# 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 and the total cases. ARIMA (1,1,1) model is obtained for the minor and total cases, ARIMA (1,1,1) model is obtained for the minor and total cases, ARIMA (1,1,0) model is obtained for the fatal 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 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

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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						
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The Carbon Farders.	5% laval	1 947381		Test critical values:	1% level	-2.612033	
	10% laund	1 612725			5% level	-1.947520	
	10/4 10/01	-1/012/20			10% level	-1.612650	
*MacKinnon (1995) one	esided p-values.						



Nul Hypothesis: FATAL has a unitroot Exogenous: None Lag Langts 0 (Astematic - based on SIC, madag=10)				Null Hypothesis: TOTAL has a unit root Exogenous: None Lag Length: 1 (Automatic based on SIC, MAXLAG=10)			
		t-Statute	Prob.*			t-Statistic	Prob.*
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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

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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.

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

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



Cale: 1963/914 Timer: 10:14 Dangler: 1900/2011 Indiaded streamdone: 50 O datality:sectualities: algudes/thr.2: 4984 terms						Date: (922)/14 Time: 17.45 Sample: 1960 2011 Inductor: observations: 50 C-statistic probabilities adjusted for 1 ARIA term					
Advontation	Partal Consistor	10	РC.	0.8#	Pot	Autocorrelation	Partial Correlation	AC	PAC	0-Stat	Prot
- () -	1.11	1 800	100	1094			1. 242	Lann		1.000	_
111	12.	2 4 628	4125	195		111	1.12	1 0.058	0.000	0.1/81	
121	14.1	1-08	-154	154	1.658	1.1		2 0.090	0.995	9.8/52	0.411
· D·	1.01	4 2194	1.185	2.825	1351	11		3 -0.048	-0.059	0.8036	0.669
1 2 1	1.01	5 108	1.00	293	1472	E.	1 81	4 0.151	0.150	2.0912	0.554
1.01	1.11	6 1071	103	2,654	1504	1 81	1.1	5 0.092	0.087	2,5829	0.630
111	10	7.409	4.03	2812	1704	1.00	1.0	6 0.112	0.075	3.3243	0.650
111	10	1402	-8.617	1571	1.791	101	10	7 -0.168	-0.185	5.0319	0.540
121	111	\$ 109	1274	2348	1851	· P ·	P I	8 -0.222	-0251	8,0944	0.324
111	1.16	18 402	4275	145	1308	111	1 1	9 -0.033	0.000	8.1626	0.418
1 10 1	i de la	11 119	119	18.8	162	10	- <b>P</b>	10 -0.176	-0.209	10.172	0.337
		0 175	3 204	7854	1407	110	1.00	11 0.067	0.112	10,471	0.400
1.	1.0	0 110	1.121	1.010	1.622	1.1.1	1 11	12 0.018	0.165	10,492	0.487
1.6	1.5	4 100	314	3-804	140		E .	13 -0.271	-0.271	15.652	0.208
		\$ 110	3 4 4 5	100	4.774	10	101	14 -0.175	-0.098	17.875	0.162
	1.11	4	1.003	10.521	1408	1 1 1	111	15 0.051	0.054	18.069	0.204
	1.20	1 1/14	10	11,215	3.712	1 1 1	111	16 0.052	-0018	18.274	0.249
	1.1	18 3.00	1.10	10.000	1 10	101	10	17 -0.084	-0.158	18.827	0.278
141	1.010	45 1/04	1.010	1104	1.728	101	101	18 -0.114	-0.113	19.885	0.280
120	1.020	10 100	1.075	10,000	1,725	101	() () ()	19 -0.081	0.113	20.432	0.309
11.1	1.010.0	1 410	10.0	10,204	1.007	1 1	101	20 -0.020	-0.137	20.465	0.357
111	1.000	10 4121	2410	14.08	8/13	1 (21)	111	21 0.145	0.045	22,356	0.322
1.1	1.010	2 400	100	1413	1522	101	111	22 -0.071	-0.009	22.823	0.353
	1.121	22 -208	8.675	74759	2,853	111	101	23 -0.012	-0.137	22,837	0.411
- 11	1.141	28 104	-6211	3,21	146	111		24 -0.029	-0.009	22 920	0.485

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).

