$ is the estimated value of time series

### (ii) Mean Absolute Deviation (MAD)

MAD The mean absolute deviation of a dataset is the average distance between each data point and the mean. It gives an idea about the variability in a dataset. The formula is given as:

$$MAD = \sum_{i=1}^{N} \left| \frac{\hat{Y}_t - \bar{\bar{Y}}}{n} \right| | \qquad (7)$$

$\hat{Y}_t$ is estimate of trend value at time t and

$\bar{\bar{Y}}$ is the mean of estimated values

### (iii)Mean Square Deviation (MSD).
The MSD is known as variance. The variance of the estimated is given as:

$$MSD = \sum_{i=1}^{N} \left( \frac{\hat{Y}_t - \bar{\bar{Y}}}{n} \right) \qquad (8)$$

The model with the least accuracy measure value gives the best model.

Other statistical tools used in this study were the Kruskal-Wallsi test and Descriptive Analysis.

### 3.4 Data Presentation
Table 1 presents the distribution of crime by type and year as sourced from the various police stations in the zones.

**Table 1: Distribution of Incidence of Crime by type and year**

| YEAR | Armed Robbery | Assault | Stealing | Kidnapping | Malicious Damage | Murder | Rape | Others | Total |
|------|------|------|------|------|------|------|------|------|------|
| 2007 | 78 | 837 | 863 | 0 | 170 | 8 | 45 | 49 | 2050 |
| 2008 | 80 | 767 | 1281 | 0 | 174 | 5 | 59 | 44 | 2410 |
| 2009 | 94 | 240 | 3747 | 5 | 104 | 7 | 44 | 142 | 4383 |
| 2010 | 86 | 207 | 2601 | 4 | 76 | 4 | 28 | 151 | 3157 |
| 2011 | 133 | 2280 | 3428 | 0 | 270 | 18 | 55 | 252 | 6435 |
| 2012 | 140 | 2510 | 2903 | 0 | 256 | 8 | 74 | 191 | 6080 |

| 2013 | 110 | 2226 | 1975 | 0 | 183 | 13 | 73 | 88 | 4665 |
|------|-----|------|------|---|-----|----|----|-----|------|
| 2014 | 123 | 1213 | 1529 | 0 | 256 | 7 | 79 | 61 | 3268 |
| 2015 | 139 | 681 | 3622 | 5 | 207 | 11 | 79 | 137 | 4881 |
| 2016 | 126 | 314 | 4649 | 4 | 135 | 4 | 38 | 211 | 5480 |
| TOTAL | 1109 | 11275 | 26598 | 18 | 1831 | 85 | 574 | 1326 | 42809 |
| Mean | 110.9 | 1127.5 | 2659.8 | 1.8 | 183.1 | 8.5 | 57.4 | 13.26 | 4280.9 |

Source: Nigerian Police Station's crime records, Asaba, Delta State, Nigeria, 2016

**Table 2: Distribution of Incidence of Crime by Zone in Delta State**

| YEAR | ZONE A | ZONE B | ZONE C | ZONE D | TOTAL |
|------|--------|--------|--------|--------|-------|
| 2007 | 544 | 515 | 474 | 517 | 2050 |
| 2008 | 660 | 640 | 584 | 526 | 2410 |
| 2009 | 1201 | 1167 | 934 | 1081 | 4383 |
| 2010 | 918 | 854 | 649 | 736 | 3157 |
| 2011 | 1471 | 1291 | 1951 | 1722 | 6435 |
| 2012 | 1635 | 1632 | 1328 | 1485 | 6080 |
| 2013 | 725 | 687 | 1562 | 1691 | 4665 |
| 2014 | 880 | 853 | 759 | 776 | 3268 |
| 2015 | 1601 | 1556 | 935 | 789 | 4881 |
| 2016 | 1224 | 1139 | 1495 | 1622 | 5480 |
| TOTAL | 10859 | 10334 | 10671 | 10945 | 42809 |
| MEAN | 1517.5 | 1400.4 | 1369.6 | 1421 | 4280.9 |

Source: Nigerian Police Station's crime records, Asaba, Delta State, Nigeria, 2016.

