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Development of Software Application for Nigerian Traffic Flow Monitoring and Prediction of High-Way Infrastructural Facilities

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Authors' contributions

This work was carried out in collaboration between both authors. Author PKO designed the study, managed the analyses of the study and monitored the final draft. Author OTO did the literature searches, monitored the software development process, wrote the protocol and the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: This study was carried out with the aim of developing a software that can predict high-way infrastructural facilities and also monitors the traffic flow of vehicles at a particular junction of a specified location in Nigeria.
Study Design: A T- Junction was identified as the study area. Relevant data on the junction was collected. The T-Junction was modelled and data collected was transferred to data base and subsequently analyzed in order to develop the required software which is capable of monitoring traffic flow as well as predicting the needed road infrastructural facilities.
Place and Duration of Study: Department of Mechanical Engineering, Federal University of Technology, Akure, Ondo State, Nigeria, between June 2013 and February 2015.
Methodology: The aim of this work was achieved by modelling one of the T– junctions in Akure City, Ondo State, Nigeria where one of the major road in the city forms an intersection with the express road. Primary data was collected through observations and oral interview with some road

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officers as well as road users. Secondary data such as traffic flow at the study area and vehicle registration in the town was gotten from Federal Road Safety Commission and Ondo State board of internal revenue respectively all in Nigeria. The data collected was processed, analyzed and modelled. Computer software was developed to validate the model.

Results: The results from the software show that for the year 2015, the possible number of vehicles in the city was forecast to be 7,894. The total no of vehicles at the junction waiting in lane 1 would be about 38, 30 for lane 2 and 45 for lane 3 respectively.

Conclusion: The software is a veritable tool that can be used to predict flow of traffic and infrastructure needed in urban environment especially at any T-junction, provided it is built on a properly designed database, which must also be amenable to constant updating.

Keywords: Software; traffic flow; high-way infrastructures; prediction.

1. INTRODUCTION

Transportation is an indispensable catalyst for activating and stimulating the tempo of economic, social, political and strategic development. Thus, effective and efficient functioning of urban centres depends on the provision of basic infrastructures. This implies that transport facilities has to be rationally developed to ensure that the movement of people and goods take place speedily, economically, safely, comfortably and in an environmentally friendly manner [1]. These transport infrastructures are necessary facilities that are responsible for easy movement on the highway to prevent accidents and traffic congestion. Some of these facilities include the following; road sign works, traffic lights, signs, milestones, road markings, barrier, car terminals, parking lots, road safety corridor, flyovers or bridges, pedestrian road sections, road collector system, emergency access ways, culverts/drainage, sideways, walkways, cycleway, lanes with associated loading and unloading facilities.

Transportation plays an important role in the political, economic and social development of any society. It constitutes the main avenue through which different parts of the society are linked together [2].

There are many challenges facing road transportation in Nigeria today. These include lack of necessary road infrastructural facilities, heavy traffic congestion, and road accidents. Road accident is the major cause of death in Nigeria. Hardly will a day pass without the occurrence of road accidents leading to increasing incidence of mortality rate as well as financial cost to both society and the individual involved [3].

According to [4], urban environment are the most prone to motor traffic accidents. This is due to the fact that 75% of traffic accidents take place in the cities. The precise role of transport in simulating greater economic and social development has been a target of research for some time.

A lot of researchers have really spent their time on highway infrastructures or road facilities. [5] worked on the assessment of the quality of urban transport system in Nigeria and investigated the quality of transport services in Ibadan metropolis. He reported that some of the urban residents who are less accessible to transport services in the neighbourhood commute on foot to meet their travel demand. He emphasized that there is need to revitalize the transport services in urban centres in Nigeria so as to improve the accessibility characteristics of urban residents and promote sustainable transport development.

