IJST EXPLORE International Journal of Science and Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-7318

International Journal of Science and Technology Volume 3 No. 4, April, 2014

Principal Component Analysis of Crime Victimizations in Katsina Senatorial Zone

Yusuf Bello, Yusuf U. Batsari, Abdullahi S. Charanchi
Department of Mathematics and Statistics, Hassan Usman Katsina Polytechnic Katsina, Katsina State, Nigeria.

ABSTRACT

This paper applies principal component analysis to analyse the spatial pattern of criminal victimization in the 11 local government areas in Katsina Senatorial Zone, Katsina State, Nigeria. The methodology for data collection was in-home, face-to-face personal interview using a stratified multistage random selection procedure. The data consists of burglary, robbery, theft, fraud, assault, murder, thuggery and rape cases. Logarithmic transformation was used to transform the victimization data to look more normal that consequently helped in proper understanding the spatial distributions of the victimizations in the zone. Batsari has the overall average victimizations, while Rimi has the lowest average victimizations in the zone. Thuggery victimizations and theft on manufactured products are more prevalent in the urban center- Katsina, and the surrounding LGAs, while theft on agricultural product in the fertile and agriculturally advantage LGAs. The LGAs on Katsina-Zamfara border and especially around Rugu forest and grazing reserve in the west toward the southern part of the zone have higher prevalence of violence and property crime victimizations-.murder, robbery, rape, burglary and livestock theft. These LGAs include Safana, Batsari, Danmusa, Jibia and Kurfi.

Keywords: *Principal Component Analysis, Victimization Survey, Rudu Forest, Katsina Senatorial Zone*

1. INTRODUCTION

Victimisation can be defined as the process of being victimised or becoming a victim. Criminal victimization has serious consequences for the citizens and society. Individual and societal aspirations for democracy, development, human rights, high standard of living are undermined by high level of criminal victimization (Alemika and Chukwuma, 2005). One of the fundamental techniques to combat criminal activities is the better understanding of the dynamics of crime. Theoretical and application-oriented approaches are needed to categorise geographical areas according to their similarities in criminal activities that would facilitate the understanding of why and where crimes take place (McGuffog et al., 2001). To effectively understand the nature and locations of criminal activities a reliable data is necessary. However, the official crimes statistics produce by the criminal justice system mostly suffer several weaknesses. Such statistics are inaccurate due to dark figures (unreported crimes), grey figures (reported but unrecorded crimes) and manipulation of records to satisfy political and/or institutional interests (as when reported increase or decrease may be advantageous to regime in power or the police force) (Alemika and Chukwuma, 2005). To complement the official statistics provided by the criminal justice system, criminologist have developed two methods for obtaining information on the extent and pattern of crime and victimization in a society. These methods are crime survey and victim survey. The accuracy in victimization survey over police data is proved to be reasonable (Averdijk and Elffers, 2012). In their work, they found that 29% of victimization reported to the police according to survey respondents could not be traced back to police data. They further calculated the total discrepancy between the police data and the victimization survey and found that reports of 18% of respondents in the victimization survey were not congruent with the police data.

To complement police crime data in Nigeria, a number of victimization surveys were conducted (Alemika and Chukwuma, 2005; Alemika and Chukwuma, 2006; Gyong, 2010). A recent national survey indicated a very low criminal victimization in Katsina State where only 6% admitted experiencing criminal victimization over the past one year covered by the 2012 survey (Cleen, 2012). However, analyses for these surveys were conducted using descriptive statistical methods that describe a single variable without relating it to the other variables simultaneously. An exploratory analysis that would consider the linear combination of all the variables is considered to be viable. A number of crime analyses using police crime data and multivariate statistical methods were conducted on Nigeria (Bello, 2011; Bello, et al., 2012a), and Katsina State in particular (Yelwa and Bello, 2012; and Bello, et al., 2012b). Instead of using the Nigeria Police crime data, this paper use multivariate statistical analysis method of principal component analysis (PCA) to analyse self-reported victimization from a survey conducted in mid 2013 in Katsina Senatorial Zone, Katsina State, Nigeria.

IJST © 2014– IJST Publications UK. All rights reserved.

2. METHODOLOGY

The data for this research work was obtained from a survey on crime victimization, fear of crime and policing in Katsina Senatorial Zone. The crimes are burglary, robbery (at own home), theft, fraud, assault, murder, thuggery and rape. The analysis covers the 11 local government areas (LGAs) of the zone. The LGAs are Katsina- the state capital, Batagarawa, Rimi, Charanchi, Kaita, Jibia, Kurfi, Dutsinma, Batsari, Danmusa and Safana. The target population were people aged 16 years and older. The methodology for data collection was in-home, face-to-face personal interview using a stratified multistage random selection procedure. 150 respondents were interviewed shared equally between the gender groups, and equally between urban, semi-urban and rural areas from each LGA. The responses were the experience of a respondent over the past three years if ever he was a victim of the crimes. The responses were converted to percentage of victimizations for the LGAs.

Normality of the Data

Although some consider PCA as a mainly descriptive technique and does not require multivariate normal assumption (Jolliffe, 2002), others explicitly stated that PCA needs multivariate normality (Qian et al., 1994). The explanation by Johnson and Wichern (2007) is a combination of the above different views. They explained that PCs depend solely on the variance matrix Σ (or correlation matrix of ρ) of $X_1, X_2, .., X_p$, and their development does not require a multivariate normal assumption. On the other hand, PCs derived for multivariate normal population have useful interpretation in term of the constant density ellipsoids. Since our sample size is very small, and among the objective of this paper is to interpret the loadings and scores plots of the PCs, the normality of the data would be useful. The normality of data is assessed by the linearity of quantile-quantile plots. In Q-Q plots, we compare the real values of the variables against the standardized values.

If normality is not a viable assumption, we can make non normal data more "normal looking" by considering *transformations* of the data (Johnson and Wichern, 2007). The normality of the data was assessed using Q-Q plots and found it far from normality. Logarithmic transformation was used to transform the data to look more normal without bothering to test the linearity of the Q-Q plots by using a sample correlation coefficient, r_Q. A test for linearity of the Q-Q plots by using r_Q was applied by William and Gedeon (2004) on crime data for US cities for considering the necessity of multivariate normal assumption before using a data in PCA. Figure 1 is a sample of Q-Q plots of the crime victimizations before and after transformation.

