An Artificial Neural Network Model for Road Accident Prediction: A Case Study of a Developing Country

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Abstract: Road traffic accidents (RTA) are one of the major root causes of the unnatural loses of human beings all over the world. Although the rates of RTAs are decreasing in most developed countries, this is not the case in developing countries. The increase in the number of vehicles and inefficient drivers on the road, as well as to the poor conditions and maintenance of the roads, are responsible for this crisis in developing countries. In this paper, we produce a design of an Artificial Neural Network (ANN) model for the analysis and prediction of accident rates in a developing country. We apply the most recent (1998 to 2010) data to our model. In the design, the number of vehicles, accidents, and population were selected and used as model parameters. The sigmoid and linear functions were used as activation functions with the feed forward-back propagation algorithm. The *performance evaluation of the model signified that the ANN model is better than other statistical methods in use.*

Keywords: Artificial neural network; road; accident; linear function; back propagation; vehicles

1 Introduction

Artificial Neural Network (ANN) systems have been applied in different information technology problems, such as traffic in communication and transportation engineering [1]. ANN has been widely applied in travel behavior, flow and management [2]. Artificial neural networks are employed for modeling the relationship that exist among driver injury severity and crash causes or factors that have to do with the driver, vehicle, roadway and the environment characteristics. The use of artificial neural networks can reveal the relationship that exists between vehicle, roadway and environment characteristics and driver injury severity [3]. Traffic forecasting problems involving complex interrelationships between variables of traffic system can be efficiently solved using ANN. They provide realistic and fast ways for developing models with enough data [4]. This study explains the use of neural networks in the modeling of the number of persons fatally injured in motor vehicle accidents in data sets of the states of the USA. The ANN models help us to compare the states' road safety performance by the number of motor vehicle fatalities.

Used in many fields, the application of ANNs has seen a lot of success in a number of different areas of specialization, including transportation engineering. Abdelwahab and Adel-Aty [3] researched the relationship that exists between driver injury severity and driver, vehicle, road, and environment characteristics, using two well-known neural network paradigms, the multilayer perceptron and the fuzzy adaptive resonance theory neural networks. Recently, ANN has been adopted for sequential forecasting of incident duration from the point of view of incident notification to the incident road clearance [5]. Prediction of the lane-change occurrence with respect to freeway crashes using the traffic surveillance data collected from a pair of dual loop detectors [6], and a study understanding the circumstances under which drivers and passengers are more likely to be killed or more severely injured in an automobile accident, can help to improve the overall driving safety situation [7].

The advantage of ANN over conventional programming depends on its ability to solve complex and non-algorithmic problems. ANN uses past experience to learn how to deal with the new and unexpected situations. The statistical distribution of the data does not need to be known when developing an ANN model. There is no need for prior knowledge about the relationships amongst the variables being modeled. Hence, ANN has the ability to model complex, nonlinear relationships without previous assumptions of the nature of the relationship, like a black box [8]. The most important key element of ANN paradigm is the novel structure of the information processing system. The synapses associated with irrelevant variables readily show negligible weight values; relevant variables present significant synapse weight values. Neural networks, which are good at broad and flat transformation of data, are nonlinear, able to relate input with output, and are error tolerant. Another advantage of ANN analysis is that it allows the inclusion of a large number of variables.

Road traffic accidents (RTAs) play an important role in the economy of any country and especially such huge financial losses in developing countries affect very much the development of these nations. Due to RTAs, the financial loss in some developing countries like Nigeria is more than the GDP of 20 African countries (see Figure 2). In the next section, we will see how RTAs affect the economy of a developing country.

In this paper, the development an Artificial Neural Network (ANN) model was carried out for the examination and prediction of accidents rate using Nigeria as a case study. Our model was developed by considering data from 1998 to 2010 for prediction accuracy. In the design of the system, the number of vehicles, accidents, and population are selected and used as model parameters. We used the sigmoid and linear functions as activation functions with the feed forward-back propagation algorithm. By analyzing the performance evaluation of the model, we found that the ANN model is better than other statistical methods.

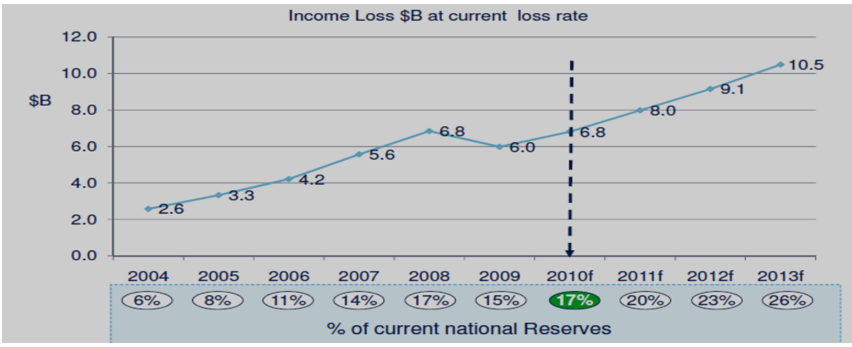
The paper is organized in the following chapters. We provide the detail of our case study, which in our case is Nigeria, in the next section. The related work is also discussed in the same section. In the next paragraph we have data of our case study.