## 4.0 Data Analysis and Result

### 4.1 Data Analysis

Figure 1 shows the distribution of total crime in from 2007 to 2016 in Delta State, Nigeria. The result shows a steeply increasing trend of the total number of crime across the years.
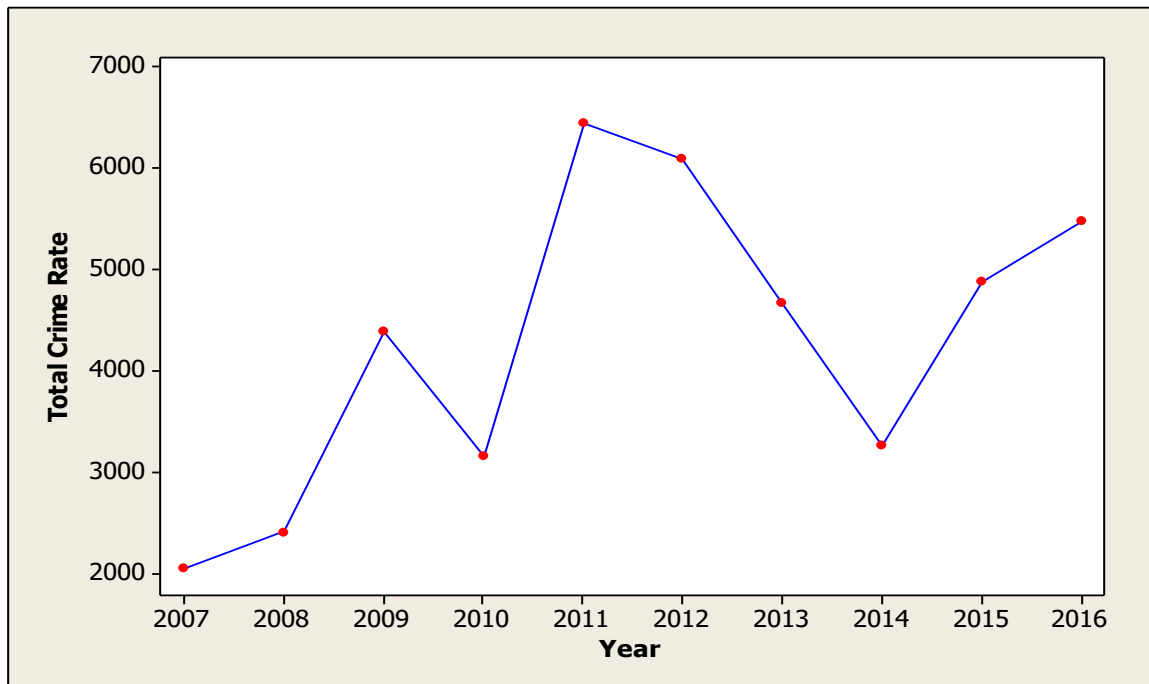
Figure 1: Time Series Plot of Annual Crime Rate in Delta State from 2007 - 2016

## Table 3: Comparison of Trend Equation for total Crime Rate in Delta State

| Name of Model | Model | MAPE | MAD | MSD |
|---|---|---|---|---|
| Linear | $Y_t = 2722 + 283*t$ | 25 | 953 | 1397309 |
| Quadratic | $Y_t = 938 + 1176*t - 81.1*t**2$ | 21 | 844 | 1049883 |
| Exponential Growth | $Y_t = 2566.01 * (1.0848**t)$ | 24 | 988 | 1560901 |