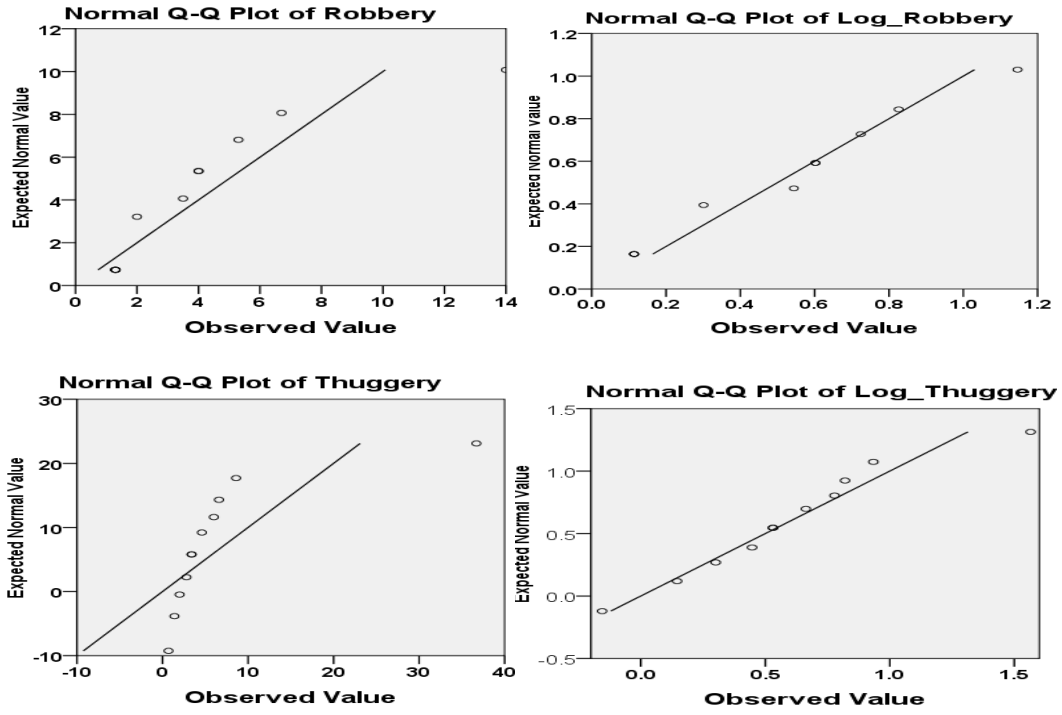


Fig.1 Q-Q plots before and after transformation

IJST © 2014– IJST Publications UK. All rights reserved.

3. PRINCIPAL COMPONENT ANALYSIS

A principal component analysis is concerned with explaining the variance-covariance structure of a set of variables through a few *linear* combinations of these variables. Its general objectives are (1) data reduction and (2) interpretation (Richard and Dean, 2007).

Let *X* be a vector of *p* random variables, and that the variances of the *p* random variables and the structure of the covariances or correlations between the *p* variables are of interest. Unless *p* is small, or the structure is very simple, it will often not be very helpful to simply look at the *p* variances and all the $\frac{1}{2}p(p-1)$ correlations or covariances. An alternative approach is to look for a few (< *p*) derived variables that preserved most of the information given by these variances and correlations or covariances. This explained the basic idea of PCA. This is achieved by transforming to a new set of variables, the PCs, which are uncorrelated, and which are ordered so that the first few retain most of the variation present in all of the original variables (Jolliffe, 2002)

Let the random vector $X' = \lfloor X_1, X_2, ..., X_p \rfloor$ have the covariance matrix Σ with eigenvalues $\lambda_1 \geq \lambda_2 \geq .... \geq \lambda_p \geq 0.$

Consider the linear combinations

$$\begin{aligned} Y_1 &= \alpha_1' X = \alpha_{11} X_1 + \alpha_{12} X_2 + ... + \alpha_{1p} X_p \\ Y_2 &= \alpha_2' X = \alpha_{21}' X_1 + \alpha_{22}' X_2 + ... + \alpha_{2p}' X_p \\ &\vdots \\ &\vdots \\ Y_p &= \alpha_p' X = \alpha_{p1}' X_1 + \alpha_{p2}' X_2 + ... + \alpha_{pp}' X_p \end{aligned} \quad (3.1)$$

of the element of ***X***, where α_j is a vector of *p* components $\alpha_{j1}, \alpha_{j2}, ..., \alpha_{jp}$.

Then

$$Var(Y_j) = \alpha_j' \Sigma \alpha_j \qquad j = 1,2,..., p \quad (3.2)$$

$$Cov(Y_j, Y_k) = \alpha_j' \Sigma \alpha_k \qquad j, k = 1,2,..., p \quad (3.3)$$

The PCs are those *uncorrelated* linear combinations $Y_1, Y_2, ..., Y_p$ whose variances in (3.2) are as large as possible (Richard and Dean, 2007).

In finding the PCs we concentrate on the variances. The first PC is the linear combination with maximum variance. That is, it maximizes $Var(Y_1) = \alpha_1' \Sigma \alpha_1$. It follows that α_1 cannot be taken simply for maximization, since $Var(Y_1) = \alpha_1' \Sigma \alpha_1$ can be increase by multiplying any α_1 by some constant. We need to put some conditions of choosing α_1 to be a coefficient vector of unit length, so that $\alpha_1' \alpha_1 = 1.$

We therefore define

First PC = Linear combination $\alpha_1' X$ that maximizes $Var(\alpha_1' X)$ subject to $\alpha_1' \alpha_1 = 1.$

Second PC = Linear combination $\alpha_2' X$ that maximizes $Var(\alpha_2' X)$ subject to

$\alpha_2' \alpha_2 = 1$ and $Cov(\alpha_1' X, \alpha_2' X) = 0.$

and, so on, so that at the *k* th stage

k th PC = Linear combination $\alpha_k' X$ that maximizes $Var(\alpha_k' X)$ subject to

$\alpha_k' \alpha_k = 1$ and

$Cov(\alpha_j' X, \alpha_k' X) = 0.$

$j = \alpha_1' X, \alpha_2' X, ..., \alpha_{k-1}' X$

Up to *p* PCs could be found, but we have to stop after the *q*th stage ($q \leq p$) when most of the variation in ***X*** have been accounted for by *q* PCs.

