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A STUDY OF PROMINENT CRIMES IN KWARA STATE NIGERIA

UNE ETUDE DES CRIMES EMINENTS DANS L'ÉTAT DE KWARA NIGERIA

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ABSTRACT

Nigeria has been experiencing high rate of criminal activities where crimes are being carried out with more perfect and sophistication for over ten years now. The recent amongst are the insurgent called Boko Haram who believed that western civilization of education for all is unlawful and the Avengers also called Militants in the Niger Delta part of Nigeria who believed the Government is cheating their people in that region. The data for this study contained records of different crime committed in Kwara states between 2004 and 2014. This research work is to: identify the prominent crime types; determine the association that existed between pairs of crime types; reduce the dimension of the data using statistical tools; and classify the crime types in different colonies. Principal Component, Biplot, correlation analysis and other statistical tools were utilized in this paper. The pair wise correlation test of significance table indicated that, out of the 45 pair wise correlations, only 6 are significant at 5% and these include; homicide-suicide, homicide-robbery, suicide-robbery, rape-theft, assault-broken, broken-theft and broken-unlawful. We observed that crime types such as assault, unlawful, broken and theft can be grouped together as the most frequent crimes committed; the prevailing cases occurred in the year 2006 and 2008. We also observed that, suicide, homicide and robbery formed the next group, which are more frequent in the year 2009, 2010 and 2011. Kidnapping and arson are not frequently committed but they are more prominent in the year 2012 and 2013. Rape formed the lowest standalone crime type committed and also less frequent with no year of prevailing occurrence.

Keywords: Principal Component; Biplot; Correlation coefficient; Crimes; Kidnapping; Robbery; Suicide; Homicide; Unlawful; Theft.

RESUME

Le Nigeria a connu un taux élevé d'activités criminelles où les crimes sont réalisés avec plus de perfection et de sophistication depuis plus de dix ans. Le récent parmi les insurgés s'appellent Boko Haram qui a cru que la civilisation occidentale de l'éducation pour tous est illégale et les Vingt-Garçons ont également appelé les Militants dans la partie du Nigéria au Nigeria, qui ont cru que le gouvernement trompe leur peuple dans cette région. Les données de cette étude contiennent des enregistrements de différents crimes commis dans les États de Kwara entre 2004 et 2014. Ce travail de recherche vise à: identifier les types de criminalité importants; Déterminer l'association qui existait entre les paires de types de criminalité; Réduire la dimension des données à l'aide d'outils statistiques; Et classer les types de crimes dans différentes colonies. Composante principale, Biplot, analyse de corrélation et autres outils statistiques ont été utilisés dans cet article. Le test de corrélation par sondage de la table de signification indiquait que, sur les 45 paires de

corrélations sages, seulement 6 sont significatifs à 5% et ceux-ci incluent; Homicide-suicide, homicide-vol, suicide-vol, vol de viol, agressé, cassé et cassé-illégal. Nous avons observé que les types de crimes tels que l'agression, l'illégalité, la rupture et le vol peuvent être regroupés comme les crimes les plus fréquents commis; Les cas en vigueur ont eu lieu en 2006 et 2008. Nous avons également observé que le suicide, l'homicide et le vol qualifié constituaient le prochain groupe, plus fréquent en 2009, 2010 et 2011. Les enlèvements et les incendies criminels ne sont pas fréquemment commis mais ils sont plus nombreux Proéminent en 2012 et 2013. Le viol a constitué le type de criminalité autonome le plus bas engagé et également moins fréquent sans année d'occurrence en cours.

Mots clés : Composant principal; Biplot; Coefficient de corrélation; Crimes; Enlèvement; Suicide; Homicide; Illicite; Vol.

INTRODUCTION

An act which is regarded as a crime in one society such as prostitution, adultery and homosexuality between consenting adults have been wholly or partially removed from the criminal law in USA (Feldman, 1997). Due to technological and advanced in societal life, perception of the people tends to change, what was regarded as mere issue in the colonial era have now become crime in the present day life. Today, it is now a crime to pollute the air and water. Pollution causes few problems and receives little attention in colonial days (WBE, 1974). Thus, the perception of an "act" to be a crime varies with time and space (UN, 1995).
In legal perspective, a crime is a violation of criminal law which in most societies can be defined broadly as any 'act or omission forbidden law on pain of punishment' (Carvell and Swinfen 1970). One of the fundamental techniques to fight criminal activities is the better known of the dynamics nature of crime. Crime is often known of as a moral threat and injurious to the society. It causes damages the personality of individual and his property and lessens trust among members of the society (Louis et al. 1981).

