Cases of Road Traffic Accident in Nigeria: A Time Series Approach

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Abstract

Road traffic accident in Nigeria is increasing at a disturbing rate and has raised one of the country major concerns. We provide appropriate and suitable time series model for the cases of road accident; the minor cases, the serious cases, the fatal cases and the total cases of road accident in Nigeria. The most widely used conventional method of time series known as Autoregressive Integrated Moving Average (ARIMA) model (also known as Box-Jenkins method) is applied to the annual cases of road accident data in Nigeria from 1960-2013, to determine patterns of road traffic accident cases along the Nigeria motorway. Appropriate models are developed for the minor cases, the serious cases, the fatal cases and the total cases. ARIMA (1,1,1) model is obtained for the minor and total cases, ARIMA (1,1,0) model is obtained for the serious cases, while ARIMA(0,1,1) model is obtained for the fatal cases using data from 1960-2011. Data from 2012 to 2013 is used to test the adequacy and performance of the models. The models are then used to forecast the different cases from 2014 till 2020, and the forecast show an average increase in the data for the cases considered.

Keywords: *ARIMA, Forecast, Minor, Fatal, Serious, Total.*

1. Introduction

Road traffic accident is an issue of concern in Nigeria, and the world at large, which accounts for over one million death in the world yearly. The World Health Organization (WHO) classified road traffic accident as one of the top ten causes of death in the world, using International Statistical Classification of Diseases and Related Health Problems (ICD) (Organization, 2013). The Global status report on road safety 2013 presents information on road safety from 182 countries, accounting for almost 99% of the world's population (Organization, 2013). The report indicates that worldwide, the total number of death due to road traffic remains unacceptably high at 1.24 million per year. Only 28 countries, covering 7% of the world's population, have comprehensive road safety laws on five key risk factors: drinking and driving, speeding, failing to use motorcycle helmets, failing to use seat-belts, and child restraints (Organization, 2013). Cases of road traffic accident is increasing in recent years in Nigeria, due to nonchalant attitude of the government to road construction, and violation of traffic rules by motor users in the country. This shows that the causes of road traffic accident are multi-factorial, ranging from government factor (inability to construct motorable roads), drivers' factor (violating traffic rules; exceeding speed limit, using out-modeled cars, drinking or making mobile call while driving, etc). Use of Motor-bikes had inflated the number of road traffic accident cases until recently when some state government banned their usage on major roads in Nigeria. These cases will increase to an alarming rate if government do not pay attention to construction of roads and providing strong penalties against road traffic violators.

WHO forecasted that about 21548 and 20404 deaths will occur due to road traffic accident in 2011 and 2013 respectively (Promotion & Prevention, 2013). Boakye Agyemang (Agyemang, Abledu, & Semevoh, 2013) worked on the statistical analysis of the systematic yearly increase in the number of accidents. He used data on yearly road traffic accidents and population values of Ghana for the period 1990 to 2012, and found out the following; a systematic obvious pattern of growth in both road traffic accidents and population for the year 1990 to 2012; a strong positive correlation between road traffic accidents and population for the year 1990 to 2012; and a regression model for estimating and forecasting the data.

David Krivec et al in a conference in Republic of Slovenia for Road Safety in 2005, used ARIMA $(1,0,0)(0,1,1)_{12}$

with constant and regressor for a short-term forecast of fatalities and severely injured persons involved in road traffic accidents in Slovenia (Series et al., 2006). Box-Jenkins approach was used to analyze annual road accident data between 1980 and 2010 to determine the patterns of road traffic accident cases, injuries and deaths along the Accra-Tema motorway (Okutu, 2011). They used ARIMA (1,1,1) to fit injury and death data while accident cases data ware modelled with ARIMA (0,1,2). The forecast of their models showed that the cases will continue to increase.

Frequency of traffic related mortalities is increasing worldwide. It was estimated that by continuing the current trends for road traffic accidents to 2020, proportion of deaths will increase up to 83% in middle and low income countries and up to 27% in high-income communities (Peden, 2004), (Mohan, Padmanabhan, & Ramjee, 2008). In the middle and low income countries, there will be about 83% increase in the proportion of death, and about 27% increase in the proportion of death in the high-income communities by 2020 if the current trend of road accidents continues.

Short-term traffic volume forecast can be carried out using one of the newly opined time series methods. Nihan & Holmesland, 1980 fits model on monthly volume on a freeway segment from year 1968 to year 1976, and used the model to forecast for year 1977. They compared the result with the actual volume of 1977, and concluded that time series technique can be used to accurately and inexpensively forecast data for short time.