The findings of the trend analysis of total crime rate showed that the Quadratic model is adequate for estimating total crime rate in Delta State. This is because the Quadratic model recorded the least measure of accuracy with MAPE value of 21, MAD value of 844 and MSD value of 1049883.
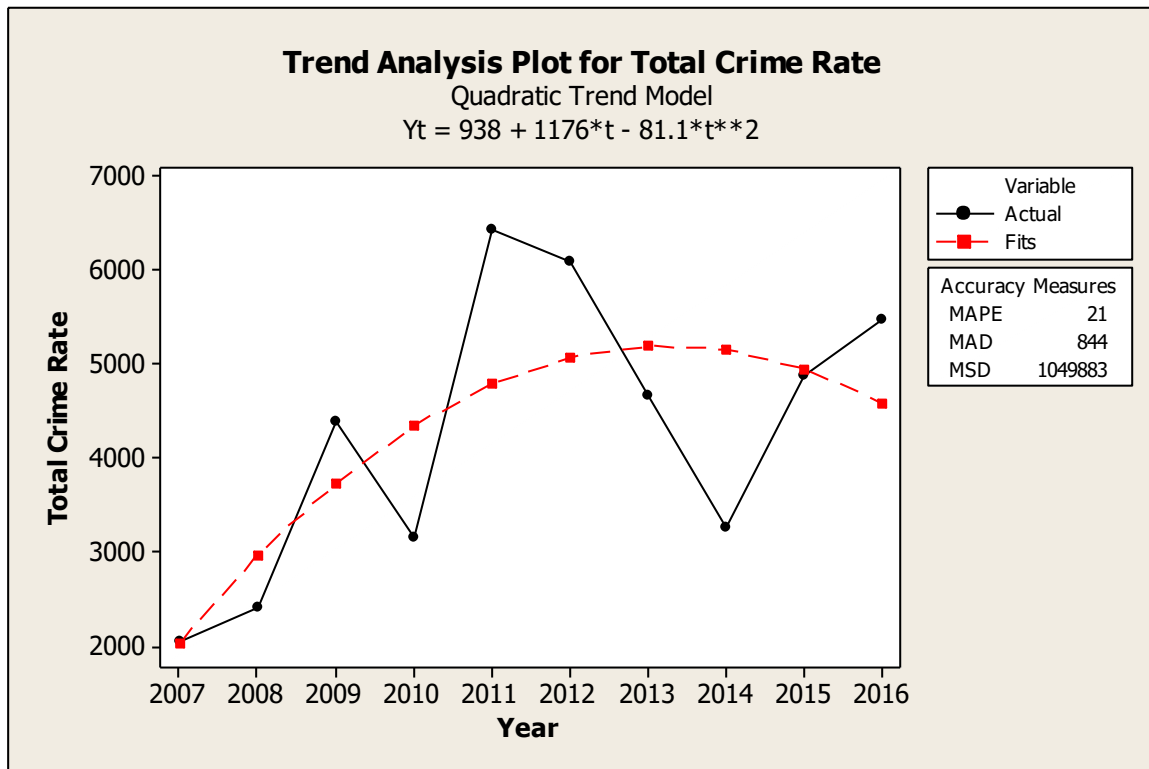
Figure 2: Quadratic Trend Plot of total Crime Rate in Delta State from 2007 - 2016

The result of the Quadratic trend model was displayed in figure 2 and it was revealed that total crime has a decreasing trend from year 2015.