The causes of crime are multiple and could be traced to bio-genetic factors, such as genetic mutation and heredity (Horton, 1939), psychological factors, such as personality disorders and sociological factors, such as learning and environment (Sutherlands, 1939).

Nigeria has one of the highest crime rates in the world (Uche, 2008). Cases of armed robbery attacks, pick-pockets, shop breaking and internet frauds have increased due to increased poverty among population as well as an alarming rate of unemployment among our youth and economics recession in the nation. This has brought about the establishment of various vigilante groups in different states, to combat crimes in those states in Nigeria. However, the introduction of modern scientific and technical methods in crime prevention and control has proved to be effective. In addition to these measures, the police force is closely monitoring the activities of these registered vigilante groups nationwide to ensure their full compliance with statutory rules and regulations.

Principal Component Analysis (PCA) is very useful in crime analysis because of its robustness in data reduction and in determining the overall criminality in a given geographical area. Principal component analysis is a data analysis tool that is usually used to reduce the dimensionality (number of variable) of a large number of interrelated variables while retaining as much of the information (variation) as possible. The computation of principal component analysis reduced to an eigenvalue – eigenvector problem. It is performed either on a correlation or a covariance matrix. If some group of measures constitutes the scores of the numerous variables, the researchers may wish to combine the score of the numerous variables into smaller number of super variables to form the group of the measures (Jolliffe, 2002). This problem mostly happens in determining the relationship between socio-economic factors and crime incidences. Principal component analysis uses the correlation among the variables to develop a small set of components that empirically summarized the correlation

among the variables. Principal component analysis can also be used to determine the overall criminality. When the first eigenvector show approximately equal loadings on all variables then the first PC measures the overall crime rate. Usman et al (2012) also studied the crime rate in Sokoto state, and Shehu et al (2010) studied that of Kastina state, both in Nigeria.

The data used for this paper were collected from the Police State Headquarters, Ilorin, Kwara state from 2004 to 2014 on different crimes. Kwara state being a state in the North Central part of Nigeria with almost the same distance from Lagos and Abuja the federal capital and linked most of Southern part to the Northern part of Nigeria. Based on her geographical location, one may expect the crime rates in Kwara to be on a higher side. Most people that were being chased away from the far North of Nigeria by the Boko Haram insurgents are now residence in Kwara state. One can view these set of people as mixed multitude.

The main purpose of this research paper is to: identify the prominent crime types; determine the association that exist between pairs of crime types; reduce the dimension of the data using statistical tools; and classify the crime types under consideration in Kwara state into groups.

METHODOLOGY

In order to analyze and study the data described above, we employed Principal Component (PC), Descriptive Statistic, Biplot, and Correlation analysis.

Principal Component (PC) analysis is data analysis tool that is usually used to reduce the dimensionality (number of variables) of a large number of interrelated variables, while retaining as much of the information (variation) as possible. It calculates an uncorrelated set of variables or *factors*. These factors are ordered so that the first few retain most of the variation present in all of the original variables. (Richard & Dean, 2001; Rencher, 2002; Hardle & Simar, 2003; Hardle & Zdenek, 2007). The basic equation is in matrix notation, given by:

$$Y = W'X \quad (1)$$

Where *W* is a matrix of coefficients that is determined by Principal Components Analysis. The matrix of weights, *W*, is calculated from the variance-covariance matrix, *S*.

This matrix is calculated using the formula:

$$S_{ij} = \frac{\sum_{k=1}^{n}(x_{ik}-\bar{x}_i)(x_{jk}-\bar{x}_j)}{n-1} \quad (2)$$

The singular value decomposition of *S* provides the solution to the Principal Components Analysis problem.

This may be defined as: $USU = L$ (3)

Where *L* is a diagonal matrix of the eigenvalues of *S*, and *U* is the matrix of eigenvectors of *S*.

W is calculated from *L* and *U*, using the relationship

$$W = UL^{-\frac{1}{2}} \quad (4)$$

It should be noted that *W* is the eigenvector matrix *U*, scaled so that the variance of each factor y_i is unity.

The correlation between and i^{th} factor and the j^{th} original variable may be computed using the formula:

$$r_{IJ} = \frac{u_{ji}\sqrt{l_i}}{s_{jj}} \quad (5)$$

Here u_{ij} is an element of u, l_i is a diagonal element of *L*, and s_{jj} is a diagonal element of *S*.

The correlations are called the factor loadings and are provided in the *Factor Loadings* report.

When the correlation matrix, *R*, is used instead of the covariance matrix, *S*, the equation for *Y* must be modified.