Time series analysis is a method of describing the inherent nature of data over time, and using it to predict the future (Hosseini, Yavarifar, & Yavarifar, 2014). The basic approaches to forecasting time series data are the self-projecting time series approach and the cause-and-effect time series approach. The former uses only the time series data for forecasting while the latter relies on the inherent series assumed to cause the pattern of the original series. Moreover, the self-projecting time series approach is not expensive to apply, it requires less data and it performs better for short and long-term forecast. The univariate version of Box-Jenkins method is a self-projecting time series forecasting method, hence, we adopt the Box-Jenkins method to explain and model our data. This requires the data to be stationary, and differencing will be used to make the data stationary if it is not stationary.

This study provides appropriate and suitable time series model for the cases of road accident; the minor cases, the serious cases, the fatal cases and the total cases of road accident in Nigeria. The most widely used conventional method of time series known as Box-Jenkins method is applied to the annual cases of road accident data in Nigeria from 1960-2013, to determine patterns of road traffic accident cases along the Nigeria's motorway.

2. Materials and Method

Data used for the analyses was collected from Federal Road Safety Corps (FRSC), Nigeria. FRSC is the body in charge of road safety administration such as ensuring safety of motorists on roads, teaching the general public on the etiquettes of highway, recommending devices meant for reducing accidents on the highways, among others. Accidents caused by road traffic are in different cases, ranging from the minor cases, the serious cases to the fatal cases. In this paper, we collected data from 1960 to 2013 and data from 1960 to 2011 will be used to model the cases of road accident; the minor cases, the serious cases and the fatal cases, and data from 2012 to 2013 will be used for model validation, while the models are used to forecast the future cases of road accidents from 2014 to 2020. Box-Jenkins method will be used to derive models for forecasting these data. This method is preferred because of its high accuracy in forecasting data, especially within a short to medium term period. Its model simplicity gives it an advantage of cost and response time, because high cost is required to run and set up complex models (Nihan & Holmesland, 1980).

3. Model Building

In theory, Auto-regressive Integrated Moving Averages ARIMA Models (Box Jenkins) are the most universal class of models for forecasting a time series data. As proposed by Box and Jenkins, that in general, forecasting based on ARIMA models comprises of three different steps:

Model Identification, Parameter estimation and Diagnostic checking. Until a desirable model for the data is identified, the three steps will be repeated (Box, Jenkins, & MacGregor, 1974). The method of Box and Jenkins dictates an iterative process requiring a sound understanding of time series analysis technique, some degree of judgement and many rounds of trials (Wu, 2013). Meanwhile, It is worth mentioning here that because of the volume of the work, the best models out of several competing models that explain the variables under study are included in the work.

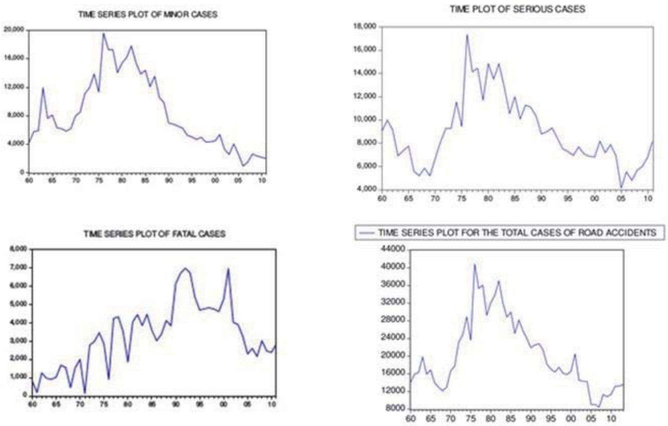


Figure 1: Time Series Plots of Minor, Serious, fatal and Total Cases of Road Accidents

Figure (1) shows the time plots of the minor cases, the serious cases, the fatal cases and the total cases of road traffic accident in Nigeria from year 1960 to 2013. The series exhibit non-stationary behaviour.

3.1 Unit root test

Also, the series were tested for stationarity by using the unit root test. Figure (2) and Figure (3) show that the series are insignificant with p-values greater than 5%. Hence, there is need to difference the data so as to make it stationary. The time series plot of the first difference series are shown in Figure (4).

UNIT ROOT TEST FOR THE MINOR CASES

Null Hypothesis: MNR has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.810643	0.3599
Test critical values:	1% level	-2.611094	
	5% level	-1.947381	
	10% level	-1.612725	

*MacKinnon (1996) one-sided p-values.

UNIT ROOT TEST OF THE SERIOUS CASES DATA

Null Hypothesis: SERUS has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.628344	0.4401
Test critical values:	1% level	-2.612033	
	5% level	-1.947520	
	10% level	-1.612650	

*MacKinnon (1996) one-sided p-values.

Figure 2: Unit Root Tests of Minor and Serious Cases of Road Accidents

UNIT ROOT OF FATAL CASES

Null Hypothesis: FATAL has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.948034	0.3016
Test critical values:	1% level	-2.611094	
	5% level	-1.947381	
	10% level	-1.612725	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: TOTAL has a unit root
Exogenous: None
Lag Length: 1 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.485404	0.5009
Test critical values:	1% level	-2.610192	
	5% level	-1.947248	
	10% level	-1.612797	

*MacKinnon (1996) one-sided p-values.