For the variables to be of similar scale, the data are standardized prior to using PC Analysis. A common standardization method is to transform all the data to have zero mean and unit standard deviation. This procedure results in transforming the random vector $X' = \lfloor X_1, X_2, .., X_p \rfloor$ to the corresponding standardized variables as $Z' = \lfloor Z_1, Z_2, ..., Z_p \rfloor$ so that *Cov*(Z) = ρ (the correlation matrix of *X*).

Procedure for Calculating Principal Components

Let *Cov*(Z) = ρ , we denote the matrix of correlation between *p* variables by

IJST © 2014– IJST Publications UK. All rights reserved.

$$\rho = \begin{bmatrix} 1 & r_{12} & \cdots & r_{1p} \\ r_{21} & 1 & \cdots & r_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ r_{p1} & r_{p2} & \cdots & 1 \end{bmatrix} \quad (3.15)$$

and the vector of the coefficients (weights or loadings) on the *p* variables for the j th component by

$$\alpha_j' = \left[\alpha_{j1}, \alpha_{j2} ... \alpha_{jp}\right]$$

$j = 1,2,...,p$.

The problem of determining the vectors α_j which maximize (1) the variance accounted for by the first component, (2) the variance accounted for by the second component, orthogonal to the first, etc., The solution for α_j can be solve by this equation $\left(\rho - \lambda_j I\right)\alpha_j = 0$ in which ***I*** is the (*p*×*p*) identity matrix, λ_j 's are the characteristics roots or eigenvalues of ρ and the α_j 's are the associated eigenvectors.

The solution of such an equation for λ_j and α_j may be obtained through the following steps:

i. Obtained the characteristics equation of **Σ**, that is $\left|\rho - \lambda_j I\right| = 0$ which leads $\rho - \lambda_j I$ to a polynomial equation in λ_j . Solve this equation for the λ_j 's.
ii. For each eigenvalue λ_j, obtained in step I., write out the matrix $\rho - \lambda_j I$.
iii. Compute the $adj\left(\rho - \lambda_j I\right)$
iv. Any column of $adj\left(\rho - \lambda_j I\right)$ is an eigenvector associated with λ_j. (Linderman et al., 1980).

Having obtained the eigenvectors, we simply determine our PCs as $Y_j = \alpha_j' Z$ for $j = 1,2,...,p.$

Interpretation of the Principal Components

The *loading* or the eigenvector $\alpha_j = \alpha_1, \alpha_2, ..., \alpha_p$, is the measure of the importance of a measured variable for a given PC (Højsgaard, 2006). When all elements of α_1 are positive, the first component is a weighted average of the variables and is sometimes referred to as *overall measure of victimization*. Likewise, the positive and negative coefficients in subsequent components may be regarded as *type of victimization* components (Rencher, 2002 and PrintCom, 2003) in the context crime victimization. The plot of the first two or three loadings against each other enhances visual interpretation (Højsgaard, 2006).

The *score* is a measure of the importance of a PC for an observation, and the plot of the first two or three PCs against each other enhances visual interpretation (Højsgaard, 2006).

The Proportion of Variance

The proportion of variance tells us the PC that best explained the original variables. A measure of how well the first *q* PCs of Z explain the variation is given by

$$\psi_q = \frac{\sum_{j=1}^{q} \lambda_j}{P} = \frac{\sum_{j=1}^{q} Var\left(Z_j\right)}{P}$$

A cumulative proportion of explained variance is a useful criterion for determining the number of components to be retained in the analysis. A Scree plot provides a good graphical representation of the ability of the PCs to explain the variation in the data (Cattell, 1966).

4. ANALYSIS AND RESULT

The results of a crime victimization survey conducted in Katsina Senatorial Zone is presented in this section. The analysis focuses on two aspect of the survey; the crime victimization in general, and theft victimization in particular.

Crime Victimization

The crime victimizations under study are burglary, robbery, theft, fraud, assault, murder, thuggery and rape. The descriptive statistics of the crime victimization is presented in Table 1. Theft is the most common victimization in the zone that on the average, about 56.4% admitted experiencing theft victimization over the past three year with a standard deviation of 12.5% of victimization. Similarly, it is the most spread victimization in the zone where the coefficient of variation shows that the standard deviation is only 22.17% of the average value. Rape is not included in the PCA because of the small number of observations in relation to the number of victimization variables. However, the survey result shows that Jibia has the highest prevalence, followed by Batsari.

IJST © 2014– IJST Publications UK. All rights reserved.

Table 1. Descriptive Statistics of Crime Victimizations in percentage

	Burglary	Robbery	Theft	Fraud	Assault	Murder	Thuggery	Rape
Average	19.55	4.06	56.40	9.65	13.47	6.37	6.93	4.79
STD	9.76	3.77	12.50	9.77	10.37	8.48	10.15	5.96
CV	49.94	92.84	22.17	101.23	76.98	133.09	146.59	124.46

The eigenvalues and the cumulative proportions of the explained variance are displayed in Table 2.

Table 2. Eigenvalues

Component	Eigenvalue	Proportion	Cummulative
1	4.2643	60.9182	60.9182
2	1.2065	17.2358	78.1540
3	0.7346	10.4936	88.6476
4	0.3793	5.4193	94.0668
5	0.2460	3.5146	97.5814
6	0.1362	1.9457	99.5271
7	0.0331	0.4729	100.0000

Considering the eigenvalue-one criterion and the Scree plot on figure 1a, it would be reasonable to retain the first two PCs. A commonly accepted rule says that it suffices to keep only PCs with eigenvalues larger than 1. Therefore first 2 PCs retained explain up to 78 percent of the total variability of the data set.