The new equation is:

$$Y = W'D^{-\frac{1}{2}}X \quad (6)$$

Where *D* is a diagonal matrix made up of the diagonal elements of *S*.

Thus, the correlation formula may be simplified since the S_{jj} are equal to one.

Consider the covariance matrix of a bivariate data

$$\Sigma = \begin{pmatrix} \delta_{11} & \delta_{21} \\ \delta_{21} & \delta_{22} \end{pmatrix} \quad (7)$$

where $\delta_{12} = \delta_{11}$ and $a_{22} > a_{11}$, assume $\delta_{11}=1$ and $\delta_{22}=10$ (a large difference) and the derived correlation matrix

$$\rho = \begin{pmatrix} 1 & r_{12} \\ r_{21} & 1 \end{pmatrix} \quad (8)$$

Where $r_{12} = r_{21}$,

Because of its large variance, X_2 will completely dominate the first principal component determined from Σ.

Meanwhile, this first principal component explains a larger proportion of the total population variance as

$$\frac{\lambda_1}{\lambda_1+\lambda_2} = \psi_{x_i} \quad (9)$$

When the variables X_1 and X_2 are standardized, however, the resulting variables contributes equally to the principal components determine from ρ so that the first principal component of the total population variance is explained as

$$\frac{\lambda_1}{\lambda_1+\lambda_2} = \psi_{x_i} \quad (10)$$

Thus $\psi_{x1} \neq \psi_{xz1}$, the proportion of variance accounted for by the component of ρ differs from the proportion for $\sum$. Since the entries of the covariance and correlation matrices are different, then the coefficient (eigenvectors) of the PC obtained from ρ differs from those obtained from $\sum$, and therefore $\alpha_j X \neq \alpha_j Z$; the principal component derived from ρ are different from those obtained from $\sum$ (Rencher, 2002, Hardle & Simar 2003; Hardle & Zdenek, 2007).

For a random vector $X' = [X_1, X_2, \dots, X_p]$ the corresponding standardized variables are $Z' = [Z_1, Z_2, \dots, Z_p]$ so that $Cov(Z) = \rho$ (the correlation matrix of X). we denote the matrix of correlation between p variables by

$$\rho = \begin{pmatrix} 1 & r_{12\dots} & r_{1p} \\ r_{2p}M & 1 & r_{2p}M \\ r_{p1} & r_{2p}L & 1 \end{pmatrix} \quad (11)$$

And the vector of the coefficient (weight or loadings) on the p variable for the j^{th} component by

$$\alpha_j = \begin{bmatrix} \alpha_{ji} \\ \alpha_{j2} \\ . \\ . \\ . \\ \alpha_{jp} \end{bmatrix} \quad (12)$$

$j = 1,2 \dots, p$

The problem of determining the vector of α_j which maximizes:

(1) The variance accounted for by the first component,

(2) The variance accounted for by the second component, orthogonal to the first and so on, the solution for α_j can be solved by this equation

$(\rho - \lambda\, \mathrm{I})\, \alpha_j = 0 \quad (13)$

In which I is the identity matrix, α_j are the characteristic roots or eigenvalue of ρ and the α_j 's are the associated eigenvectors.

In other words, let X be a vector of p random variables, the main idea of the Principal Component transformation is to look for a few below p derived variables that preserved most of the information given by the variance of the p random variables. Let the random vector $X' = [X_1, X_2 \dots, X_P]$ have the covariance matrix with eigenvalues $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0$

The linear combinations is given by

$$Y = \alpha_j' X = \alpha_{J1} X_1 + \alpha_{J2} X_2 \dots + \alpha_{jp} X_P = \sum_{K=1}^{P} \alpha_{JK} X_K, \quad \text{j=1,2…,p} \quad (14)$$

of the element of X, where α_J' is a vector of p components $(\alpha_{J1}, \alpha_{J2}, \alpha_{jp} \dots, \alpha_{jp}.)$

The variance and covariance matrix is

$$Var(Y_j) = \alpha_j' \Sigma \alpha_{j,} \quad j=1,2\dots,p \quad (15)$$

$$Cov(Y_j, Y_k) = \alpha_j' \Sigma \alpha_k \quad \text{j,k=1,2…,p} \quad (16)$$

The PCs are those *uncorrelated* linear combinations $Y_1, Y_2, \dots, Y_p$ whose variances in (15) are as large as possible. In finding the PCs we concentrate on the variances. First, we look for a linear combination with maximum variance, so that

$$\alpha_j' X = \alpha_{11} X_1 + \alpha_{12} X_2 + \dots + \alpha_{1p} X_p = \sum_{k=1}^{p} \alpha_{1k} X_k$$