Figure 3: Unit Root Tests of fatal and Total Cases of Road Accidents

The correlogram plots of the first difference, in Figure (5) appear to be stationary with significant spikes within the first two lags. These are buttressed by the unit root tests of the series in Figure (6). The probability values of the unit root tests are all below 5%, indicating that the data are now stationary. The order of the ARIMA models would be guessed from the correlogram plots to determine the best models to model the series.

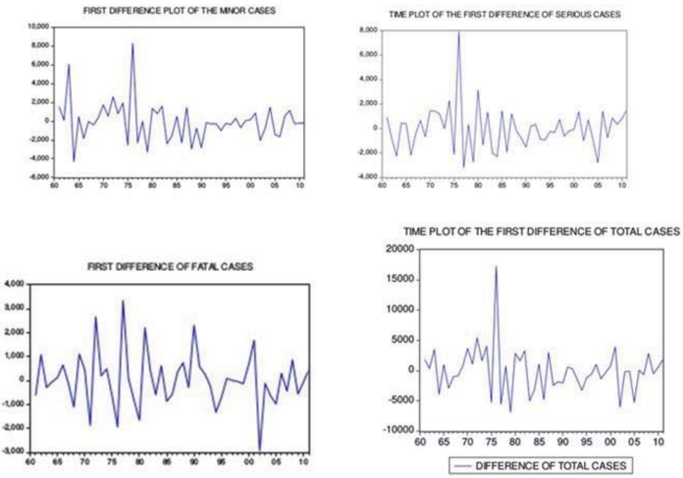


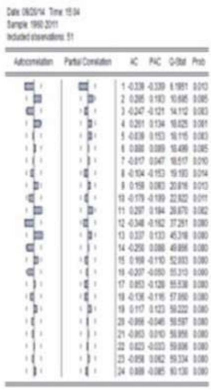
Figure 4: Time Series Plot of the First Difference for The Minor, Serious, fatal and Total Cases of Road Accidents

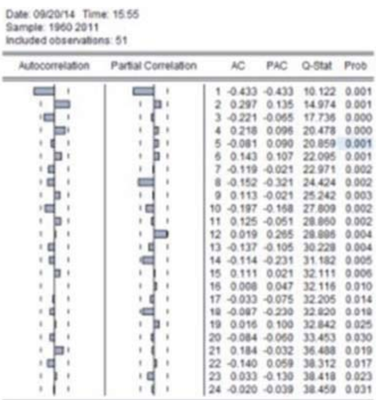
3.2 Model Outputs

From the correlogram plots in Figure (5), many competing models were guessed. Out of all the competing models, the best models for minor, serious, fatal and total cases of road accident are ARIMA(1,1,1), ARIMA(1,1,0), ARIMA(0,1,1) and ARIMA(1,1,1) respectively.

The outputs are displayed in Figure (7). All the variables are significants and their respective Durbin-Watson statistics values are close to 2, suggesting that some of the serial correlation were eliminated in the error terms. The error terms are not serially correlated (because the error terms of a good model must not be serially correlated). Moreover, the R-squared value, which tells us the percentage of the dependent variable that is explained by the independent(s) variable(s), is low. This indicates that a differenced data is harder to fit than a level data.

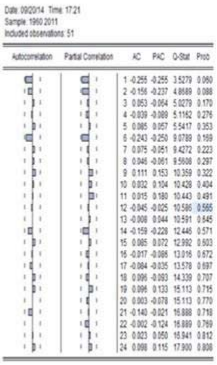
4. Residual Diagnostic





Date: 09/20/14 Time: 15:55
Sample: 1960 2011
Included observations: 51

	AC	PAC	Q-Stat	Prob
1	-0.433	-0.433	10.122	0.001
2	0.297	0.135	14.974	0.001
3	-0.221	-0.065	17.736	0.000
4	0.218	0.096	20.478	0.000
5	-0.081	0.090	20.859	0.001
6	0.143	0.107	22.095	0.001
7	-0.119	-0.021	22.971	0.002
8	-0.152	-0.321	24.424	0.002
9	0.113	-0.021	25.242	0.003
10	-0.197	-0.168	27.809	0.002
11	0.125	-0.051	28.860	0.002
12	0.019	0.265	28.886	0.004
13	-0.137	-0.105	30.228	0.004
14	-0.114	-0.231	31.182	0.005
15	0.111	0.021	32.111	0.006
16	0.008	0.047	32.116	0.010
17	-0.033	-0.075	32.205	0.014
18	-0.087	-0.230	32.820	0.018
19	0.016	0.100	32.842	0.025
20	-0.084	-0.060	33.453	0.030
21	0.184	-0.032	36.488	0.019
22	-0.140	0.059	38.312	0.017
23	0.033	-0.130	38.418	0.023
24	-0.020	-0.039	38.459	0.031