2 Facts regarding RTAs in Nigeria: A Case Study under Consideration

Poor road structure and population growth have greatly led to an increase in accident rates. The establishment of the Federal Road Safety Corps (FRSC) by the government of the Federal Republic of Nigeria in 1988 (vides Decree 45 of 1988 as amended by Decree 35 of 1992, with effect from 18th February, 1988) was to reduce the accidents. The Commission was given the following responsibilities; policymaking, organization and administration of road safety in Nigeria. Mr. Osita Chidoka, the FRSC Corps Marshal and Chief Executive, estimated that Nigeria currently loses three billion naira every year to road crashes. Road crashes cost Nigeria 13% of her gross national product (GNP), which inhibits economic and social development [9]. Nigeria loses about 3% of GDP from Road Traffic Crashes that is about 17% of current National reserves as shown in Figure 1.

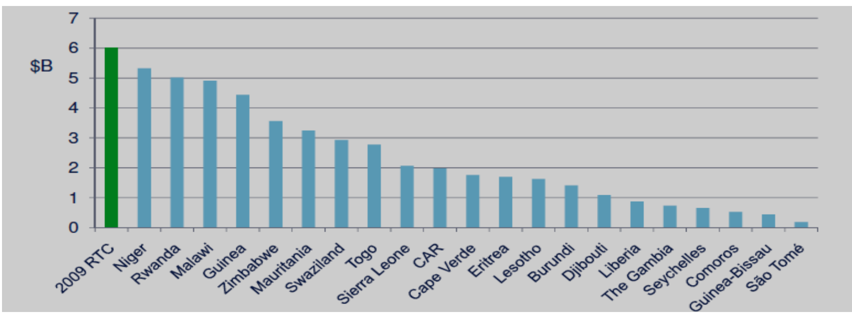
Income lost from 2009 RTCs in Nigeria was more than the GDP of over 20 individual African countries. Nigerian income losses for 2009 vs. 2009 GDP select African Countries are shown in Figure 2.

The cause of traffic accidents can be a factor or combination of many factors. The basic factors which cause or increase the severity of probable accidents are driver's behavior, vehicle features, highway characteristics, environmental effects and traffic characteristics (Ozgan, 2003).



Source: Euromonitor, CBN, World Bank, PwC Analysis

Figure 1
Nigeria's current national reserves



Source: IFC, PwC Analysis

Figure 2
Nigeria's 2009 vs. 2009 GDP of selected African countries

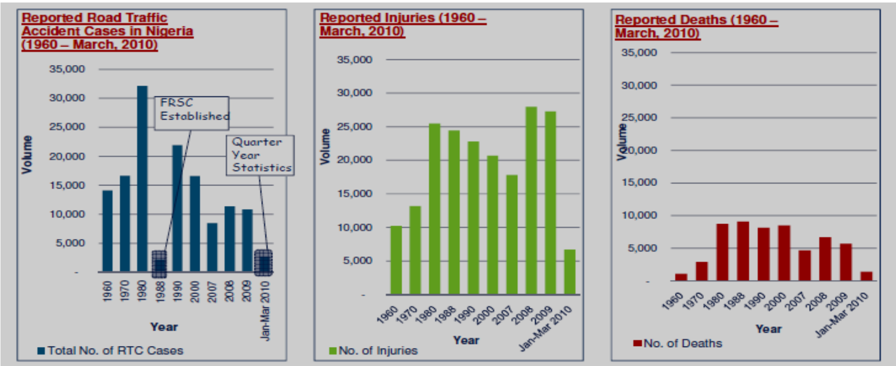
Traffic volumes in number of vehicles per day and road lengths in kilometers are the most important explanatory variables in an accident prediction model, both for road sections and intersections. The parameters of the model can vary significantly between road types and countries because road characteristics, user behavior and vehicle types can differ. An accident prediction model is a mathematical formula describing the relation between the level of existing road safety, such as crashes, injuries, fatalities etc., and variables that explain this level, such as road length, width, and traffic volume.

In Nigeria, about 85% of the accounted causes of road accidents are believed to have been constituted by human factors [10]. Many researches carried out in Nigeria revealed that most accidents caused by human factors are the result of driving while drunk, drugs, inexperience or poor driving skills, health problems, psychological problems and temperament. These have been shown in different ways by drivers. It is also noted that these human factors are the greatest contribution to the increasing surge of traffic accidents in Nigeria [10]. The attitude towards road traffic accidents includes such behavioral elements of the drivers as: sleeping while driving and tiredness, inadequate preparation for a journey, not been familiar with the highway signs, cutting corners, driving after taking excess alcohol, driving with bad eye sight especially in the night, ignorance of the use seat belts, the incapability of handling unforeseen circumstances, wrong use of road signs and vehicle signaling, overtaking and incompetent maneuvering.