Next, we look for a linear combination $\alpha_2' X$ uncorrelated with $\alpha_1' X$ having maximum variance, and so on, so that at the K^{th} stage a linear combination $\alpha_k' X$ is found that has maximum variance subject to being uncorrelated with $\alpha_1' X, \alpha_2' X, \dots, \alpha_{k-1}' X$. . The k^{th} derived variable $\alpha_k^1 X$ is the k^{th} Principal Component. Up to p Principal Components could be found, but we must stop after the q^{th} stage ($q \leq p$) when most of the variation in X have been accounted for by q Principal Components (Richard & Dean, 2001; Hardle & Zdenek, 2007).

The variance of a Principal Component is equal to the eigenvalue corresponding to that Principal Component,

$$Var(Y_j) = \alpha_j' \Sigma \alpha_j = \lambda_j \quad \text{j=1, 2…, p} \quad (17)$$

The total variance in a data set is equal to the total variance of Principal Components

$$\sigma_{11} + \sigma_{22} + \cdots + \sigma_{pp} = \sum_{j=1}^{p} Var(X_j) = \lambda_1 + \lambda_2 + \cdots \lambda_p = \sum_{j=1}^{p} Var(Y_j) \quad (18)$$

The data was standardized for the variables to be

of similar scale using a common standardization method of transforming all the data to have zero mean and unit standard deviation. For a random vector $X' = [X_1, X_2, \ldots, X_P]$ the corresponding standardized variables are

$$Z = \left\{ z_j = \frac{(X_J - \mu_J)}{\sqrt{\sigma_{jj}}} \right\} \quad j = 1, 2, \ldots, p \qquad (19)$$

In matrix notation,

$$Z = (V^{1/2})^{-1}(X - \mu) \qquad (20)$$

Thus E(Z) = 0 and Cov(Z)=ρ

The Principal Components of *Z* can be obtained from eigenvectors of the correlation matrix ρ of *X*. All our previous properties for *X* are applied for the *Z*, so that the notation Y_j refers to the j^{th} Principal Component and (λ_j, α_j) refers to the eigenvalue – eigenvector pair. (Richard and Dean, 2001; Hardle & Zdenek, 2007).

The j^{th} Principal Component of the standardized variables $Z^1 = [z_1, z_2 \ldots, z_p]$ with Cov (Z) =ρ is given by

$$Y_j = \alpha_j' Z = \alpha_j' (V^{1/2})^{-1}(X - \mu) \qquad (21)$$

so that

$$\sum_{j=1}^{p} Var(Y_j) = \sum_{j=1}^{p} Var(Z_j) = P$$

j=1, 2…, p (22)

In this case, $(\lambda_1, \alpha_1), (\lambda_2, \alpha_2), \ldots (\lambda_p, \alpha_p)$ are the eigenvalue- eigenvector pairs for with $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0$ as obtained before.

RESULTS AND DISCUSSIONS

In Table 1, we have descriptive statistics of all the crimes, which includes the mean, the standard deviation as well as the number of years under consideration.

Table 1: Descriptive Statistics.

Descriptive Statistics			
	Mean	Std. Deviation	No. of years
Homicide	25.6364	10.69834	11
Suicide	3.4545	2.84125	11
Robbery	65.5455	31.80680	11
Kidnapping	3.8182	5.23103	11
Rape	14.8182	9.15225	11
Assault	81.6364	63.29972	11
Broken	103.7273	95.93966	11
Theft	136.1818	176.38244	11
Unlawful	23.4545	17.51207	11
Arson	12.0000	19.26136	11

The pair wise correlation analysis for all the crimes under consideration are presented in Table 2.

Table 2: Correlation Analysis

Correlation	Homicide	Suicide	Robbery	Kidnapping	Rape	Assault	Broken	Theft	Unlawful	Arson
Homicide	.661	.897	.193	.471	.212	.177	-.273	.443	-.023	
Suicide		.731	-.202	.480	-.053	.023	-.428	.239	-.175	
Robbery			-.074	.229	.098	.264	-.088	.488	-.086	
Kidnapping				.310	.356	-.095	-.254	-.051	.553	
Rape					.011	-.305	-.574	-.089	.031	
Assault						.721	.209	.644	.015	
Broken							.642	.916	-.497	
Theft								.431	-.421	
Unlawful									-.515	
Arson										

a. Determinant = 5.44E-006

In Table 3, we present the inverse of pair wise correlation matrix for all the crimes under consideration.

Table 3: Inverse of Correlation Matrix.