Date: 09/20/14 Time: 17:21
Sample: 1960 2011
Included observations: 51

	AC	PAC	Q-Stat	Prob
1	-0.255	-0.255	3.5279	0.060
2	-0.156	-0.237	4.8689	0.088
3	0.053	-0.064	5.0279	0.170
4	-0.039	-0.089	5.1162	0.276
5	0.085	0.057	5.5417	0.353
6	-0.243	-0.250	9.0789	0.169
7	0.075	-0.051	9.4272	0.223
8	0.046	-0.061	9.5608	0.297
9	0.111	0.153	10.359	0.322
10	0.032	0.104	10.428	0.404
11	0.015	0.180	10.443	0.491
12	-0.045	-0.025	10.586	0.565
13	-0.008	0.044	10.591	0.645
14	-0.159	-0.228	12.446	0.571
15	0.085	0.072	12.992	0.603
16	-0.017	-0.086	13.016	0.672
17	-0.084	-0.035	13.578	0.697
18	0.096	-0.093	14.339	0.707
19	0.096	0.133	15.113	0.715
20	0.003	-0.078	15.113	0.770
21	-0.140	-0.021	16.888	0.718
22	-0.002	-0.124	16.889	0.769
23	0.023	0.050	16.941	0.812
24	0.098	0.115	17.900	0.808

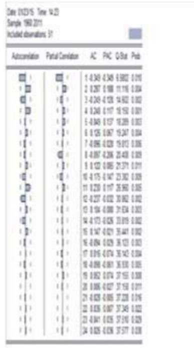


Figure 5: Correlogram Plot for the first difference of the Minor, Serious, fatal and Total Cases of Road Accidents

Figure (8) and Figure (9) show the correlogram plots of residuals for the best models of the series. The probability values of the Q-statistics are all greater than 5%, indicating that the residuals are all White Noise, that is, they are not forecastable. Model with a non-forecastable residuals will yield a good out-sample forecast with minimum error. The residual plots are shown in Figure (10), the random effect of the residuals are evident in the plots.

UNIT ROOT TEST OF THE FIRST DIFFERENCE SERIES.

Null Hypothesis: DM has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.00875	0.0000
Test critical values:	1% level	-2.612033	
	5% level	-1.947520	
	10% level	-1.612650	

*MacKinnon (1996) one-sided p-values.

UNIT ROOT TEST OF THE DIFFERENCED SERIES; SERIOUS CASES

Null Hypothesis: DS has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.14274	0.0000
Test critical values:	1% level	-2.612033	
	5% level	-1.947520	
	10% level	-1.612650	

*MacKinnon (1996) one-sided p-values.

UNIT ROOT TEST FOR THE FIRST DIFFERENCE OF ARIMA(0,1,1); FATAL CASES

Null Hypothesis: DF has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.096125	0.0000
Test critical values:	1% level	-2.612033	
	5% level	-1.947520	
	10% level	-1.612650	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: DTC has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=0)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.448009	0.0051
Test critical values:	1% level	-4.234491	
	5% level	-2.349470	
	10% level	-1.656218	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 2

Figure 6: Unit Root Tests of the First Difference of Minor, Serious, fatal and Total Cases of Road Accidents

ARIMA(1,1,1) OUTPUT OF THE MINOR CASE

Dependent Variable: D(MNR)
Method: Least Squares
Date: 09/20/14 Time: 15:02
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments
Convergence achieved after 12 iterations
MA Backcast: 1961

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.815892	0.142611	-5.721099	0.0000
MA(1)	0.607063	0.206097	2.945527	0.0050

R-squared	0.188277	Mean dependent var	-75.78000
Adjusted R-squared	0.171366	S.D. dependent var	2114.743
S.E. of regression	1925.037	Akaike info criterion	18.00246
Sum squared resid	1.78E+08	Schwarz criterion	18.07894
Log likelihood	-448.0614	Hannan-Quinn criter.	18.03158
Durbin-Watson stat	1.949005		

Inverted AR Roots	-.82
Inverted MA Roots	-.61

MODEL OUTPUT OF ARIMA(1,1,0); SERIOUS CASES

Dependent Variable: D(SERIUS)
Method: Least Squares
Date: 09/20/14 Time: 15:43
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.438836	0.129128	-3.398465	0.0014

R-squared	0.190481	Mean dependent var	-32.50000
Adjusted R-squared	0.190481	S.D. dependent var	1815.832
S.E. of regression	1633.764	Akaike info criterion	17.65496
Sum squared resid	1.31E+08	Schwarz criterion	17.69320
Log likelihood	-440.3739	Hannan-Quinn criter.	17.66952
Durbin-Watson stat	1.852321		