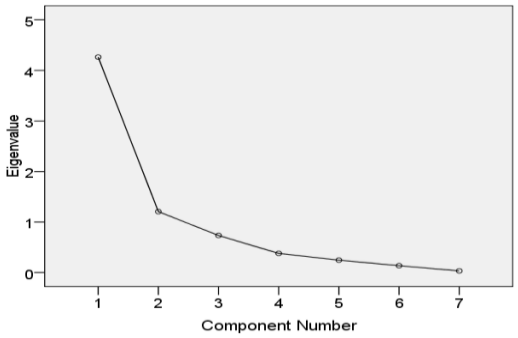


Fig. 1a Scree plot crime victimization

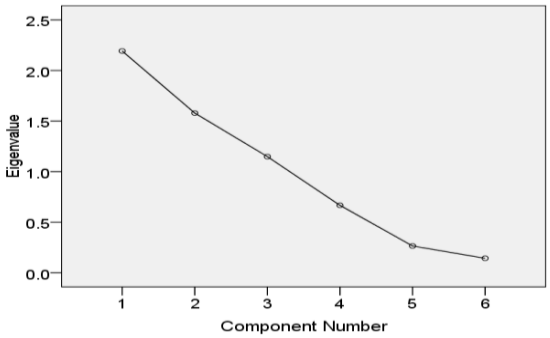


Fig. 1a Scree plot theft victimization

The first PC, from Table 2 and Fig. 2a, combines the number of all the victimizations with approximately positive average constant weight, and is interpreted as the overall measure of victimization. Batsari has the overall crime victimizations in the Zone. Next to Batsari is Jibia, then Katsina, and then Safana. Rimi has the lowest crime victimizations in the zone.

Table 3. Eigenvectors

	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5	Comp.6	Comp.7
Burglary	0.325	-0.631	0.204	0.131	-0.117	0.363	-0.54
Robbery	0.429	-0.147	-0.068	0.254	0.254	0.761	-0.379

IJST © 2014– IJST Publications UK. All rights reserved.

Theft	0.391	0.224	0.335	0.616	-0.467	-0.204	0.214
Fraud	0.429	0.265	-0.247	0.003	0.138	0.747	0.328
Assault	0.369	0.371	-0.541	-0.131	-0.225	-0.236	-0.557
Murder	0.372	-0.463	-0.194	-0.459	-0.322	-0.262	0.475
Thuggery	0.313	0.327	0.672	-0.558	0.122	-0.038	-0.129

The second component has partitioned the victimizations into two categories; the violence crimes- burglary, murder and robbery that are negatively correlated, and the concentrated crimes- thuggery, theft, assault and fraud that are positively correlated. This classification has partitioned the zone geographically between the LGAs located mostly in the western and eastern parts. The western part area is termed "*Katsina-Zamfara border axis*". This area is endowed with fertile land, good grazing reserve and the spread of forest reserves. A notable forest reserves in the zone is Dajin Rugu (Rugu forest) that has became a hideout to thieves and armed robbers (Katcrime, 2013; Segun 2013; Rugforest, 2012).

The LGAs in the western part (border axis) include Danmusa, Safana, Batsari, Jibia, Kurfi, and Rimi appeared to have the larger prevalence of robbery, murder and burglary. Kurfi is not actually on the border, but is close to the border to the west, and therefore share some characteristics. The western part is fertile and falls on the cattles' herdsmen route linking Niger Republic to Sothern part of Nigeria via Rugu forest. The migration by Fulani herdsmen in search of pasture in Nigeria result in clashes with farmers and sometime claims lives (Peoples Daily, 2013; Aderibigbe, 2013). Although, Rimi is included in the classification despite the fact that it is located in the eastern part geographically, and with the lowest average victimizations, this is because it shows tendency toward burglary- the most prevalent in the area. The other LGAs in the eastern part have less prevalence of the violence crimes. However, crime over lap administrative border, and therefore, the more an area is closer to the Katsina-Zamfara border, especially around Rugu forest, the more is prone to robbery.

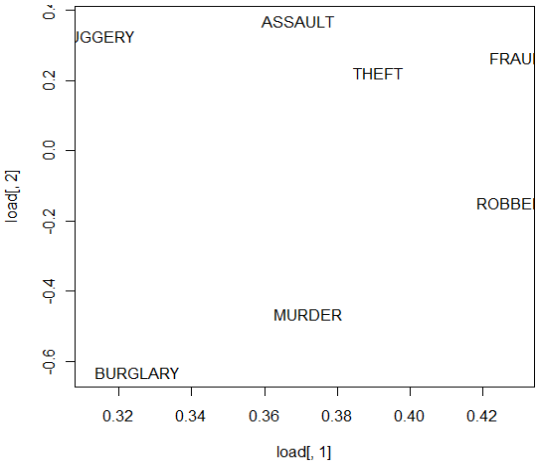


Fig.2a Loadings plot of the first two Components

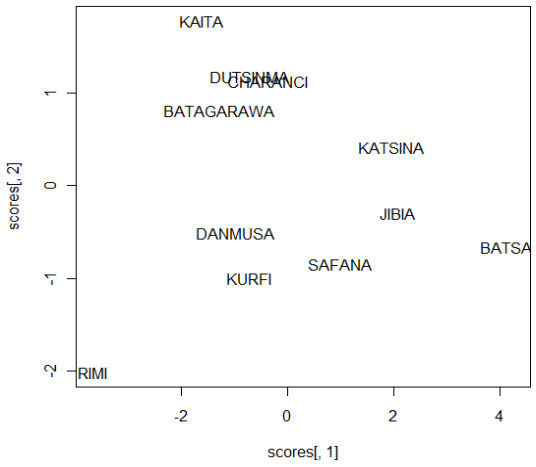


Fig.2b Scores plot of the first two Components

Components 2 and 3 in figure 3 have further explored the classification by components 1 and 2 by partitioning the LGAs and the victimization into four quadrants. The 1st quadrant composes of theft and thuggery that are common in Katsina- the state capital, Batagarawa- where some part of it is within the Katsina municipal, and Charanchi- which is also close to Katsina. The high correlation of thuggery to components 2 and 3 in figure 4a is an indication that Katsina has the highest prevalence in figure 4b. This is an indication of associating thuggery victimizations to urbanization. This is because thuggery in Nigeria is associated to politics (Agba, 2011; Agodom, 2011; Nigeria, 2012), and the urban areas are the centers for political activities. The incidences in the neighbouring LGAs are as the result of proximity to the urban area. The 2nd quadrant composes of burglary that is common in Rimi, Safana and Jibia, although close examination shows that the last two have much tendency toward robbery. The 3rd quadrant composes of murder and robbery that are common in Batsari, Kurfi and Danmusa.