Inverse of Correlation Matrix										
	Homicide	Suicide	robbery	Kidnapping	Rape	Assault	broken	theft	unlawful	Arson
Homicide	18.924	4.174	-19.845	-3.587	-1.789	-5.286	6.500	2.955	-1.006	5.540
Suicide	4.174	6.960	-7.925	.497	-2.541	1.281	-6.248	4.778	3.611	1.186
Robbery	-19.845	-7.925	25.801	3.931	1.832	6.441	-3.503	-5.069	-4.503	-8.154
Kidnapping	-3.587	.497	3.931	3.392	-1.159	1.255	-1.950	-.106	-.894	-2.991
Rape	-1.789	-2.541	1.832	-1.159	4.109	-3.270	7.298	-1.593	-1.961	2.181
Assault	-5.286	1.281	6.441	1.255	-3.270	11.707	-19.061	3.705	3.892	-6.026
Broken	6.500	-6.248	-3.503	-1.950	7.298	-19.061	48.938	-12.074	-22.647	7.475
Theft	2.955	4.778	-5.069	-.106	-1.593	3.705	-12.074	7.194	5.710	.489
Unlawful	-1.006	3.611	-4.503	-.894	-1.961	3.892	-22.647	5.710	19.271	1.791
Arson	5.540	1.186	-8.154	-2.991	2.181	-6.026	7.475	.489	1.791	7.158

We present the probability (p) values for the pair wise correlation of all the crimes under considerations at 5% level of significance in Table 4.

Table 4: P-values for Correlation at 5% level of significance.

Correlation	Homicide	Suicide	Robbery	Kidnapping	Rape	Assault	Broken	Theft	Unlawful	Arson
Homicide		**.013****	**<.001****	.284	.072	.266	.301	.209	.086	.473
Suicide			**.005****	.275	.067	.438	.473	.094	.240	.303
Robbery				.415	.249	.387	.216	.399	.064	.401
Kidnapping					.176	.141	.390	.226	.440	.039
Rape						.488	.181	**.032****	.397	.464
Assault							**.006****	.269	.016	.482
Broken								**.017****	**<.001****	.060
Theft									.093	.099
Unlawful										.053
Arson										
a. Determinant = 5.44E-006										

The pair wise correlation test of significance table indicates that out of the 45 pair wise correlations only 6 are significant at 5% level of significance and this includes; homicide-suicide, homicide-robbery, suicide-robbery, rape-theft, assault-broken, broken-theft and broken-unlawful.

In Table 5, we present the analysis of the eigen value of the crimes under consideration.

Table 5: Eigen value analysis.

Total Variance Explained	Initial Eigenvalue		
Components	Total	% of Variance	Cumulative %
1	3.437	34.370	34.370
2	2.997	29.974	64.344
3	1.779	17.789	82.133
4	.809	8.085	90.218
5	.467	4.671	94.890
6	.227	2.271	97.161
7	.177	1.767	98.928
8	.074	.741	99.668
9	.020	.198	99.866
10	.013	.134	100.000

In Figure 1, we present the scree plot of the eigen values

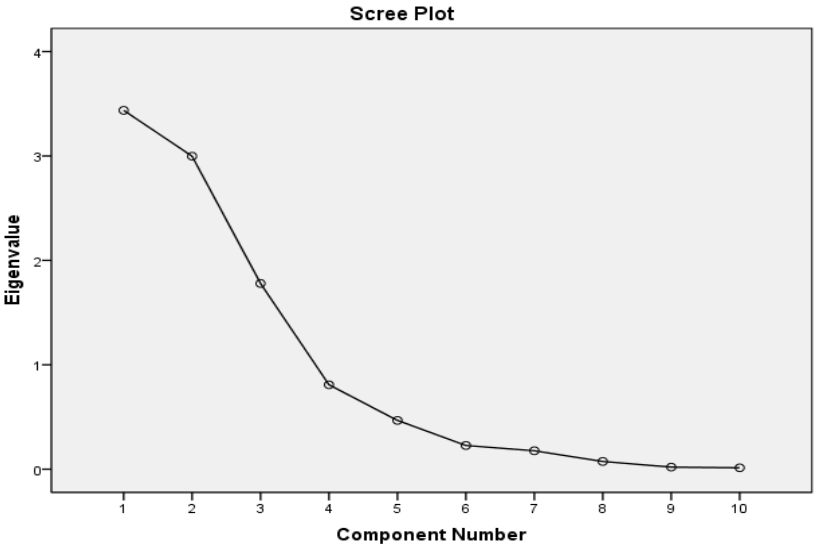

Figure 1: Scree plot of Eigen value.