Inverted AR Roots	-.44

OUTPUT OF ARIMA(0,1,1); FATAL CASES

Dependent Variable: D(FATAL)
Method: Least Squares
Date: 09/20/14 Time: 17:15
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments
Convergence achieved after 6 iterations
MA Backcast: 1960

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MA(1)	-0.406170	0.129303	-3.141234	0.0028

R-squared	0.103770	Mean dependent var	39.49020
Adjusted R-squared	0.103770	S.D. dependent var	1136.340
S.E. of regression	1075.766	Akaike info criterion	16.81887
Sum squared resid	57863638	Schwarz criterion	16.85675
Log likelihood	-427.8811	Hannan-Quinn criter.	16.83334
Durbin-Watson stat	1.872692		

Inverted MA Roots	.41

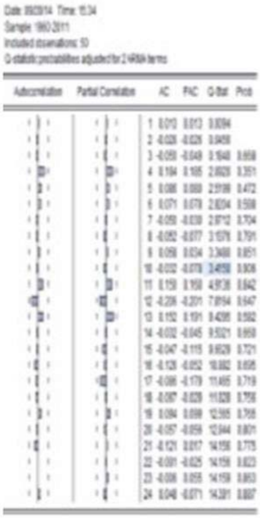
Dependent Variable: D(TC)
Method: Least Squares
Date: 01/23/15 Time: 14:25
Sample (adjusted): 1962 2011
Included observations: 50 after adjustments
Convergence achieved after 20 iterations
Backcast: 1961

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.787679	0.186703	-4.218891	0.0001
MA(1)	0.519769	0.261594	1.986930	0.0052

R-squared	0.166752	Mean dependent var	-55.34000
Adjusted R-squared	0.149392	S.D. dependent var	3827.846
S.E. of regression	3530.361	Akaike info criterion	19.21537
Sum squared resid	5.98E+08	Schwarz criterion	19.29185
Log likelihood	-478.3842	Durbin-Watson stat	1.956111

Inverted AR Roots	-.79
Inverted MA Roots	-.52

Figure 7: Time Series Models for Minor, Serious, fatal and Total Cases of Road Accidents



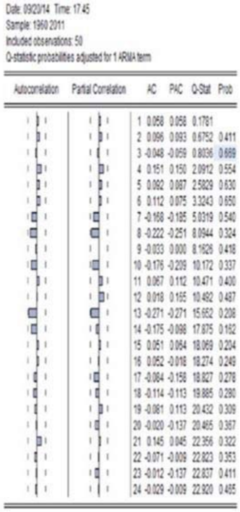
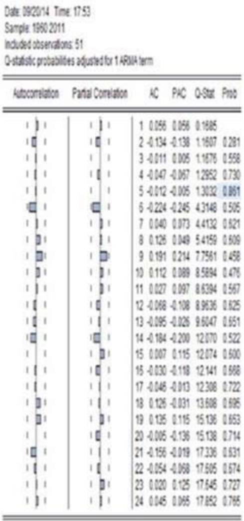


Figure 8: Correlogram Plot of the Residuals for Minor and Serious cases of Road Accidents

The plots of the unit root tests in Figure (11) show that the inverted roots of the selected models are all within a unit circle. For an ARIMA model to be stationary and invertible, the inverted roots of the AR and MA respectively, must be less than one. Hence, we can say our models are stationary and invertible (as the case may be).

The in-sample forecast evaluation of the models, Figure (13) shows that the Bias proportions, which measure the level of systematic error, are close to zero. The variance proportions are also close to zero (a high value will imply that the variance of the original series is greater than that of the forecast series), and the covariance proportions, which measure the degree of forecast error that can be credited to the random nature of the forecast series are very close to one in all cases. The sum total of the bias, variance and covariance proportion must be one.

As a result of this, we have a good In-sample forecast plot in Figure (12).



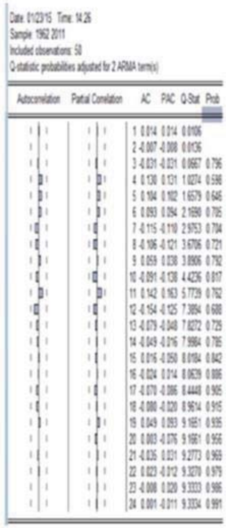


Figure 9: Correlogram Plot of the Residuals Fatal and Total Cases of Road Accidents