The 4th quadrant composes of fraud and assault that are prevalent in Dutsin-ma and Kaita. Further analysis from figure 4a indicates that Dutsin-ma is more related to fraud victimization while Kaita is related to the prevalence of assault. The prevalence of assault and fraud in Dutsinma LGA might be related to the

IJST © 2014– IJST Publications UK. All rights reserved.

socioeconomic structure of the area. The LG headquarter is Dutsinma town which is located at the center of the state and the second most important urban center in the zone. It has an important weekly market. The town is a newly sprang up town composing largely of *migrants*, rapidly grown as the result of becoming administrative and educational centers.

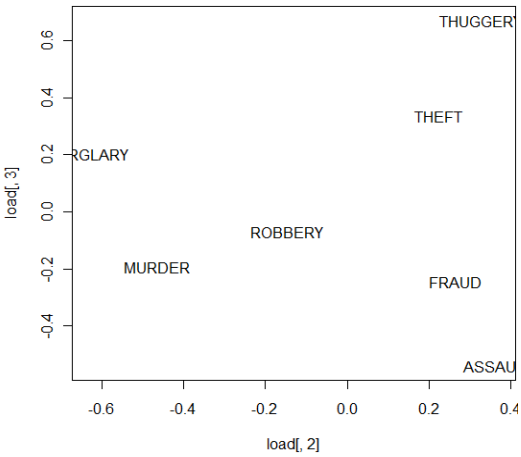


Fig.3a Loadings plot of the 2nd and 3rd Components

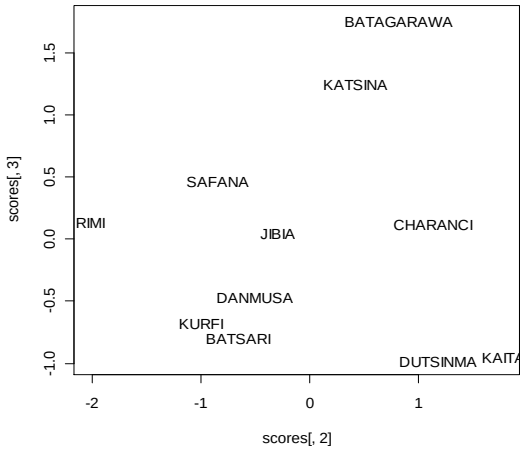


Fig.3b Scores plot of the 2nd and 3rd Components

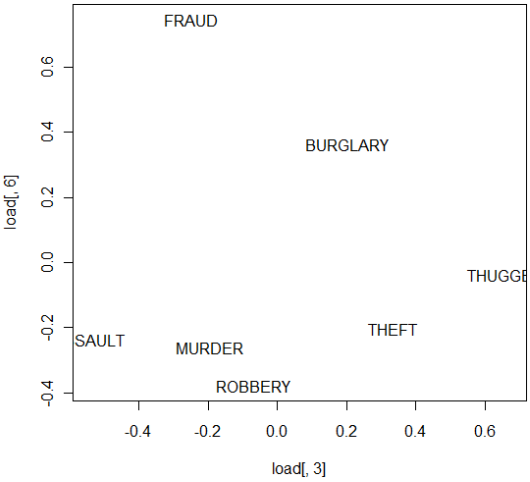


Fig.3a Loadings plot of the 3rd and 6th Components

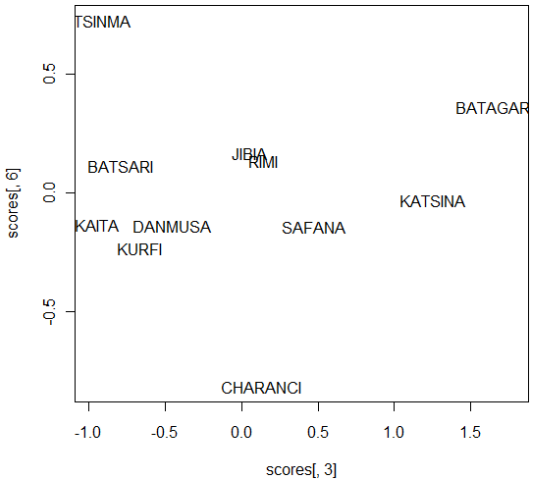


Fig.3b Scores plot of the 3rd and 6th Components

Component 4 is highly correlated with theft in figure 5a, and correspondingly in figure 5b, Charanchi and Jibia show tendency toward the prevalence of theft victimization. Probably the high rate of theft in the two areas might be as the results of locations of important international markets- notably livestock markets. This factor provides easy and close market to the stolen items.

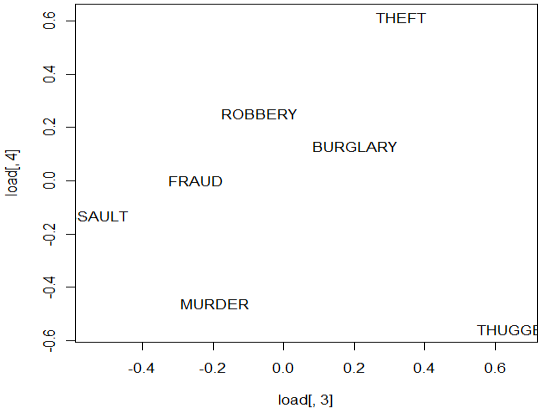


Fig.5a Loadings plot of the 3rd and 4th Components

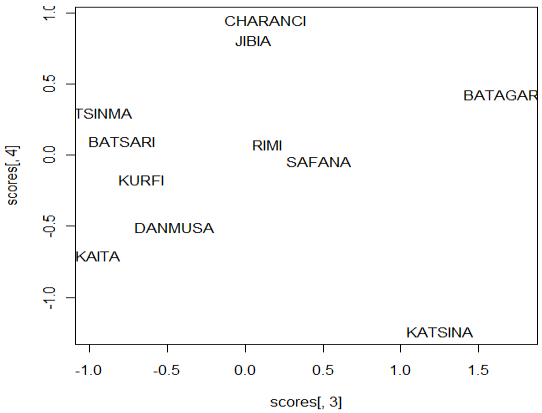


Fig.5b Scores plot of the 3rd and 4th Components

IJST © 2014– IJST Publications UK. All rights reserved.