Osime et al. [11] observed in their study that about 285,699 cases of RTA occurred between 1970 and 1979 with 57,136 deaths, which amounts to 20%. Again, 188,012 cases of RTA occurred between 1990 and 1999, where about 76,870 deaths were recorded, amounting to 41%. Reasons for this include the oil explosion in Nigeria, which occurred in the 1970s. This empowered many Nigerians financially to afford cars of their choices. This also aided in the repair of roads and the construction of new roads in Nigeria. But given that people were not yet exposed to high traffic of cars in Nigeria roads, this led to many cases of RTAs. Also, due to the fact that people are new to the development, cases of speeding could still be assumed to be relatively small. With the availability of good roads and due to the fact that some drivers drive with reasonable speed, which amount to some cases of RTAs, the deaths that occurred were about 20%. However, there was a sharp change observed between 1990 and 1999. The mortality rate increased to 41%, while the number of RTAs decreased. This is the time economic recession was observed in Nigeria, which led to the inability of acquiring new cars by most people; instead there was an increase in the purchase of used cars, which in turn led to an increase in RTAs. The economic recession also affected most roads, which left them in a bad state, making it more likely to cause fatal accidents. The country equally experienced neglect in the health sector, with little attention paid to RTAs cases.

Research on the trends of accidents on Nigeria roads starting from 1960 to 1989 shows an increase in the number of fatal accidents that occurred. It was also discovered that about 18,000 deaths were recorded between 1960 and 1969 with respect to road accidents. This figure given here increased by five times between 1980 and 1989, with more than 92,000 deaths recorded [12]. The total amount of RTAs in Nigeria between 1960 and 2004 is 969,850 with 275,178 recorded deaths and 843,691 recorded injuries within the same period. In 1988, the rate of RTAs reduced drastically, which is attributed to the effectiveness of the Federal Road Safety Commission in Nigeria, which assumed operation on 18th February 1988. The key responsibility of the Federal Road Safety Commission is to bring to sustainable minimum the rate of RTAs in Nigeria. The major strategies to achieve this as adopted by the commission to improve road safety in Nigeria are through awareness and enforcement.

The number of injured and killed people is currently increasing rapidly in Nigeria. If until 2020 the trends in RTAs continue, it will be considered as the second most noted cause of fatalities in the world. RTAs contribute greatly in huge economic overheads, extreme human distress and disaster. A long term sustainable road traffic system can be achieved if the traffic safety work is developed and intensified. Figure 3 shows Nigeria's position in RTAs.



Source: FRSC, PwC Analysis

Figure 3

Nigeria's position in reported RTA causes, injuries and death

Records obtained from Federal Road Safety Corps (FRSC) in 2009 states that about 4,120 deaths were recorded, with 20,975 seriously injured persons in RTAs involving about 11,031 vehicles across Nigeria. In 2008, the commission stated that about 11,341 RTAs occurred, claiming a total number of 6,661 lives and with 27,980 injured persons. From January to June 2010, RTAs amounted to 5,560 cases, with 3,183 deaths and 14,349 injuries.

3 Related Studies

The issue of Road traffic accident (RTA) has been seen to be dreadful all over the world. The rate of RTAs has reduced in some developed countries, while it still on the increase in some developing countries [13]. It has been observed that RTA is prevalent in Nigeria, with seasonal epidemics [14]. It has been reported by the police force that a total of 98,168 deaths occurred between 1980 and 1989, and 244,864 persons were injured in RTAs [15]. This brings an average of 10,000 persons being killed and 25,000 persons being injured annually. A document has stated that one third and one ninth of the whole of Nigerians may be exposed to the risk being injured or killed, respectively, annually by RTAs [16]. Despite the struggle to reduce the rate of RTAs in Nigeria, it is still ranked high with respect to RTA in the world [17]. The most disturbing aspect is the economic back-bone of a nation, are the young adult group, who are the most affected by these RTAs [18], [19]. Oladehinde et al. [20] discussed the visual functions of commercial drivers in relation to road accidents in Nigeria and basically observed that it is one of the causes of road traffic accidents.

Most traffic accident prediction models are based on statistical regression techniques. In 1949, Smeed [21] studied the calculated number of fatally injured persons in the accidents and compared the accident rates in different countries. Thus, the first study concerning deaths in traffic accidents were executed by Smeed and the study became the initiator of many practical models [21]. He proposed to consider the trend of the accident rates in the USA and the economic cost of road accidents, and he analyzed the level of success of various accident prevention methods used.

Many practical models have been established on the basis of Smeed's work [21]. Leeming [22] proposed the Smeed’s factors for different countries and different years. Pitsiava-Latinapoulou and Tsohos [23] analyzed a 14-year record concerning the relationship between fatal road accidents and the number of registered vehicles in Greece using statistical method and described a relationship that is at a fairly good degree of accuracy by Smeed's equation (SE). Adams [24] examined accident black spot treatment and seat belt legislation on behalf of vehicle safety regulations, benefitting from explanations of Smeed's Law. Broughton [25] validated the empirical relationship between SE (Sameed’s equation) and other developed models on the basis of SE to provide common methods for predicting fatality and accident totals. Gharaybeh [26] researched the development of traffic safety in Jordan over the last two decades, using Smeed's Formula. Navin et al. [27] developed a road safety model that includes special cases of the Smeed’s model.