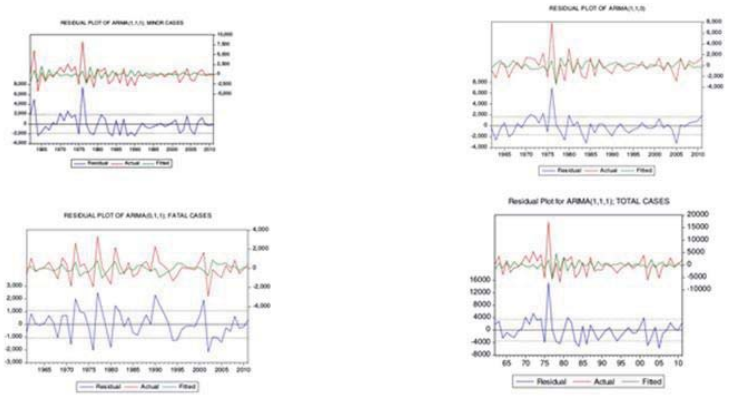


Figure 10: Residual Plots of Minor, Serious, fatal and Total Cases of Road Accidents

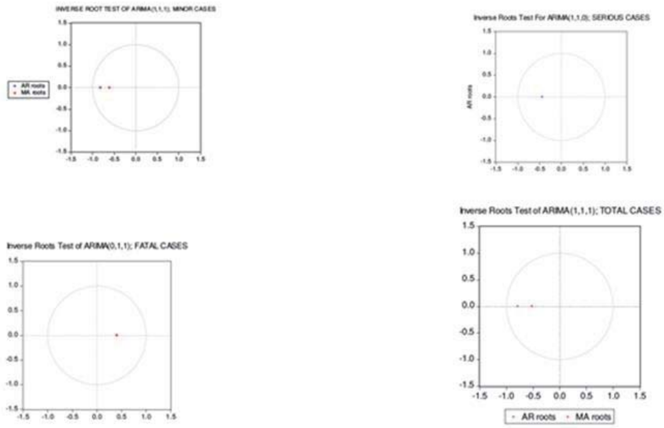


Figure 11: Unit Root Tests of Minor, Serious, fatal and Total Cases of Road Accidents

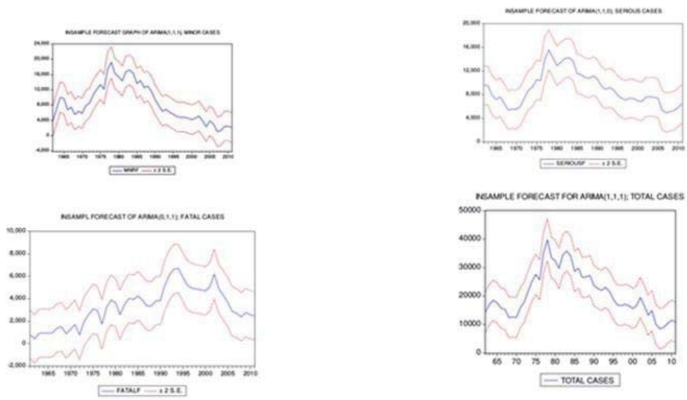


Figure 12: In-sample Forecast Plot of Minor, Serious, fatal and Total Cases of Road Accidents

Table 1: Validation Table for ARIMA(1,1,1) Model of Minor Cases.

Year	Minor Cases	Forecast	% Variation
2012	2050	2065.14	0.74%
2013	1700	1711.18	0.66%

Forecast: MNRF
Actual: MNR
Forecast sample: 1960 2011
Adjusted sample: 1962 2011
Included observations: 50

Root Mean Squared Error	1886.143
Mean Absolute Error	1375.870
Mean Absolute Percentage Error	21.89623
Theil Inequality Coefficient	0.096432
Bias Proportion	0.001087
Variance Proportion	0.003355
Covariance Proportion	0.995558

Forecast: SERUSF
Actual: SERUS
Forecast sample: 1960 2011
Adjusted sample: 1962 2011
Included observations: 50

Root Mean Squared Error	1617.344
Mean Absolute Error	1128.979
Mean Absolute Percentage Error	13.29000
Theil Inequality Coefficient	0.086350
Bias Proportion	0.001044
Variance Proportion	0.007392
Covariance Proportion	0.991565

Forecast: FATALF
Actual: FATAL
Forecast sample: 1960 2011
Adjusted sample: 1961 2011
Included observations: 51

Root Mean Squared Error	1065.167
Mean Absolute Error	834.7060
Mean Absolute Percentage Error	61.08243
Theil Inequality Coefficient	0.142937
Bias Proportion	0.003479
Variance Proportion	0.005209
Covariance Proportion	0.991313

INSAMPLE FORECAST EVALUATION

Forecast: TCF
Actual: TC
Forecast sample: 1960 2013
Adjusted sample: 1962 2013
Included observations: 52

Root Mean Squared Error	3392.250
Mean Absolute Error	2397.535
Mean Absolute Percentage Error	11.86328
Theil Inequality Coefficient	0.077016
Bias Proportion	0.000116
Variance Proportion	0.001605
Covariance Proportion	0.998279

Figure 13: In-sample Forecast Evaluation of Minor, Serious, fatal and Total Cases of Road Accidents

5. Model Forecast

After determining the best-fit model for the series and estimating related parameters, the third phase of Box-Jenkins fitting model was evaluated for series prediction.