Figure 3 has categorized Batsari, Danmusa and Kurfi were robbery and murder victimizations are prevalent, a further analysis in figure 6 reveals the strong positive and moderate negative correlations of robbery and murder, respectively to component 5. This mean Danmusa has high tendency toward robbery victimization, while Kurfi has tendency toward murder. The tendency of Kurfi toward murder may relate to the location of the western part of the LGA on the Fulani herdsmen route that occasionally results into clashes with farmers. Already, Batsari has been marked with the overall combinations of the crime victimizations, followed by Jibia, and then Safana, all located in the western part of the zone.

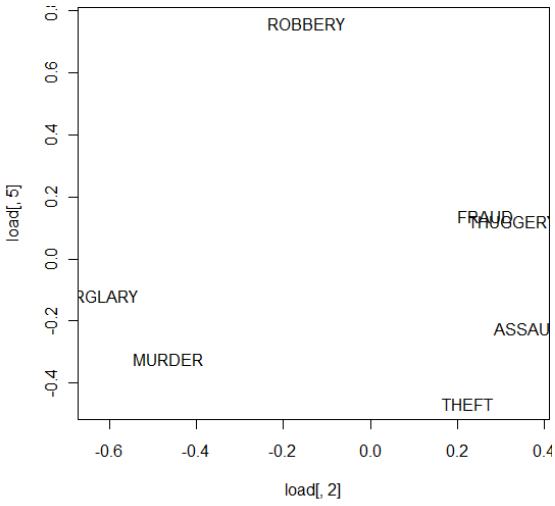


Fig.6a Loadings plot of the 2nd and 5th Components

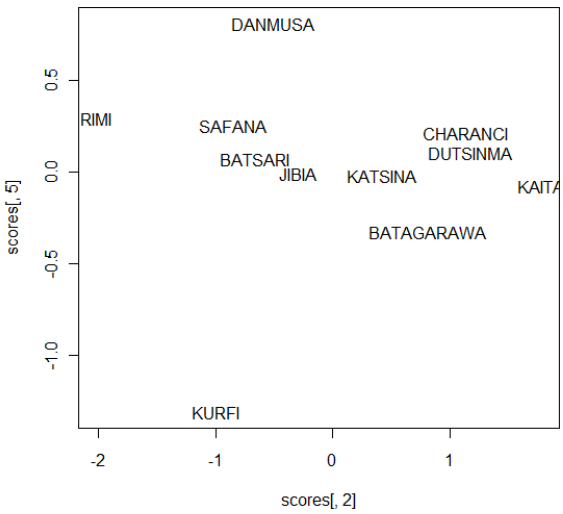


Fig.6b Scores plot of the 2nd and 5th Components

Theft Victimizations

We consider cases of theft victimizations separately being the most common and the most spread among the victimizations. The items under study are GSM, livestock, poultry, vehicle, food and pick pocketing (PPKT). Food theft entails the theft of raw food from farm lands and bagged ones. The eigenvalues and the cumulative proportions of the explained variance are displayed in Table 4. The Scree plot on figure 1b is not sufficient to determine the components to be retained, however, considering the eigenvalue-one criterion it would be reasonable to retain the first three components that explain up to 82 percent of the total variability of the data set.

Table 4. Eigenvalues

Component	Eigenvalue	Proportion	Cummulative
1	2.19290	36.54833	36.54833
2	1.57950	26.32500	62.87333
3	1.14930	19.15500	82.02833
4	0.66800	11.13333	93.16167
5	0.26580	4.43000	97.59167
6	0.14450	2.40833	100.00000

The eigenvectors are presented in Table 5. The positive and negative coefficients in the components may be regarded as *type of victimization* components. The plot of components 1 and 2 is shown in figure 7.

Table 5 Eigenvectors

	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5	Comp.6
GSM	-0.263	-0.496	0.240	-0.756	0.187	-0.144
Livestock	-0.113	0.522	0.626	-0.256	-0.301	0.409

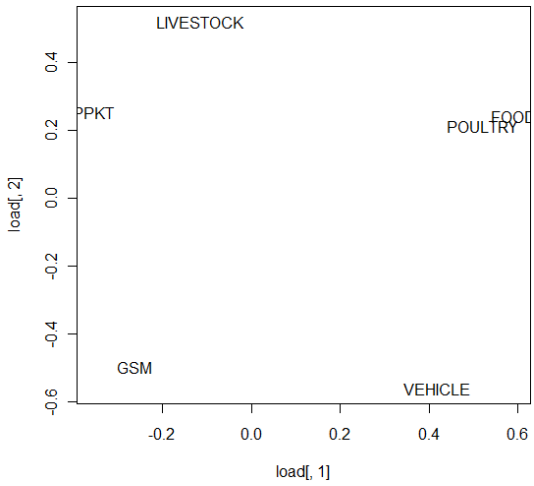
IJST © 2014– IJST Publications UK. All rights reserved.