Many communications traffic and transportation engineering problems have been solved using ANN methodology [28]. ANNs have been applied in travel behavior management and the flow of traffic [2]. Artificial neural networks were employed for modeling the factors that have to do with driver injury severity and causes of crash with respect to vehicles, drivers, roadway and environment features. The use of artificial neural networks can reveal the factors that relate to vehicle, roadway and environment features and driver injury severity [29]. Traffic forecasting problems involving complex interrelationships between variables of traffic system can be efficiently solved using ANN. They offer realistic and continual ways of building models, thereby providing enough data [4]. This study explains the use of ANN in the designing of the number of persons fatally injured in motor vehicle accidents in data sets of the states of the US. The ANN models have assisted us to compare the safety of the states' roads by the number of motor vehicle fatalities.

The use of ANNs has been effective in a variety of areas which includes transportation engineering. Abdelwahab and Adel-Aty [29] researched the factors concerning driver injury strictness and driver, vehicle, road, and environment features by applying two popular ANN algorithms known as the multilayer perceptron algorithm and the fuzzy adaptive resonance theory ANN. Chronological forecasting of event duration from a point of view of event notification to the event road clearance has been carried out by ANN recently [5]. The occurrence of lane-change related freeway crashes has been predicted using the traffic inspection data composed from a pair of dual loop detectors [6], and the establishment of a study which will provide clear knowledge of how drivers and passengers can easily be killed or most likely be deeply injured RTAs will go a long way to way to advance the driving safety condition [7].

The advantage of ANN against normal programming languages is that it can be used to solve non algorithmic problems or provide solutions to complex problems. ANN can learn how to deal with the new and unexpected situations with the help of past experience. There is no need to establish the how the data are distributed when building an ANN models. Also there is no need to establish before-hand how the variables being used in the model relate to one another. It has the capability to model compound, non-linear factors without establishing before-hand the nature of the factors, like a black box [8]. The major component of an ANN algorithm is the original configuration of the information processing system. The synapses related to irrelevant variables shows very little function values; on the other hand, important variables give important synapse function values. Neural networks which are good at broad and flat transformation of data are nonlinear, able to relate input with output and are error tolerant. Another advantage of ANN analysis is that it allows the inclusion of a large number of variables.

4 Proposed Methodology

The road traffic accidents (RTA) data obtained from the FRSC and Nigerian Police was from 1998 to 2010 (Table 1). In 2003, there were 16,795 accounted cases of road traffic accidents; 28,215 person were injured with 8672 recorded deaths. The ratio of deaths to RTA was 1.93:1 in 2003.

Multi-layer perceptron ANN adopts different learning algorithms; and one the most well-known techniques is back propagation and it was used in this study.

Table 1
Data of road traffic accident cases, the injured persons with deaths

Year	Total cases reported	No. of persons killed	No. of persons injured
1998	17,117	6578	17,547
1999	12,503	5953	18,000
2000	12,325	6336	20,555
2001	15,621	7845	26,745
2002	16,452	8452	27,102
2003	16,795	8672	28,215
2004	14,279	5351	16, 897
2005	8962	4519	15,779
2006	9114	4944	17,390
2007	9132	4916	20,944
2008	11,341	6661	27,980
2009	11,031	4120	20,975
Jan-June 2010	5,560	3183	14, 349

The road accident was categorized using a self-organizing map (SOM) based clustering. The number of RTAs, vehicles, and populace were taken and used as model factors. Road types and country are also used as parameters. The input variables are the number of vehicles per day and the road length in kilometers. The designed Multi-Layer Perceptron Neural Network (MLPNN) consists of the input layers, hidden layers and an output layer, as shown in Figure 4.

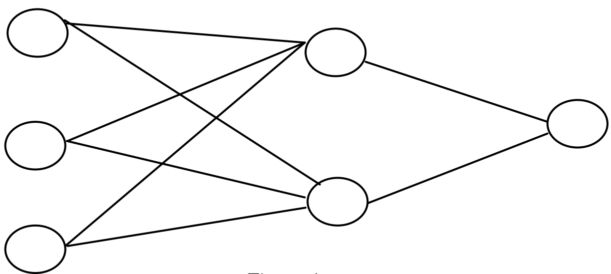


Figure 4
Neural Network

After clustering the entire datasets, (ANN) is used to get a model that is the best for predicting road traffic accident, as ANN always learns from past experience after it completes its first training, and so it becomes an appropriate methodology for prediction. The ANN technique shows some tolerance to a good extent over errors that may exist within the training set. It has the ability to show the veiled and dependencies that are not linear and still learn from its past experience after completing its first training, and this makes it appropriate method that is suitable for prediction. The Multi-Layer Perceptron Neural Network (MLPNN), which is also called the multilayer feed-forward neural network, was chosen and used in this study. Figure 5 is a graphical representation of the overall architecture of the proposed system.