## Table 4: Summary of Actual, Fitted Trend and Residual of total Crime Rate in Delta State

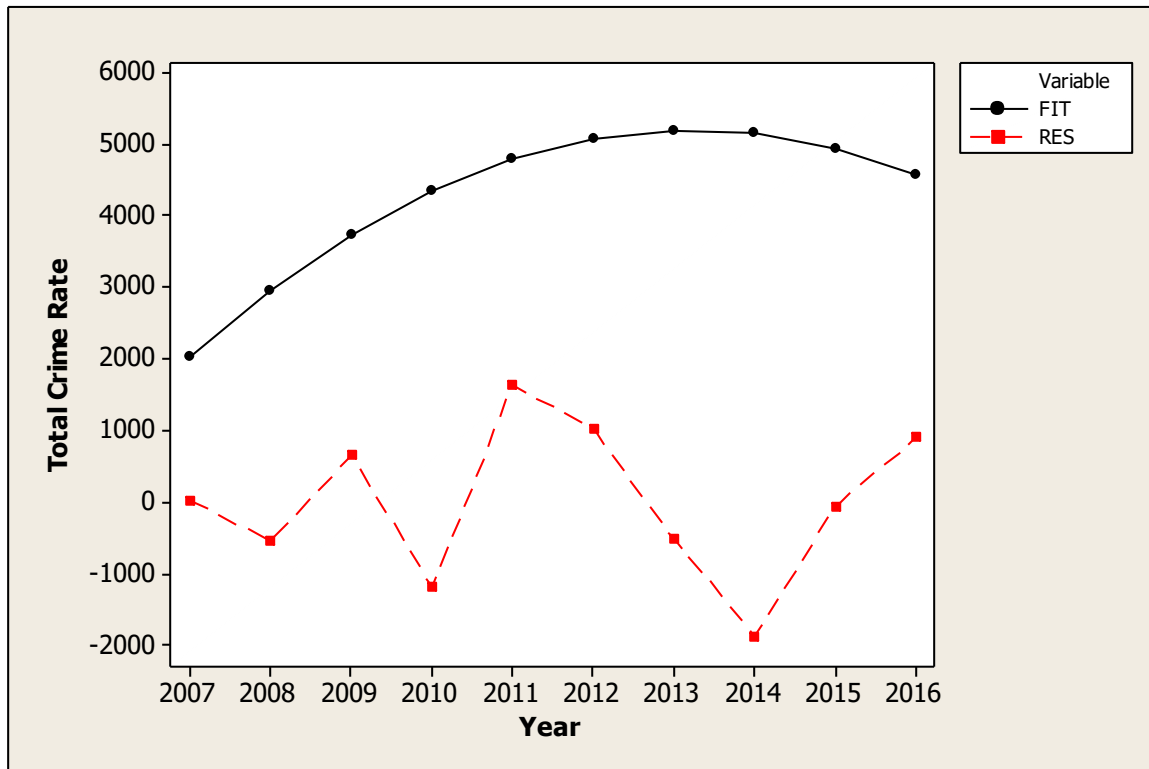| YEAR | Total Crime Rate | Fit | Residual |
|---|---|---|---|
| 2007 | 2050 | 2032.191 | 17.80909 |
| 2008 | 2410 | 2964.53 | -554.53 |
| 2009 | 4383 | 3734.635 | 648.3652 |
| 2010 | 3157 | 4342.505 | -1185.5 |
| 2011 | 6435 | 4788.139 | 1646.861 |
| 2012 | 6080 | 5071.539 | 1008.461 |
| 2013 | 4665 | 5192.705 | -527.705 |
| 2014 | 3268 | 5151.635 | -1883.63 |
| 2015 | 4881 | 4948.33 | -67.3303 |
| 2016 | 5480 | 4582.791 | 897.2091 |

Figure 3: Quadratic Trend Plot of total Crime Rate and Residual in Delta State from 2007 - 2016

The result of the Quadratic trend model displayed in table 4 and figure 3 validates the choice of the Quadratic model in estimating the trend since the residual is minimal across the years.

**Table 5: Test of Stationarity of the series using the Kwiatkowski-Phillips-Schmidt-Shin Test Statistic for total Crime Rate in Delta State**

| Null Hypothesis: Annual Crime Rate is stationary | | | | |
|---|---|---|---|---|
| Exogenous: Constant | | | | |
| Bandwidth: 0 (Newey-West automatic) using Bartlett kernel | | | | |
| | | | | |
| | | | | LM-Stat. |
| | | | | |
| Kwiatkowski-Phillips-Schmidt-Shin test statistic | | | | 0.386092 |
| Asymptotic critical values*: | | 1% level | | 0.739000 |
| | | 5% level | | 0.463000 |
| | | 10% level | | 0.347000 |
| | | | | |

**International Journal of Research**

Available at https://pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 22
November 2018

| *Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1) | | | | |
|---|---|---|---|---|
| | | | | |
| Residual variance (no correction) | | | | 2059912. |
| HAC corrected variance (Bartlett kernel) | | | | 2059912. |
| | | | | |
| | | | | |

The result of the stationarity analysis presented in table 5 found a test value of 0.3861 which falls on the acceptance region of the hypothesis. This result implies that the series is stationary and can be used to make future forecast of the series.