Date: 09/20/14 Tim Sample: 1960 2011 Included observatio Q-statistic probabili	ns: 51 fes adjusted for 1 AR	NA term				Date 812915 Sample 1962 20 Included obsenat C-statistic stobal	ime: 14:28 11 ons: 50 Altes adjusted for 2 Al	NA termin	6		
Autocorrelation	Partial Correlation	AC	PAC	0-Stat	Prob	Atsomition	Partial Conelation	ĸ	PAC	0.94	r Pob
- (1)	1 11	1 0.056	0.056	0.1885						_	-
101	10.1	2 -0 134	-0 138	1.1607	0.281	111	111	1 005	1014	0.010	6
111	13	3-0011	0.005	1.1576	0.558	1.1	1.1	2400	4 008	003	6
111	101	4 410	-0.067	12952	0.730		111	3443	4.01	105	7 0.79
111	1 1	5-0012	-0.005	13032	0.861	1 1	1 11	413	0.131	1.027	4 0.536
	e :	5 -0 224	-0.245	43148	0.505	1 ( ) (	1 11	5 0 10	1.12	1.657	9 0 648
111	1.0	7 0.040	0.073	44130	0.621	1.01	(1)	6 1 (5)	1 1 1 1	218	0 0.76
1 01	111	8 0 126	0.049	5,4159	0.609	101	101	7415	-110	295	3 0.714
1 10	1.0	9 0 191	0.214	7 7561	0.458	18.1	101	8-419	4 121	3679	6 0.721
1 11	1.1	10 0 112	0.089	2 4244	0.476	1.11	111	9.169	113	3 8 90	6 0.752
111	1.11	11 0.027	0.097	8 6394	0.587	10	101	11-125	4.138	143	6 0.817
111	101	12 -0.068	-0.108	8 9636	0.625	1 11	1 (2)	11 0.54	1.153	5.173	8 075
18.1		13 -0.095	-0.026	9.6247	0.651	101	101	1245	113	135	4 0 688
10 1	100 1	14 -0 184	-0.200	12 070	0.522	101	111	13 4 67	144	142	2 0 725
1.	1.01	15 0.007	0.115	12 074	0.500	111	111	14-444	1416	199	A 0.76
111	10	15-0.030	-5 118	12141	0.668	111	111	15 101	4151	1018	4 684
111	1.11	17-0.045	-0.013	12 108	0.722	111	111	16-440	1014	103	9 0 896
1 11	111	18 0 126	-0.031	13 608	0.695		101	17 4 67	1408	144	8 0.995
1 81	1.81	19 0 135	0115	15 135	0.653	101	111	18.4.00	4 121	1951	4 0.915
1.5	10.1	20 -0.005	-51%	15 138	0.714	111	10	19.044	0.093	9倍	1.099
10.1	1 11	21 -0 156	-0.019	17 116	0.631		111	20 0.00	418	916	1 0 957
111	101	22 -0.054	-0.068	17 505	0.574	1.8.1	11	21-4.03	100	9,277.	3 0.965
111	1.01	23 0.020	6125	17545	0.727	1 1	1.1	22 0 02	1112	9.327	0.0575
111	111	24 0.045	0.065	17 850	0.765	1.1	1 1	23 4 00	1 1 121	930	0 0 999
	1 212	1	- 314			3. 1	111	24 0.00	1-0011	9333	4 0 991

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	Mi	nor Cases	Forecast	% Varia	tion
2012		2050	2065.14	0.74%	6
2013		1700	1711.18 0.66%		
Forecast MNRF Actual: MNR Forecast sample Adjusted sample Included closery	× 1960 2011 × 1962 2011 ationa: 50			Forecast: SERUSF Actual: SERUS Forecast sample: 1960 2011 Adjusted sample: 1962 2011 Included observations: 50	
Root Mean Squ Mean Absolute I Mean Absolute I Theil Inequality i Bias Proport Variance Pro Covariance P	ared Error Error Pescertage Error Coefficient on portion 'roportion	1886.143 1375.870 21.89623 0.006432 0.001087 0.995558		Root Mean Squared Error Mean Absolute Error Mean Absolute Personage Error Theil Inequality Coefficient Bas Proportion Variance Proportion Covariance Proportion	1617.344 1128.979 13.29000 0.006350 0.001044 0.007392 0.991565
				INSAMPLE FORECAST EVA	ALUATION
Forecast: FATALF Actual: FATAL Forecast sample: 1960 2 Adjusted sample: 1961 2	2011			Forecast: TCF Actual: TC Forecast sample: 1960 2 Adjusted sample: 1962 2 Included observations: 5	013 013 2
Pool Mean Squared Em Mean Absolute Error Mean Absolute Error Mean Absolute Percenta Theil Inequality Coefficie Bias Proportion Variance Proportion Covariance Proportion	r 1065.16 834.706 m 61.0854 m 0.14290 0.00347 0.00547 n 0.09131			Root Mean Squared Error Mean Absolute Error Mean Absolute Perconta Theil Inequality Coefficie Bias Proportion Variance Proportion Covariance Proportion	er 3392.250 2397.535 ge Error 11.66328 et 0.077016 0.000116 0.0001605 n 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,

 $\begin{array}{l} Y_t - Y_{t-1} = \psi(Y_{t-1} - Y_{t-2}) + e_t - \theta_{\theta_{t-1}} \\ Y_t = (1 + \psi)Y_{t-1} - \psiY_{t-2} + e_t - \theta_{\theta_{t-1}} \\ \text{Substituting the values of } \psi \text{ and } \theta \text{ as given in Figure (7), the model for the minor cases becomes,} \\ Y_t = 1.815892Y_{t-1} - 0.815892Y_{t-2} + e_t - 0.607063e_{t-1} \\ \text{(2)} \\ \text{Furthermore, the general difference of ARIMA (1,1,0); serious cases, is given as,} \\ Y_t - Y_{t-1} = \psi(Y_{t-1} - Y_{t-2}) + e_t \\ Y_t = (1 + \psi)Y_{t-1} - \psiY_{t-2} + e_t \\ Y_t = (1 + \psi)Y_{t-1} - \psiY_{t-2} + e_t \\ \text{(3)} \\ \text{Substituting the value of } \psi \text{ as given in Figure (7), the model for the serious cases becomes,} \\ Y_t = 0.561164Y_{t-1} + 0.438836Y_{t-2} + e_t \\ \end{array}$ 

Also, the general difference of ARIMA (0,1,1); fatal cases, is given as,  $Y_t - Y_{t-1} = e_t - \theta_{\theta_{t-1}}$  (5) Substituting the value of  $\theta$  as given in Figure (7), the model for the fatal cases becomes,  $Y_t = Y_{t-1} + e_t + 0.406170e_{t-1}$  (6) And finally, the general difference of ARIMA (1,1,1); Total cases, is given as,  $Y_t - Y_{t-1} = \psi(Y_{t-1} - Y_{t-2}) + e_t - \theta_{\theta_{t-1}}$  (7) Substituting the values of  $\psi$  and  $\theta$  as given in Figure (7), the model for the Minor cases becomes,  $Y_t = 0.212321Y_{t-1} + 0.787679Y_{t-2} + e_t - 0.519769e_{t-1}$  (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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