The data that is present in the databases are obtained from Federal Road Safety Commission, Abuja-Nigeria. The data are preprocessed by removing the duplicates and providing the values that are missing. The data were first formatted to an acceptable form for clustering; this is because data that have similar factors are clustered together, while data that have less peculiar factors are clustered differently through a methodology called unsupervised grouping of similar datasets into a predefined groups. To prepare the data that is best for mapping out the process, there is need to change data consequently. The formatted data are further preprocessed in order to put the data in the form best for clustering. Clustering was performed with a k-means algorithm. SOM was used as the basis for clustering of data items. The method proposed uses k-means measurement, which is used to measure distance or differences that exist between the sampled data, because it is the major factor for cluster scrutiny. After clustering all the datasets, with self-organizing map techniques, ANNs are used to obtained best pair of road accidents for the specified type of accident characteristics. The prediction was done using Multilayer Perceptron Neural Networks (MLPNN).

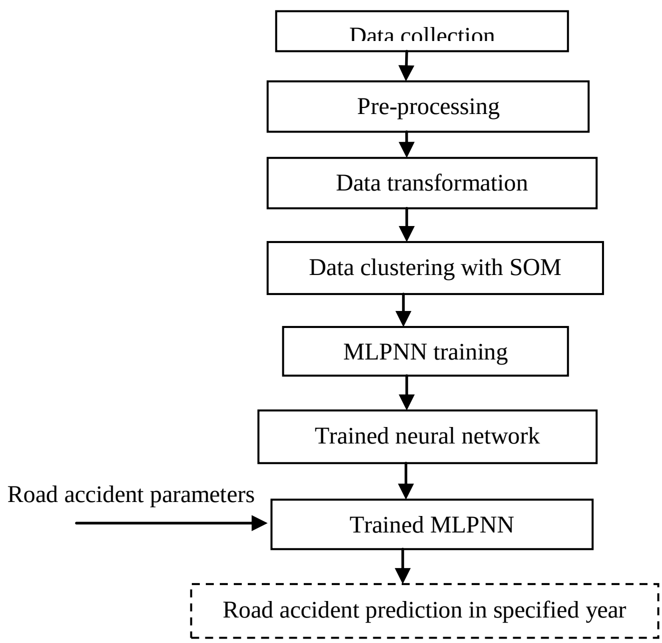


Figure 5
The training architecture

One of the simple algorithms used in this research is:

```
        Initialize map
        For r from 0 to 1                   (where r is the weight vector)
                Randomly select a sample
                Get best matching unit
                Scale neighbours
Increase r with small amount
        End for
```

Initialization of weight vectors is step one in building up of the SOM, after which a vector among the samples is selected randomly and SOM searched for weight vectors that best represent the sample. Each weight vector has a location, with neighboring weights very close to it. The chosen weight is compensated as it is more likely to be the randomly chosen sample vector. Also, the neighbors of that weight are also rewarded, as it is likely to be the selected sample vector. Here, r is increased a little with respect to amount of neighbors, and to what extent will each weight can learn to decrease with time. The steps are repeated a good number of times.

The major aim for carrying out training in a multilayer feed-forward network is to obtain what will make ANN output weight values to match the actual target values very closely. To design and train multilayer perceptron network involves several challenges, which include determining the number of hidden layers to be used in the network, determining the number of neurons to be used in each hidden layer, establishing a general acceptable solution that avoids local minima, converging to an optimal solution as and when due or in good time, and validating the neural network to test for over fitting.

Though there exist errors and noise in the training set, ANN still possesses the capability to find the dependencies that are hidden and are not linear, and it also learns from past experience as it completes its training. ANN is still the best prediction tool.

One of the best training ANN algorithm for prediction is Back propagation (BP). During prediction using BP, errors found in the network are propagated backward to the appropriate nodes. BP carries out is process by adjusting the weight values along with the bias values in order to increase the square sum of the difference that exist among the given output and output values that is generated by the network.

The back propagation technique was used efficiently by these steps [30]:

1) A sample for training was presented to the ANN.
2) The output of the ANN was compared with required output and the calculation of error in each output neuron is done.

3) The calculation of the local error, which is estimated from each neuron by establishing what the output should have been with a scaling factor and to what extent either low or high the output, must be adjusted in order to match the needed output.

4) Lowering the local error by adjusting of the weights of each neuron.

5) Fault is assigned to neurons for the local error found at the previous level; this assigns a higher task to neurons that are strongly connected by weights.

6) Iterate algorithm starting from step 3 using neurons found at the previous level; use each neuron fault as its error.

In this study, the adjustment of the weight value was carried out using conjugated gradient algorithm with help of gradient during backward propagation of errors in the network. The conjugate gradients algorithm uses more paths that are direct to best group of weight values when compared with the gradient descent. It is also faster and more robust. It does not require explicit specification of learning rate and momentum factors.

The steps [30] in the proposed approach are given as follows;

1) Calculate the amount of data in the dataset

2) Generate a group of clusters and establish the centroid of the clusters.

3) Establish the Euclidean distance for each data using the centroids the existing groups of clusters.

4) Allocate data to the group of clusters using minimum distance

5) Iterate steps three and step four until all changes in the clusters disappears.

6) This step deals with the generation of the standard deviation for the group of clusters that are formed. Put aside all the clusters with generated standard deviation that are less than 0.