We present the first three eigen values selected from Table 5 in Table 6 with their both extraction and rotation sums of squared loadings.

Table 6: Three Eigen value selected

Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Total	% of Variance	Cumulative %	To tal	% of Variance	Cumulative %
3.437	34.370	34.370	3.112	31.115	31.115
2.997	29.974	64.344	3.070	30.695	61.811
1.779	17.789	82.133	2.032	20.322	82.133

From Tables 5 and 6, only three factors in the initial solution have eigenvalue greater than 1.

Together, they account for almost 82% of the variability in the original variables. This suggests that three latent (unobservable) influences are associated with crimes in Kwara State, but there remains room for a lot of unexplained variation.
In Table 7, we have the eigen vector for the crimes under consideration for the principal component.

Table 7: Eigen vector obtained

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
Homicide	0.3278	-0.411	-0.0469	0.2061	-0.2891	0.0686	-0.4295	0.3159	-0.5262	-0.1717
Suicide	0.2377	-0.4163	0.2805	-0.0122	0.3592	-0.05	0.6809	0.1739	-0.2408	0.089
Robbery	0.363	-0.3305	0.1245	0.4545	-0.1612	-0.1072	-0.0514	-0.0598	0.6911	0.1252
Kidnapping	-0.0724	-0.1607	-0.6516	-0.0457	-0.4082	0.3898	0.4353	0.1412	0.11	0.0465
Rape	0.0081	-0.4385	-0.0685	-0.6355	-0.248	-0.4827	-0.0431	-0.2904	0.0756	-0.1125
Assault	0.3155	0.0927	-0.5148	-0.1752	0.4573	-0.2813	-0.2085	0.3842	0.1086	0.3241
Broken	0.4645	0.261	-0.1349	-0.0443	0.1247	0.0126	0.1488	-0.0615	0.1161	-0.8005
Theft	0.2031	0.4594	0.0404	0.1622	-0.4994	-0.544	0.2957	0.1106	-0.2034	0.1825
Unlawful	0.511	0.0977	-0.0928	-0.0658	0.0173	0.2903	-0.032	-0.6636	-0.2386	0.3653
Arson	-0.2851	-0.1818	-0.4252	0.5306	0.2427	-0.37	0.0617	-0.3976	-0.2148	-0.1396

We present the first three selected principal components for the crimes in Table 8.

Table 8: Three principal components selected

Variable	PC1	PC2	PC3
Homicide	**0.3278**	-0.411	-0.0469
Suicide	**0.2377**	-0.4163	**0.2805**
Robbery	**0.363**	-0.3305	**0.1245**
Kidnapping	-0.0724	-0.1607	-0.6516
Rape	0.0081	-0.4385	-0.0685
Assault	**0.3155**	0.0927	-0.5148
Broken	**0.4645**	**0.261**	-0.1349
Theft	**0.2031**	**0.4594**	0.0404
Unlawful	**0.511**	0.0977	-0.0928
Arson	-0.2851	-0.1818	-0.4252

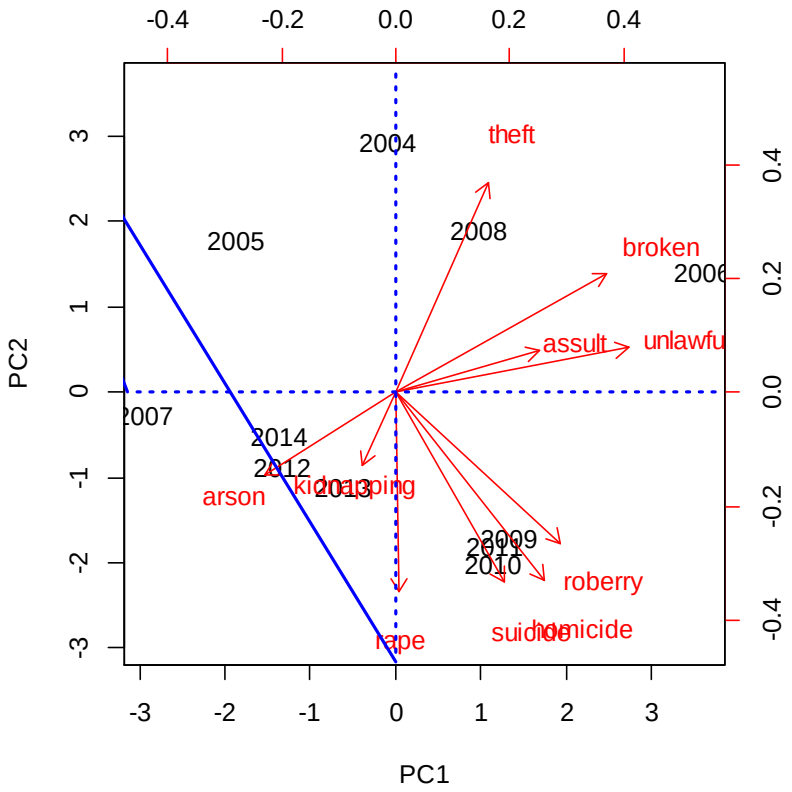

Figure 2: Biplot of component 1 and 2.