Using the ARIMA (1,1,1) model, the model predicted that in 2012 an approximately 2066 minor cases, this gives 0.74% percentage increase when compared with the real value of 2050 minor cases. Also, the model predicted that in 2013 an approximately 1712 minor cases, this gives 0.66% percentage increament when compared with the real value of 1700 Minor cases as given in Table (1).

Table 2: Validation Table for ARIMA(1,1,0) Model of Serious Cases.

Year	Serious Cases	Forecast	% Variation
2012	8277	7680.32	-7.21%
2013	8589	7977.27	-7.12%

Using the ARIMA (1,1,0) model, the model predicted that in 2012 an approximately 7681 serious cases, this gives 7.21% percentage decrease when compared with the real value of 8277 serious cases. Also, the model predicted that in 2013 an approximately 7978 Serious cases, this gives 7.12% percentage decrease when compared with the real value of 8589 serious cases as given in Table (2).

Table 3: Validation Table for ARIMA(0,1,1) Model of Fatal Cases.

Year	Fatal Cases	Forecast	% Variation
2012	2935	2688.66	-8.391%
2013	3294	2688.66	-18.38%

The ARIMA (0,1,1) model predicted the same value of fatal cases of road accident, in 2012 and 2013, approximately 2689 fatal cases were predicted as shown in Table (3). These led to 8.39% and 18.38% percentage decrease in fatal cases of road accident. The constant predicted values are due to the nature of the forecasting model for the cases, since moving average model is not forecastable for the first difference.

Table 4: Validation Table for ARIMA(1,1,1) Model of Total Cases.

Year	Total Cases	Forecast	% Variation
2012	13262	12962.39	-2.26%
2013	13583	13146.40	-3.21%

Conclusively, using the ARIMA (1,1,1) model, the model predicted that in 2012 an approximately 12963 total cases, this gives 2.26% percentage decrease when compared with the real value of 13262. Also, the model predicted an approximately 13147 of Total cases in 2013, this gives 3.21% percentage decrease when compared with the real value of 13583 total cases as given in Table (4).

Table 5: Forecast Table for The Cases Considered.

Year	Minor Cases	Serious Cases	Fatal Cases	Total Cases
2014	1803.93	7846.95	2688.66	13001.46
2015	1719.13	7904.14	2688.66	13115.62
2016	1788.32	7879.05	2688.66	13025.70
2017	1731.87	7890.06	2688.66	13096.53
2018	1777.93	7885.23	2688.66	13040.74
2019	1740.35	7887.35	2688.66	13084.68
2020	1771.01	7886.41	2688.66	13050.07

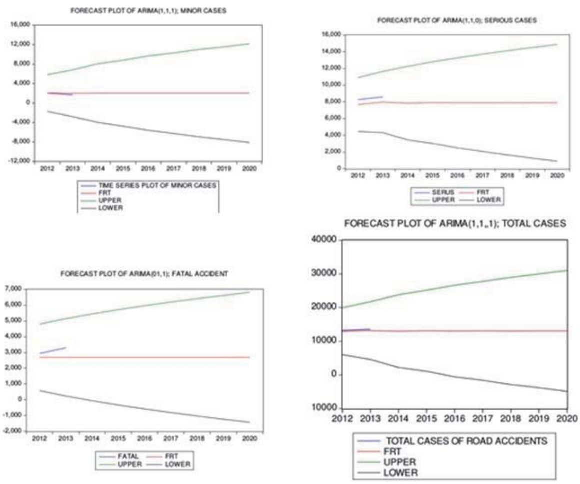


Figure 14: Forecast plots of Minor, Serious, fatal and Total Cases of Road Accidents

6. Model Representation

The general difference of ARIMA (1,1,1); minor cases, is given as,

$Y_t - Y_{t-1} = \psi(Y_{t-1} - Y_{t-2}) + e_t - \theta e_{t-1}$

$Y_t = (1 + \psi)Y_{t-1} - \psi Y_{t-2} + e_t - \theta e_{t-1}$ (1)

Substituting the values of ψ and θ as given in Figure (7), the model for the minor cases becomes,

$Y_t = 1.815892Y_{t-1} - 0.815892Y_{t-2} + e_t - 0.607063e_{t-1}$ (2)

Furthermore, the general difference of ARIMA (1,1,0); serious cases, is given as,

$Y_t - Y_{t-1} = \psi(Y_{t-1} - Y_{t-2}) + e_t$

$Y_t = (1 + \psi)Y_{t-1} - \psi Y_{t-2} + e_t$ (3)