7) The above steps are repeated until the generated standard deviation for the whole clusters attains a value that is less than 0.

The following pseudo-code shows the algorithm for clustering:

Set N_C, N_o (where $N_C = 1$ and $N_o = 1$)
Calculate N_C (where $N_C = N_C - N_o + 1$
Form C_{if} clusters of N_C size
compute centroid
Iterate
For every value starting from one to N and N_C
Compute the Euclidean distance
Find the list distance

Apply data to a group of cluster until all no change is found in the clusters
For every cluster value which is equal from one to N_C
Compute the standard deviation
If standard deviation is less than Φ
Remove C_r from C_{if} where C_r € C_{if} and add to C_a
Find the rest of the clusters until its values reaches zero

Where

N = Amount of data in the dataset, N_C = Amount or a group of clusters

N_o = Amount or a group of clusters that has zero standard deviation

C_a = Original clusters, C_{if} = Intermediately formed clusters

C_r = Cluster that will be removed.

Figure 6 is the flow chart diagram depicting the process of clustering T. The first value for $N_C = 1$ and $N_o = 0$. The minimum distance among the clusters is obtained by after computing the centroid and Euclidean distance of the data items.

5 Results

The designed MLPNN contains three input layers with two hidden layers and one output layer. The output layer carries out the prediction of the RTA rate when presented with the factors.

Comparing 2004 and 2005 RTA summary from Table 2, there is an observed 37% reduction in total RTA cases; the amount of persons killed was reduced by 16%; and the amount of persons injured was reduced by 7%.

Table 2
Summary of 2004 and 2005 RTA

Year	**2004**	**2005**	**Remarks**
Total reported RTA cases	14279	8962	37% reduction in RTA
Persons killed	5351	4519	16% reduction in the number of persons killed
Persons injured	16897	15779	7% reduction in the number of persons injured

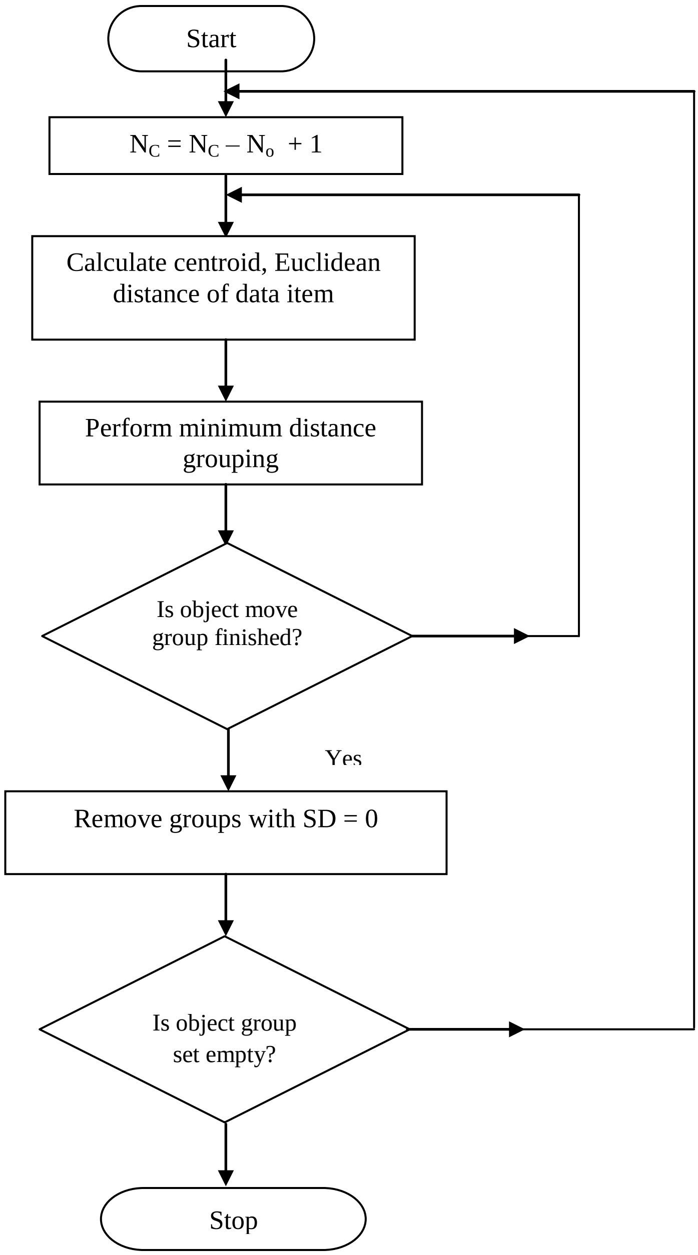


Figure 6
Clustering process flowchart

The road traffic accident summary of 2004 and 2005 are shown in Figures 7 and 8, respectively.