The red arrows (crime type) indicate the factor loading for the components while the black point (year) indicate the score for each of the components. The first component (Figure 2) rank unlawful as the highest crime type which is more prominent in the year 2006. It can also be observed that assault, unlawful, broken and theft are the most peculiar crime type in year 2006 and 2008 as indicated by the two principal components. Component 1 also categories theft, suicide and homicide as also very high. The two components rank rape, kidnapping and arson as very low crime type in the state. Component 2 (Figure 3) indicate that crime rate is very high in the year 2004 which might be attributed to the crime type indicted to be peculiar to the two principal components.

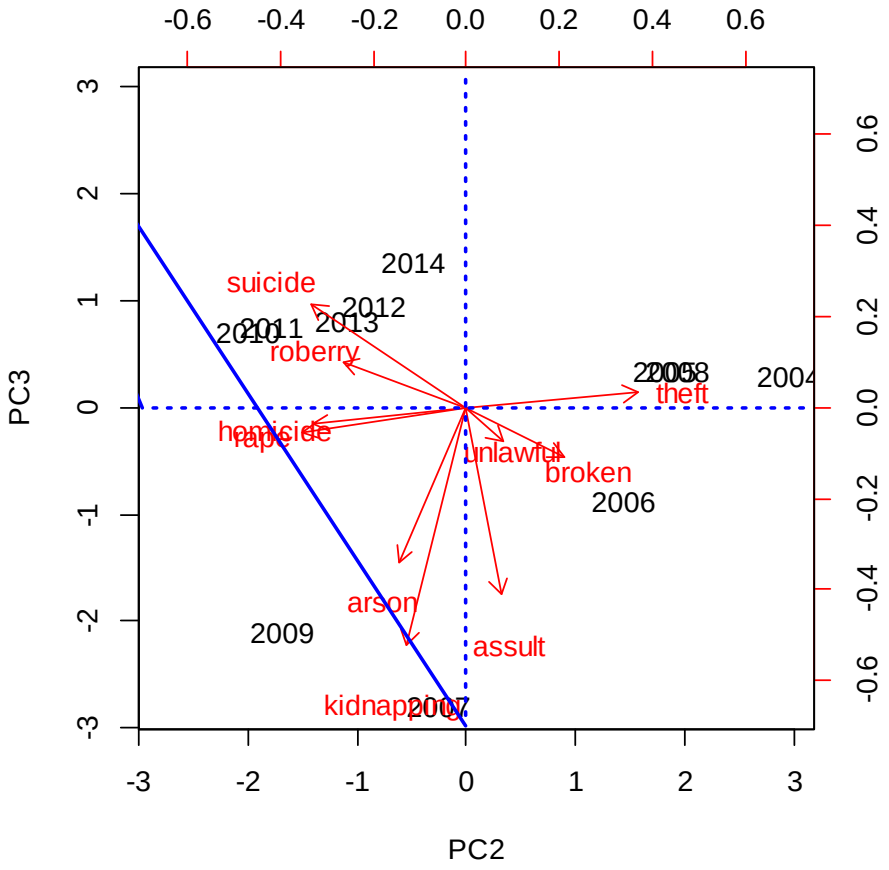

Figure 3: Biplot of component 2 and 3.

The second component rank theft as the highest crime type which is more prominent in the year 2004. It can also be observed that assault, unlawful, broken and theft are the most peculiar crime type in year 2004, 2005, 2006 and 2008 as indicated by the component 2. The two components rank kidnapping and arson as very low crime type in the state.