## Table 6: Result of Four Years Forecast of Future total Crime in Delta State

| Period | Forecast |
|---|---|
| 2017 | 4055 |
| 2018 | 3365 |
| 2019 | 2513 |
| 2020 | 1498 |

**International Journal of Research**

Available at https://pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
p-ISSN: 2348-795X
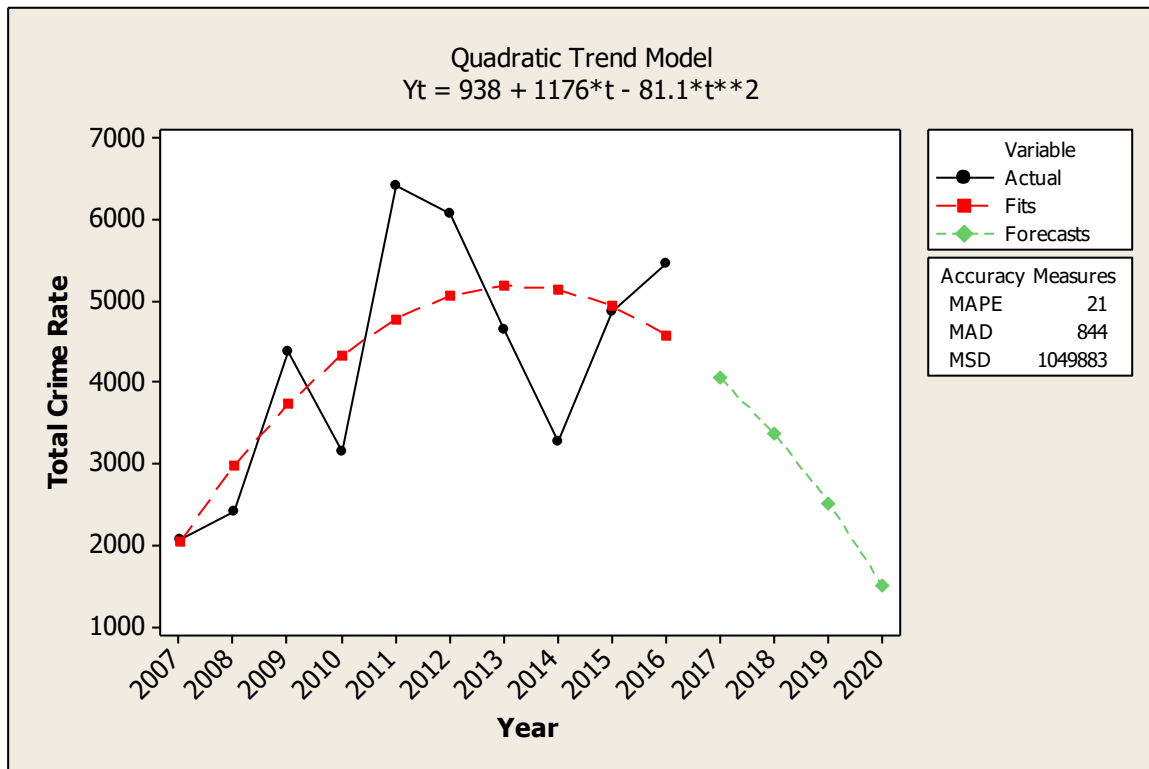Volume 05 Issue 22
November 2018

**Figure 4: Graph of Total Crime Rate and Four Years Forecast**

The result obtained in table 6 and figure 4 revealed a decreasing trend of total crime in Delta State. It was found that all things being equal, the total crime in Delta State as at Year 2020 will be about 1498 cases.

The Kruskal-Wallis test statistic was used to test whether crimes across the five zones in Delta State are the same.

**Table 7: Kruskal-Wallis Test: Crime Rate versus Zones**

| Zones | N | Median | Average Rank | Z |
|-------|-----|--------|--------------|-------|
| A | 10 | 1059.5 | 26.2 | 0.17 |
| B | 10 | 996.5 | 24.1 | -0.34 |
| C | 10 | 934.5 | 24.8 | -0.17 |
| D | 10 | 935.0 | 26.2 | 0.17 |
| E | 10 | 935.0 | 26.2 | 0.17 |

**International Journal of Research**

Available at https://pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 22
November 2018