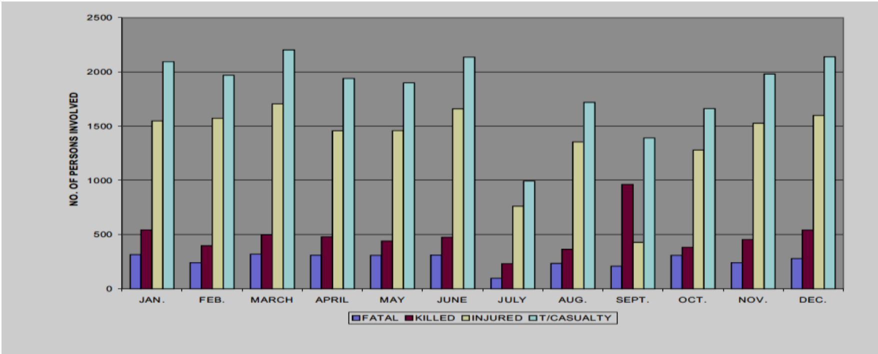


Figure 7

Road Traffic Accident summary 2004

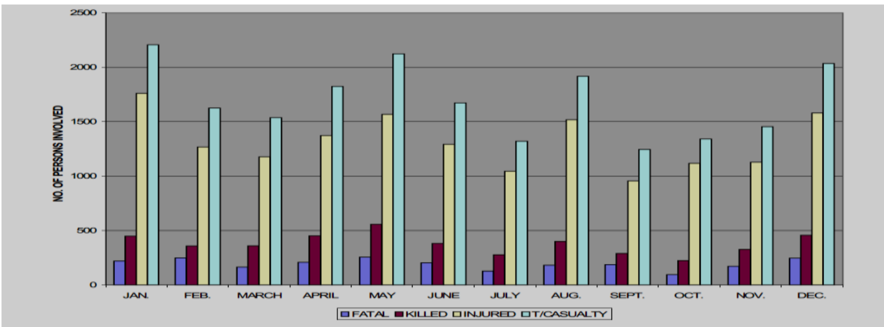


Figure 8

Road Traffic Accident summary 2005

Tables 3(a) and 3(b) are the data of RTA year summary of cases reported, total persons killed and persons injured for 2005 and 2004 respectively.

Table 3(a): 2005 RTA summary

Month	Total cases reported	Persons killed	Persons injured
Jan	980	447	1760
Feb	1040	358	1267
March	591	359	1178
April	679	450	1373
May	1118	556	1567
June	841	381	1291

Table 3(b): 2004 RTA summary

Month	Total cases reported	Persons killed	Persons injured
Jan	1333	544	1550
Feb	1039	397	1572
March	1312	498	1705
April	1498	481	1458
May	1206	440	1459
June	1144	476	1661

July	438	276	1045	July	487	233	761
Aug	956	399	1518	Aug	1136	365	1354
Sept	630	289	955	Sept	829	963	428
Oct	376	224	1117	Oct	1925	383	1279
Nov	624	325	1128	Nov	1036	455	1526
Dec	689	455	1580	Dec	1104	542	1598
Total	**8962**	**4519**	**15779**	**Total**	**14049**	**5777**	**16351**

From the comparison of 2004 and 2005, it was observed that 2004 has the higher reported RTA cases, number of persons killed and also number of persons injured.

Figure 9 shows the drift in RTAs starting from the year 2000 to the year 2007. The amount of RTAs in the year 2007 equals to 12,038, which implies an increase of 3.2% greater that of the year 2006 and another increase of 2.8% greater than that of the year 2000.

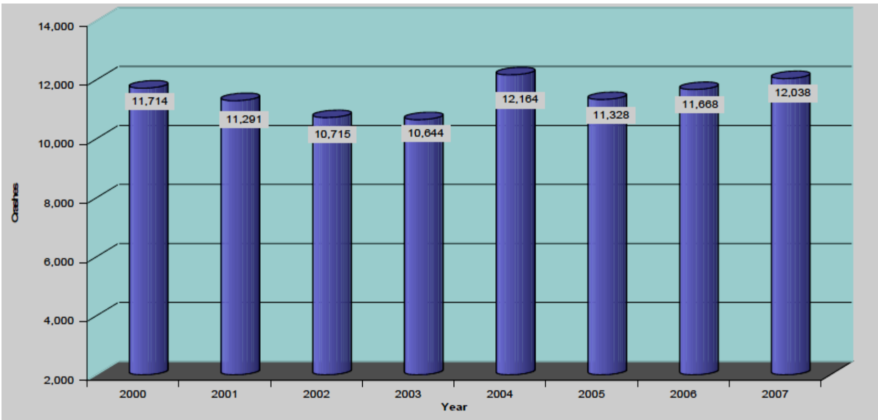


Figure 9
RTA 2000 – 2007

From the analysis of 2004 against 2005 and also from 2000 to 2007, the RTA target verses actual from 2001-2015 were obtained through prediction from collected data. Figure 10 shows the predicted RTA for 2010 to 2015.