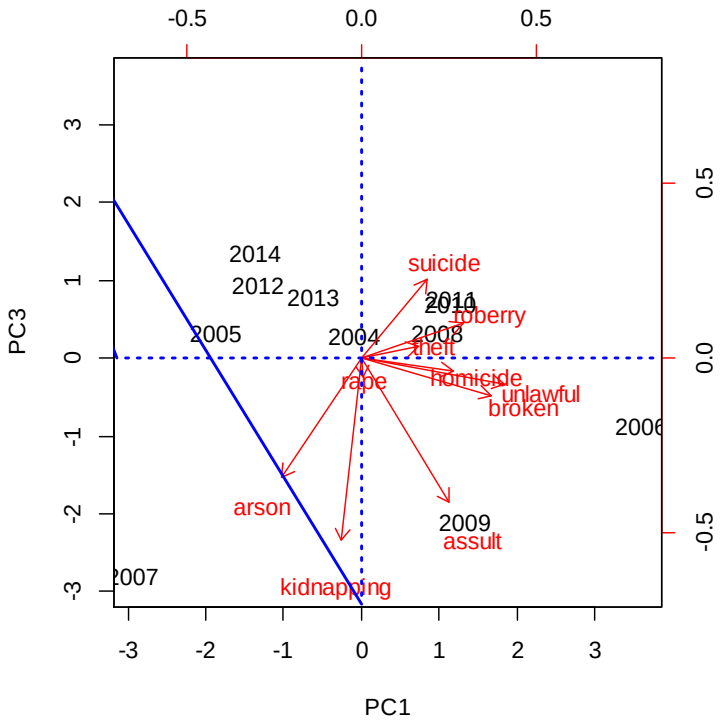

Figure 4: Biplot of component 1 and 3.

The third component (Figure 4) rank suicide as the highest crime type which is more prominent in the year 2014. It can also be observed that suicide, robbery, and theft are the most peculiar crime type in year 2010, 2011 and 2008 as indicated by the component. The two components rank kidnapping and arson as very low crime type in the state.

CONCLUSION

Based on the various analyses, it can be concluded that there exists bivariate association between some of the factors considered, the pairs involved are homicide-suicide, homicide-robbery, suicide-robbery, rape-theft, assault-broken, broken-theft and broken-unlawful. We observed that the optimal number of components for the data is 3, and the percentage of variation accounted by the components is about 82%. We also observed that Crime type, such as assault, unlawful, broken and theft can be grouped together as the most frequent type of crime committed; the prevailing cases occurred in the year 2006 and 2008. Also, suicide, homicide and robbery formed the next group and they were more frequent in the year 2009, 2010 and 2011. Kidnapping and arson are not frequently committed but they are more prominent in the year 2012 and 2013. Rape formed the lowest standalone crime type committed and also less frequent with no year of prevailing occurrence.

REFERENCES

1. CARVELL I.G. and SWINFEN G.E., 1970. *Criminal law and procedure. London: Sweet and Maxwell.*

2. FELDMAN M.P., 1997. *The psychological of crime*. Cambridge: University Press. Financial Times (2009). London, Thursday 30/04/2009.

3. HARDLE W. and SIMAR L, 2003. *Applied Multivariate Statistical analysis, 2nd edition*. New York: Springer-verlag.

4. HARDLE W. and ZDENEK H., 2007. *Multivariate Statistics: Exercises and Solutions*. New York:Springer-verlag.

5. HORTON E., 1939. *The American Criminal*, Cambridge, MA. Harvard University press.

6. JOLLIFFE I.T., 2002. *Principal Component Analysis 2nd edn*. New York: Springer-verlag.

7. LOIS S., COOKIE W.S., LOUIS A.Z. and SHELDON R.E., 1981. *Human Response to Social problems*. Illinois: The Dorsey Press.

8. RENCHER A.C., 2002. *Methods Multivariate Analysis, 2nd edn*. New York: Wiley.

9. RICHARD A.J. and DEAN W.W., 2001. *Applied Multivariate Statistical Analysis, 3rd edn*. NewDelhi: Prentice-Hall.

10. SHEHU U., GULUMBE H.G, DIKKO and YUSUF Bello, 2010. Analysis of Crime Data Using Principal Component Analysis: A case study of Kastina State. *CBN Journal of Applied Statistics, 3(2).*

11. SUTHERLAND E.H., 1939. The white-colar criminal. *American Sociological Review, 5: 1-12*

12. USMAN U., YAKUBU M. and BELLO A. Z., 2012. An Investigation on the Rate of Crime in Sokoto State Using Principal Component Analysis. *Nigeria Journal of Basic and Applied Science, 20(2).*

13. UCHE O., 2008. *Nigeria Prison Robbed by Criminals.* http://www.whichwayNigeria.net /Nigerian-prison-robbed-criminals/ (7/10/2013).

14. UN, 1995. States in Disarray: The Social Effects of Globalization. *UN Research Institute for social Development.*

15. WBE, 1974. The World Book Encyclopedia. Vol. 4. USA. *Field Enterprises Educational Corporation. Pp. 908 -912.*