| Overall | 50 | 25.5 | | |
|---------|----|----|--|--|

H = 0.18  DF = 4  P = 0.996

The result obtained in table 7 found a test value of 0.18 and a p-value of 0.996 which falls on the acceptance region of the hypothesis.  This result implies that there exist no significant difference on the total crime in the zones. It was found that Zone A, D and E evenly recorded the highest mean rank followed by Zone C and then  Zone B.
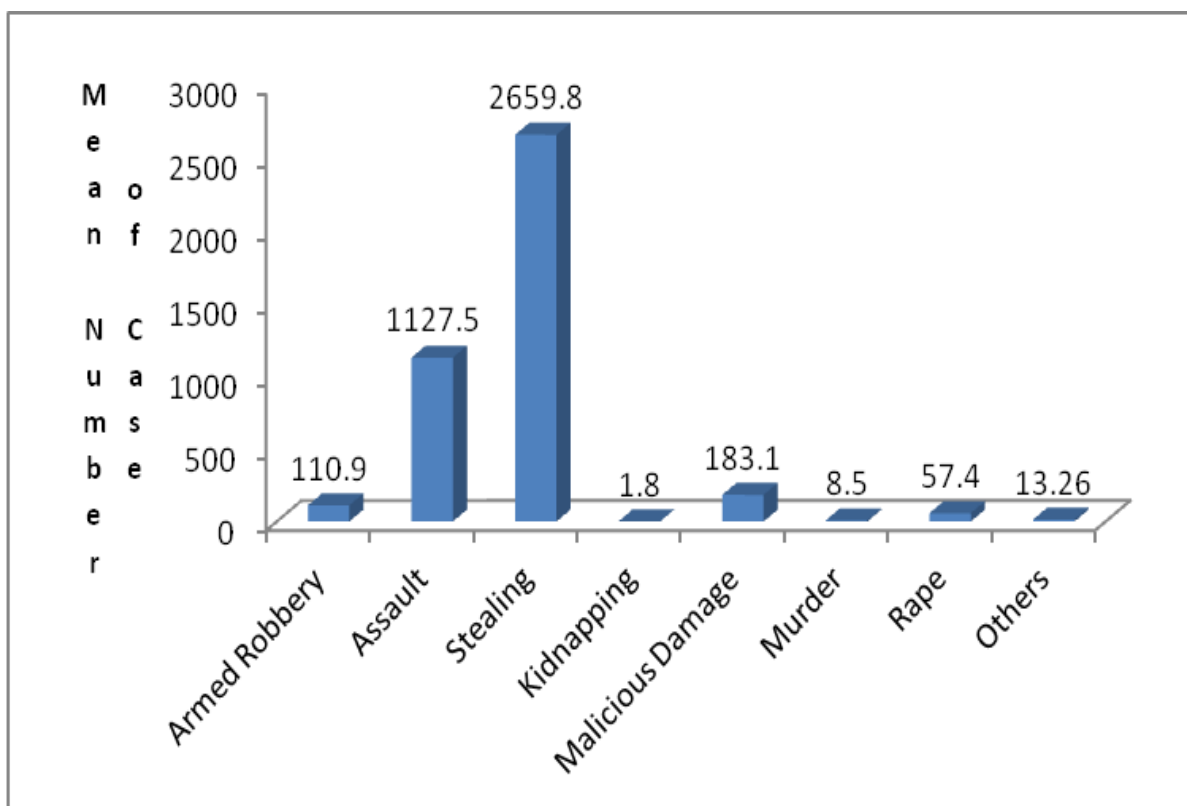


**Figure 5:  Graph of all the categories of  Crime recorded in Delta State**

Findings of figure 5 showed that stealing is most occurring crime with a mean value of 2659.8 cases while Kidnapping recorded the least occurring crime with mean value of 1.8 cases.

## 5.0 Conclusion

This study evaluates the crime rate in Delta State Nigeria from 2007 to 2016. The findings of the study showed that the Quadratic model was adequate for estimating  total crime trend in Delta State. It was found that total crime has an creasing Quadratic trend across the observed period. The series was found to be stationary and the four years forecast revealed a decreasing crime trend from

2017 to 2020. It was found that crime across the zones were not statistically significant. Also, findings showed that stealing is one of the most committed crime in Asaba which this validates the alarming rate of poverty and hunger in the state and Nigeria in general. Based on the findings of the present study, it is recommendations for government to improve the living standard of the citizens so that crime will not be easily attractive.

## REFERENCES

[1]. Ahmed, A. (2012). The Pattern and Distribution Of Crime Incidence In An Urban Environment: A Case Study Of Osun State, Southwestern Nigeria. *International Journal of Humanities and Social Science Vol.* 2(5):178-188.

[2]. Boba, R. (2001). *Introductory Guide To Crime Analysis And Mapping.* Washington, DC.