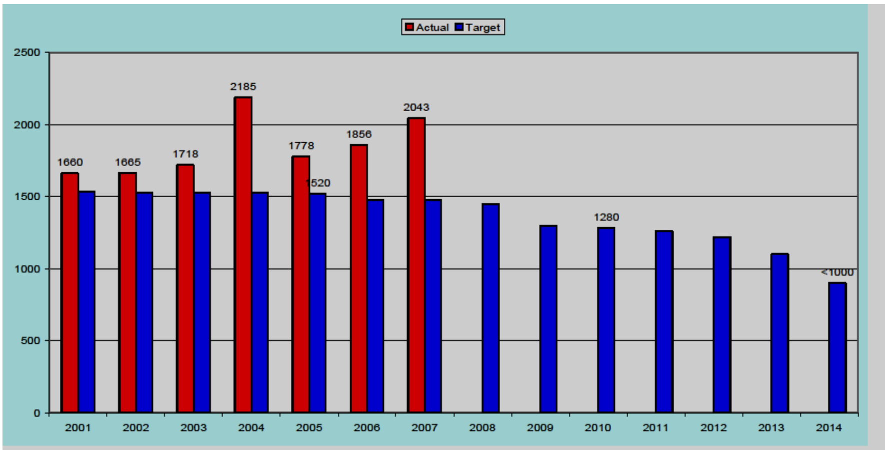


Figure 10

RTA fatalities target vs. actual 2001-2015

6 Discussion

The comparative analysis of 2004 against 2005 and 2000 to 2007 made the prediction of RTA for 2010 to 2015 using primary source collected data capable of allowing an accurate and good data model. The multilayer feed-forward neural network with its learning technique worked through the output value comparison with the accurate answer and also performed the computation of the already established error function. The error is inputted back to the ANN algorithm and it adjusts the weight values of every connection to bring down the values of the error function to minimal.

Hungary has an area of 93 030 km^2, and inhabitants of 10 174 853 (2002), a road network of 158 798 km (2000) and passenger car ratio of 273 per 1 000 inhabitants (2003). The adoption of Hungarian National Transport Safety Program (NKP) by the government took place in 1993 with the primary aim being to bring to a minimal the amount of fatalities and seriously injured persons to 20 to 30 percent when compared to 1992 figure. Efficient transport safety programs were to be submitted and for adoption in 2005 for a duration between 2010 and 2015. The national road network makes up 19% of the total road network. 52% of the accidents involving personal injuries and 77% of the fatal accidents took place on the national road network in 2003. The number of deaths per million vehicle kilometer varies between 30 and 32, which is one of the highest figures in the European Union [31].

Non-use of the seat belt, speeding, inefficient road bypass and inadequate police plan for road safety are the major challenges in Hungary with respect to road safety. In spite of this Hungary has succeeded to achieve a decrease in fatalities per 10 000 vehicles from 10.1 (1990) to 2.8 (2004). From CARE project data (http://europa.eu.int/comm/transport/ care/index_en.htm), it was noted that the amount of accidents, injuries and fatalities declined all through the time between 1991-2000. There were 1 200 deaths on Hungarian roads in 2000. The amount of accidents, injuries and fatalities increased again from 2000 to 2004. Recent fatality figures are however lower than in the mid-1990s.

The major cause of deaths within age range of 4 to 35 in North America has been revealed to be RTAs [32]. The long and far distances people drive in order to pay visit relatives, attend school and go to work across the state are the major causes of high rate of death and serious injuries. The effectiveness of safety measure in cars have brought down the amount of deaths due to RTAs by one out of three in Canada for the past twenty years, while rate of injuries still remain the same in recent years [33].

The major human factors the influence RTAs should be given higher priority by performing some tasks [34], such as carrying out full research in order to have a consistent foundation for determining the main human elements that contribute to road accidents with latest circumstances; these tasks includes checking, and modifying the local rules, disciplinary measures for correcting and filtering out the traffic offenders; putting in effective awareness for the drivers to enlighten and educate them; developing effective vehicle mechanics operation policies; developing hazard perception systems; danger assessment and decision making; giving adequate concern for further enlightenment and training; staging safety awareness with a focus on: change in human behavior, enhancing driving skills, and organizing a good level of traffic monitoring. These tasks helped in Hungarian RTA reduction and improved road safety and can be used for Nigeria case.

Conclusion

Some of these designed solutions will go a long way in reducing RTAs in Nigeria when implemented. The institution of a high level National Road Safety Council will complement the effort of FRSC, and also a special sub-group for road safety information and campaigns. Revisiting the activities and duties of all the bodies that are charged with the national responsibility for road safety management activities will equally go a long way to reduce RTAs in Nigeria; enhancing the collaboration among the Ministry of Works, FRSC, VIO, hospitals, transporters, NCDC, Army, Police Force, and insurance companies with respect to RTAs coming together to develop one inclusive and comprehensive annual national statistical yearbook on all RTAs; the development of strong a policy to regulate driving speed limits; an urgent plan to develop means for black spot management, and creating a special funding for black spots; and revisiting the rules for commercial traffic, and fortify the full implementation of the rules, together with the rules governing the transportation of human beings, their luggage and goods.

ANN showed its advantage over conventional programming in this study. This is due to its capability to provide solutions to non-algorithmic problems and can learn how to deal with the new and unexpected situations by the help of past experience. Neural networks are able to relate input with output, allow large number of variables and are error tolerant.

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