Poultry	0.519	0.213	-0.354	-0.417	0.418	0.460
Vehicle	0.418	-0.561	0.012	0.005	-0.616	0.362
Food	0.590	0.241	0.149	-0.24	-0.219	-0.683
PPKT	-0.354	0.253	-0.635	-0.362	-0.522	-0.061

In figure 7 component 2 has partitioned theft victimizations into theft on manufactured products (GSM and vehicle theft) and theft on agricultural products (livestock, poultry and food theft). LGAs associated with crime on agricultural products are Jibia, Danmusa, Batsari , Safana, Charanchi, Kaita and Dutsinma. All these LGAs possess important food and livestock markets and some are bestowed with forest and grazing reserves (Jibia, Danmusa, Batsari and Safana). Possibly the prevalence of pick pocketing in these areas is related to financial transactions taking place especially on market days. LGAs associated with crime on manufactured products are Katsina- the urban center, and the neighbouring Batagarawa, Kurfi and Rimi LGAs. These LGAs are agriculturally disadvantage areas (except Kurfi) and possess very unimportant food and livestock markets. It is the availability that provide ample opportunity to commit crime, in the urban center manufactured products are more available than the agricultural products, and therefore they are more prone to be steal. The neighbouring LGAs must have affected by proximity to the urban center

Conponent1 has further partitioned the loadings and scores plots into four quadrants accordingly. The first quadrant consists of food and poultry theft which are prevalent in Safana, Danmusa, Charanchi, Batsari and Dutsinma. These areas are fertile and therefore are important food, poultry and livestock producers in the zone and possess at least national markets for the agricultural products. Although, Charanchi is not as fertile, however, it possesses the most important international market in the zone. Noting that proximity to market accelerates property victimization. The victimizations in the second quadrant are pick pocketing and livestock theft and the affected LGAs are Jibia and Kaita. These LGAs boarder the zone to the north with the Niger Republic and they possess international livestock markets. The rapid flow of huge amount of money and congestion characterized by livestock markets possibly facilitate the rampant pick pocketing in the areas (CFID, 2010).

The fourth quadrant consists of GSM theft and is common in Batagarawa. The Katsina, Rimi and Kurfi in the third quadrant show tendency toward vehicle theft.



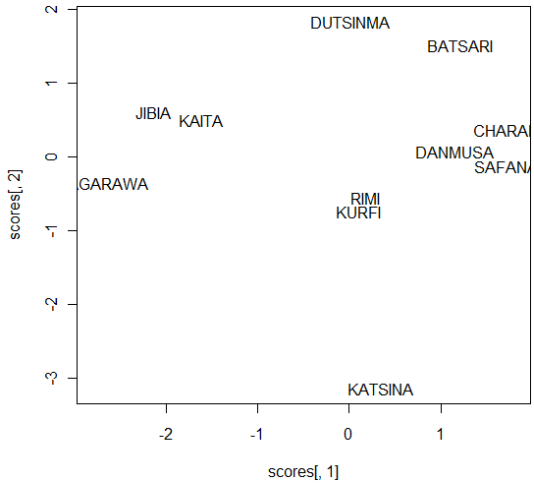
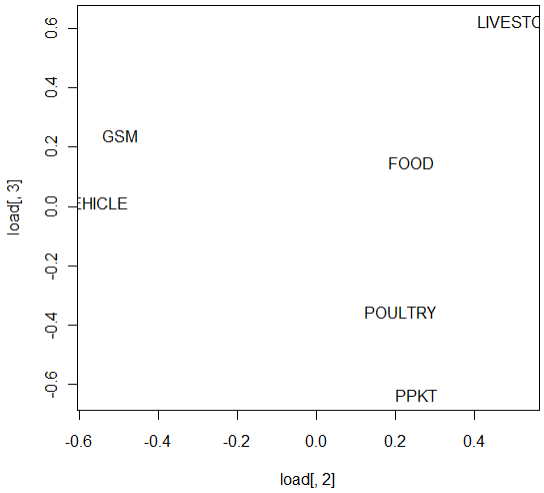


Fig.7a Loadings plot of the first two Components **Fig.7b Scores plot of the first two Components**

Figure 8 has further explored the pattern of theft victimization described in fig.9. The high correlation of vehicle and GSM theft to component2 indicated that the urban center- Katsina is the most affected with the theft victimization on manufactured products. Livestock theft appeared to be most common in the LGAs around the forest and grazing reserve that include Jibia, Batsari, Danmusa and Safana. Pick pocketing appeared to be common in Dutsinma.

IJST © 2014– IJST Publications UK. All rights reserved.



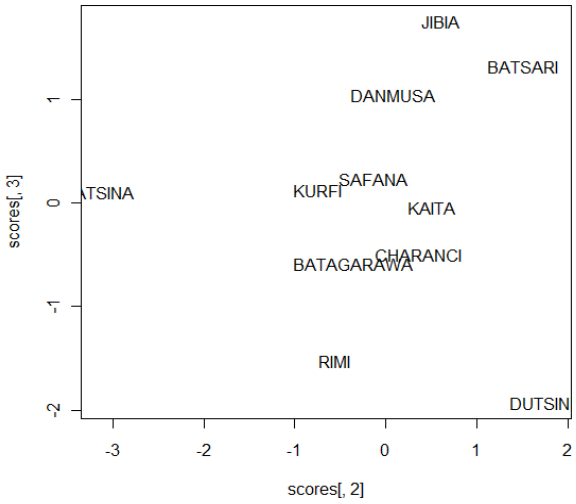


Fig.5a Loadings plot of the 2nd and 3rd Components **Fig.5b Scores plot of the 2nd and 3rd Components**

4. CONCLUSION

The result of the analysis has revealed that Batsari has the overall average crime victimization in the zone, and then followed by jibia. Rimi has the lowest average crime victimization, although it shows tendency towards burglary. The LGAs on Katsina-Zamfara border have higher prevalence of violence and property crime victimizations- murder, robbery, rape and burglary. These LGAs include Safana, Batsari, Danmusa, Jibia and Kurfi. The occurrence of thuggery victimizations can be associated to urbanization, since the larger thuggery victimizations has took place in the capital city- Katsina and the immediate neighbouring Batagarawa LGA. Assault and fraud victimizations are very common in Dutsinma. Despite the fact that theft victimization is the most common and the most spread in the zone, it is very prevalent in Charanchi and Jibia LGAs. These areas locate the most important international livestock markets in the zone. The zone is partitioned into two parts in term of theft victimization. The urban center in the zone locating the state capital- Katsina and neighbouring LGAs including Batagarawa, Kurfi and Rimi have tendency toward theft on manufactured goods- GSM and vehicle. The other LGAs show tendency theft on agricultural products- livestock, food and poultry.