[3]. Canter, P. (2000). *Using A Geographic Information System For Tactical Crime Analysis.* California: Sage Publications.

[4]. Ghani, Z. A (2017). A comparative study of urban crime between Malaysia and Nigeria. *Journal of Urban Management,* 6:19-29.

[5]. Habibullah, M. S., Baharom, A. H., & Tan, K. S. (2013). Crime and police personnel in Malaysia: An empirical investigation. Prosiding Persidangan Kebangsaan Ekonomi Malaysia Ke VIII (2013).

[6]. Ojiako, J.C., Okafor, C. K., Igbokwe, E.C. Enedah, I.C. (2016). Modeling of Crime Pattern in Anaocha L.G.A, Anambra State, Nigeria Using GIS Approach. *International Journal of Innovative Research in Engineering & Management*, 3(5):403-408

[7]. Olajuyigbe A, Omole, K, Bayode, T. and Adenigba, A. (2016). Crime Mapping and Analysis in the Core Area of Akure, Nigeria. *J Remote Sensing & GIS*, 5(4):1-7

[8]. Olajuyigbe, A. E., Adegboyega, A. B and Adenigba, A. D (2015). Spatial Analysis of Factors Responsible for Spread of Crime Activities in Akure, Nigeria, Using GIS Techniques. *International Journal of Criminology and Sociological Theory*, 8(1):1-19.

[9]. Osuji, G.A., Obubu, M., Obiora-Ilouno, H.O (2015). An Investigation On Crime Rate In Southeastern Nigeria. *European Journal of Statistics and Probability*, (4):1-9.

[10]. Oyinloye, M. A., Olamiju, I. O. and Otokiti, V. K (2017). Spatial Distribution of Crime in Akure, Nigeria: *The GIS Perspectives. Journal of Geosciences*, 2(2): 21-38.

[11]. Richard, W. and Lorraine, M. (2011). *Environmental Criminology and Crime Analysis.* London: Routledge.

[12]. Tenibiaje, D. J. (2010). Personality and development of crime in Nigeria. *Current Research Journal of Social Sciences*, 2(4), 214–219.

[13]. Tretter, E. (2013). Sustainability and neoliberal urban development: The environment, crime and the remaking of Austin's downtown. Urban Studies Journal, Pp 1–16.

[14]. Usman, U., Yakubu, M., & Bello, A. Z. (2012). An investigation on the rate of crime in Sokoto state using principal

component analysis. *Nigerian Journal of Basic and Applied Science*, 20(2), 152–160.

[15]. Yelwa, S. A. and Bello, Y. (2012). Complementing GIS with Cluster Analysis in Assessing Property Crime in Katsina State, Nigeria. *American International Journal of Contemporary Research,* 2(7):191-198.
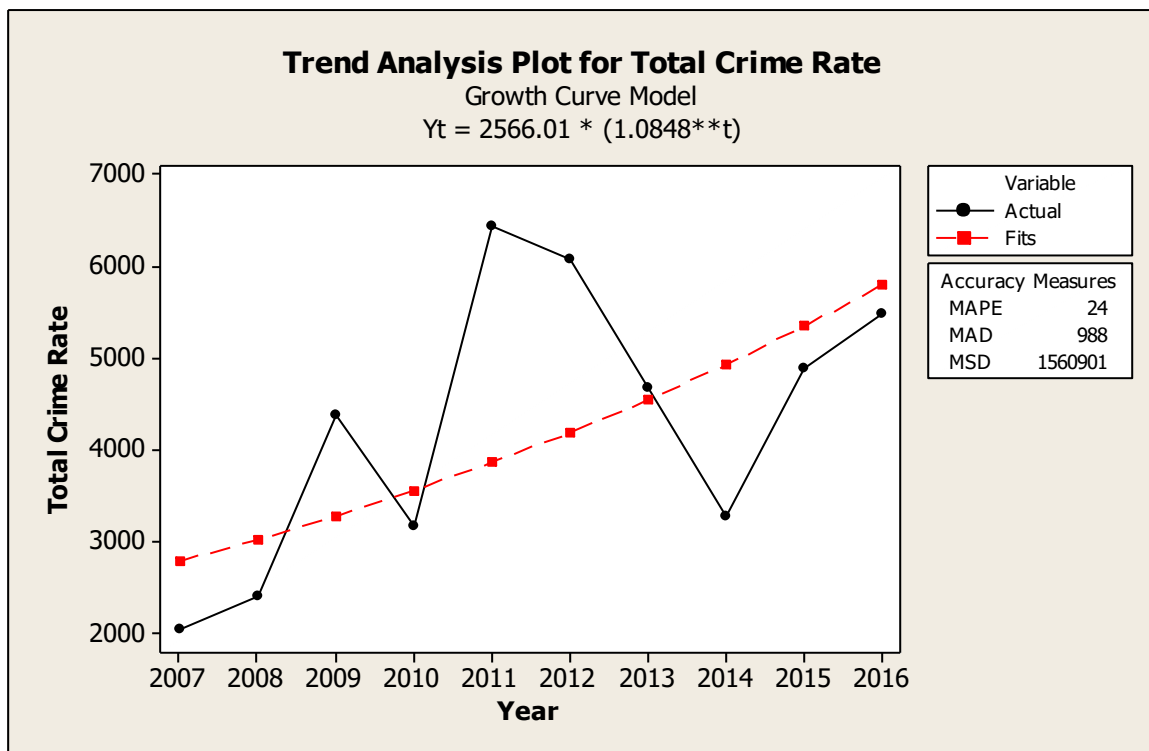
# Appendix