Substituting the value of ψ as given in Figure (7), the model for the serious cases becomes,

$Y_t = 0.561164Y_{t-1} + 0.438836Y_{t-2} + e_t$ (4)

Also, the general difference of ARIMA (0,1,1); fatal cases, is given as,

$$Y_t - Y_{t-1} = e_t - \theta e_{t-1}$$

$$Y_t = Y_{t-1} + e_t - \theta e_{t-1} \qquad (5)$$

Substituting the value of θ as given in Figure (7), the model for the fatal cases becomes,

$$Y_t = Y_{t-1} + e_t + 0.406170 e_{t-1} \qquad (6)$$

And finally, the general difference of ARIMA (1,1,1); Total cases, is given as,

$$Y_t - Y_{t-1} = \psi(Y_{t-1} - Y_{t-2}) + e_t - \theta e_{t-1}$$

$$Y_t = (1 + \psi)Y_{t-1} - \psi Y_{t-2} + e_t - \theta e_{t-1} \qquad (7)$$

Substituting the values of ψ and θ as given in Figure (7), the model for the Minor cases becomes,

$$Y_t = 0.212321 Y_{t-1} + 0.787679 Y_{t-2} + e_t - 0.519769 e_{t-1} \qquad (8)$$

7. Discussion

One of the major concerns in Nigeria is the increasing Road traffic accident, which is at a disturbing rate. Federal Road Safety Corps (FRSC) of Nigeria recognizes the negative impacts of road safety accident and has commended the positive contribution of road safety researches as necessary tools to have significant accident initiatives. This research is carried out in order to identify the patterns of road traffic accident cases; the minor cases, the serious cases, the fatal cases and the total cases, by developing appropriate time series ARIMA models and predicts 7 years cases of road traffic accident (minor, serious, fatal and total cases) along the Nigeria's motorway.

Time series analysis of the data from the years 1960-2013 showed that patterns of road traffic accident cases are increasing (on average) along the Nigeria's motorway. The most widely used conventional method of time series known as Autoregressive Integrated Moving Average (ARIMA) model, also known as Box-Jenkins method was applied to the annual cases of road traffic accident data in Nigeria from 1960-2013 to determine patterns of road traffic accident cases along the Nigeria's motorways. After identifying various tentative models, the appropriate models for the accident cases (minor, serious, fatal and total cases) are as follows.

ARIMA (1,1,1) was used to model the minor and total cases, ARIMA (1,1,0) was used to model the serious cases, while ARIMA(0,1,1) model was for the fatal cases using the data from 1960-2011. The adequacy and performance of the model were tested on the remaining data from 2012 to 2013.

We provide 7 years forecasts of the cases of road accident using the models developed and they showed that road traffic accident cases examined; minor cases, serious cases, fatal cases and total cases would continue to increase. This study provides reliable and genuine information that could be useful for determining road accident rate on Nigeria's motorways and provide necessary prevention for the unwanted act. This study would also be used for providing important information to increase the level of awareness among stakeholders concerning road safety, since the problem has become a growing issue in Nigeria. More so, in setting priorities when planning road traffic accident interventions. Most Importantly, this study would provide expected benefit to the road users, Road Safety Corps, researchers and other stakeholders in understanding the rate of the cases of road accident.

8. Recommendation

With the results at hand, it is very obvious that if government remain nonchalant and individuals are also waiting for government to do everything, the cases will continue to increase (on average) according to the forecast values. Note that the models should not be used for a long time forecast because it will results to unnecessarily large forecast. To avoid increase in road traffic accident, the following must be taking care of; Road Safety Agency should create awareness program for the citizens so as to inform (or remind) them of the rules and regulations. Phrases like "Do not make phone call while driving", "It's better to be late that to be late", "Do not drink and drive", and so on, should be found on car stickers, on billboard, in advertisement and other noticeable place for the drivers. This awareness can be done on television stations, radio stations, billboard, and so on.

Also, the law makers should give strict and immediate punishment for lawbrakers. Once some people are punish for violating the rules and regulations, it would serve as lessons for others. Moreover, the awareness should not be limited to drivers alone. The entire citizens must also be aware of the rules and regulations of Road Traffic. Like the use of over-head bridge instead of crossing high-way roads; how to rescue victims immediately incase of accidents, and so on.

Maintenance of motorways is also a key factor in reducing road traffic accident. Government should always ensure the maintenance of roads and provision of alternative routes (in case of very busy roads). More so, there should be special road for big vehicles like trucks, Lorries, and so on.

Furthermore, government and Road safety Agency should not be left alone to solve these problems. Since researchers know fact about figures, besides analyzing the cases of road traffic accidents, they should also be involved in educating the masses about the rate at which road traffic accident is increasing. This would also go a long way in reducing the accident cases.

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