The use loadings and scores plots of PCA has prove to be useful in understanding the pattern of criminal victimization in Katsina Senatorial Zone. Having understood the spatial pattern of the crimes and victimizations in the zone, and particularly, the Katsina-Zamfara border and Rugu forest area, the research can go further to determine the socioeconomic origin of the criminal activities in the areas, and the way forward for possible solutions.

Acknowledgements

We would like to acknowledge the financial support from the Tertiary Education Trust Fund (TETFUND) for sponsoring the research project under the TETFUND Research Projects Intervention. We also thank Musa I. Sha'iskawa and Aminu Y. El Ladan for their uncountable advice and moral support toward the success of the project.

REFERENCES

[1]. Aderibigbe, N. (2013), 33 Feared Dead As Fulani Herdsmen, Farmers Clash Again In Benue, Information Nigeria, http://www.informationng.com/2013/09/33-feared-dead-as-fulani-herdsmen-farmers-clash-again-in-benue. html

[2]. Agba, M.S. (2011). Political Thuggery and Democratic Dividends in Nigeria: An Empirical Study, Higher Education of Social Science, 1, (1), 58-65

[3]. Agodom, U. (2012), The professionalisation of political thuggery in Nigeria, Daily Trust, 19/12/2012

[4]. Alemika, E.E.O. and Chukuma, I.C. (2005), Criminal Victimization and Fear of Crime in Lagos Metropolis, Nigeria. CLEEN Foundation Monograph Series, NO. 1, CLEEN Foundation, www.cleen.org.

[5]. Alemika, E.E.O. and Chukuma, I.C. (2006), Criminal Victimization, Safety and policing in Nigeria. CLEEN Foundation Monograph Series, NO. 1, CLEEN Foundation, www.cleen.org.

IJST © 2014– IJST Publications UK. All rights reserved.

[6]. Averdijk, M. and Elffers, H. (2012), The discrepancy between survey-based victim accounts and police reports revisited, *International Review of Victimology*, 18(2): 91-107.

[7]. Bello, Y. (2011), Detecting Areas with Overall Crime Rates using Principal Component Analysis. Presented at the 35th Annual Conference of the Nigeria Statistical Association on the 21st – 23rd September, 2011 at the Presidential Hotel, Akure, Ondo State.

[8]. Bello, Y., Gulumbe, S.U. and Yelwa, S.A. (2012a), Simultaneous Application of Agglomerative Algorithms on Interval Measures for Better Classification of Crime Data across the States in Nigeria. *Research Journal of Applied Science*, 7(1): 41 – 47.

[9]. Bello, Y., Gulumbe, S.U., Yelwa, S. A. and Badamasi, M.M. (2012b), Monitoring Crime Rates with Control Charts using GIS Classification. *Journal of Engineering and Applied Sciences*, 7(2): 207 – 214.

[10]. Cattell, R.B. (1966), The Scree test for the number of factors. *Multivariate Behavioral Research*, *1*,245-276.

[11]. CFID (2010), Maigatari Market Project in Jigawa State, Security, Justice and Growth, Security Justice and growth, Department for international Development, British Council, http://www.j4a-nigeria.org/joomdocs/Maigatari.pdf

[12]. Cleen (2012), Summary of Findings of 2012 National Crime and Safety Survey, http://cleenfoundation.blogspot.com/2012/07/summary-of-findings-of-2012-national.html

[13]. Gyong, J.E. (2010), Criminal Victimization and the Reporting of Crime in Kaduna State: Towards Integrating the Victim of Crime into Criminological Discourse, *Current Research Journal of Social Sciences*, 2(5): 288-295.

[14]. Højsgaard, S. (2006), Example of multivariate analysis in R – Principal component analysis (PCA). httpgene://tics.agrsci.dk/statistics/courses/Rcourse-Djf2006 / day3/ PCA-notes

[15]. Johnson, R.A. and Wichern, D.W. (2007), Applied Multivariate Statistical Analysis, 6th edn. Upper Saddle River, NJ: Prentice Hall: Prentice-Hall.

[16]. Jolliffe, I.T. (2002), Principal Component Analysis, 2nd edn. New York: Springer-Verlag.

[17]. Katcrime (2013), Rising Wave Of Criminality In Katsina, http://www.nigeriaa2z.com/2012/04/08/rising-wave-of-criminality-in-katsina/

[18]. Linderman, R.H., Peter, F. and Gold, R.Z. (1980), Introduction to Bivariate and Multivariate Analysis. Scott, Foresman and Company.

[19]. McGuffog, I., Western, J.S. and Mullins, P. (2001), Exploratory Spatial Data Analysis Techniques for Examining Urban Crime. British Journal of criminology, Vol. 41, Issues 2, pp. 309 – 329.

[20]. Nigeria (2012), Nigeria: PAC Suggests Solutions to Thuggery, allAfrica, http://allafrica.com/stories/ 201203 290302 .html

[21]. Peoples Daily (2013), One killed in Katsina Fulani, farmers' clash, 30/10/2013

[22]. Printcom (2003), http://support.sas.com/onlinedoc/912/getDoc/common.hlp/images/ copyrite .htm

[23]. Rencher, A. C. (2002), Methods of Multivariate Analysis, 2nd edn. New York: Wiley.

[24]. Rugforest (2012), The lost glory of Rugu Forest, Sunday Trust Online 08 January 2012

[25]. Segun (2013), Bandit Attacks Displace Northern Nigeria Herders, Agro Business, http://agronigeria.com.ng/2013/06/20/bandit-attacks-displace-northern-nigeria-herders/

[26]. Qian, G., Gabor, G. and Gupta, R.P. (1994). Principal components selection by the criterion of the minimum mean difference of complexity. In Principal Component Analysis, 2nd edn, eds. Jolliffe, I. T. (2002), 19. New York: Springer-Verlag.

[27]. William, K. and Gedeon, R. (2004), A Multivariate Statistical Analysis of Crime Rate in US Cities.

[28]. 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): 190 – 198.

IJST © 2014– IJST Publications UK. All rights reserved.