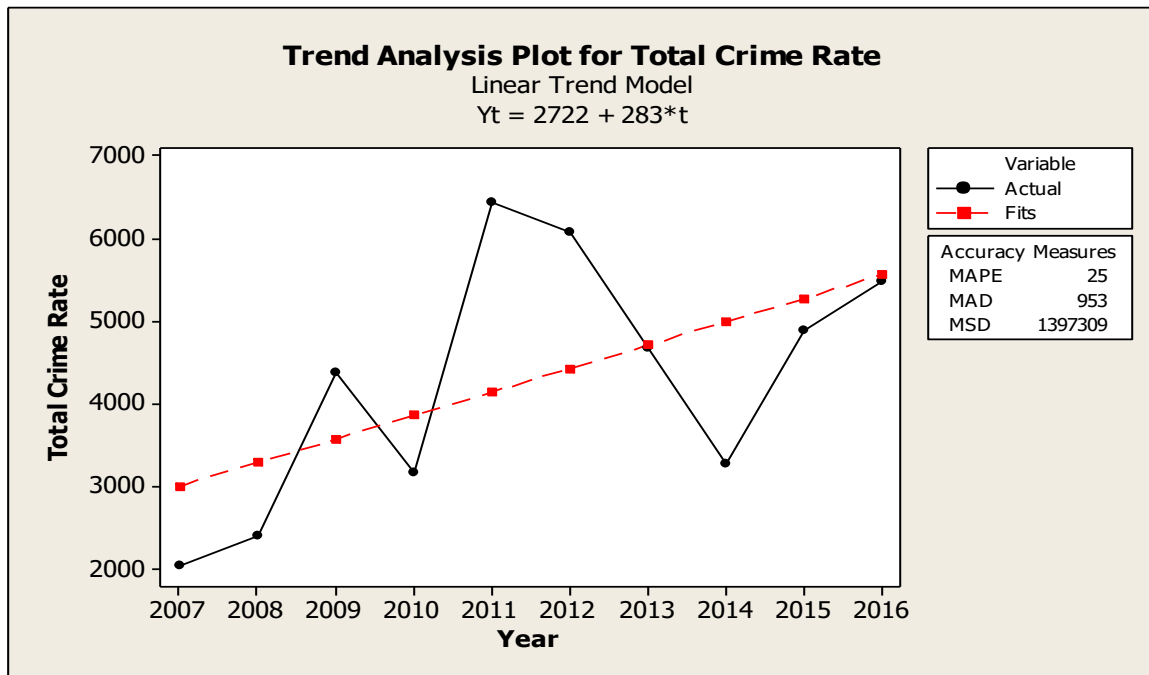Figure 6: Growth Curve Trend Plot of total Crime Rate in Delta State from 2007 - 2016

Figure 7: Linear Trend Plot of total Crime Rate in Delta State from 2007 - 2016