Atubi [6] posited that transport system management as a process has become an indispensable tool for efficient urban transport system and as such requires strong inter agency collaborations such that all relevant institutions and stake holders act in a mutually reinforced manner. [7] put forward a theory to explain the spatio-temporal relationships that exist between transport and urban growth. This theory has five distinctive phases. The theory, explains and shows that the more complex a city becomes the more sophisticated and complex the transport system which it requires. [8] emphasized on transportation education and espouses the significance of training and retraining scheme. They asserted that a thorough appreciation of transport education becomes essential tool in effective planning and performance of road safety management.

However, in spite of many research work that had been done in this area, none of these researchers has developed a model in form of programmed software that will accept analysed data from previous and current infrastructural

facilities and traffic information at a place, particularly a T-junction and at the same time predict infrastructural facilities for future years based on the available facilities on ground.

Therefore, this work takes into consideration all the effects of lack or inadequate highway infrastructural facilities by developing a software which will predict the exact infrastructural facilities that will be necessary for a different sections of the road by taking into account some factors such as the length of that road, how busy the road is and the purpose of the road to predict the useful facilities to aid the ease of movement on that road without interfering with the physical environment. The software developed can be applied to any T-junction along any road in Nigeria as long as the required information is supplied to the system.

2. METHODOLOGY

The detailed steps adopted in achieving the aim of this work are stated below;

2.1 Problem Definition and Identification

A T-junction is made up of three different roads coming together at a point. It usually consists of the major road intercepted by a minor road. The problem examined in this work is to model the traffic flow on a T junction using road block junction along Ilesha-Owo Expressway, Akure, as a case study and hence develop computer software to validate the model developed.

On the major road under study, there are two major lanes (l_1) and (l_2). On the minor road there is only one intercepting lane (l_3) as shown in the Fig. 1.

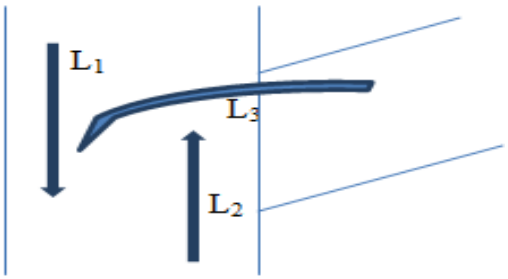

Fig. 1. Schematic of the study area

2.2 Data Collection

The two methods adopted for collecting data required for this study includes; primary and secondary method.

The primary source of data collection involves direct collection of information on the field, oral interview and observations. The data collected from primary sources include pictures of traffic-congested zones, information on traffic-congested junctions (points), the roads (lines)as well as oral interview with road officers such as Federal Road Safety Corps (FRSC), Federal Road Maintenance Agencies (FERMA).The secondary source of data collection involves sourcing information from existing records. Such data include traffics flow along Benin-Akure-Ilesha road taking Road block junction as the counting point from (FRSC), number of vehicles registration in Akure from year 2008 – 2012 from Ondo state board of internal revenue, Akure, Nigeria.

2.3 Transferring of Data to Database

The database was structured in a format for implementation in a software environment. Similarly, Microsoft Visio was used for designing some of the figures.

2.4 Data Presentation and Analysis

Fig. 2 shows the graph of total number of registered vehicles against years.

A critical study of the graph in Fig. 2 shows that rate of vehicle increase in Akure follows a geometric pattern of the form;

$$T_n = ar^{c-1} \quad (1)$$

where;

a = first term (which signifies the first reference year from the data)
r = common ratio
c = number of terms/years
T_n= total no of vehicles in the city in a particular year.

Using the data from the figure showing years with their respective number of vehicles in the city and using year 2008 as the reference year i.e. the first years, it was calculated that the common ratio (r) is 1.58

Therefore,

common ratio (r) = 1.58
c= (required year = 2008)

So, with the value of (r) known which signifies the trend of vehicle increase in the city, the formula

can be used to forecast the likely number of vehicles in the city in the future using year 2008 as the reference point.

Moreover, the likely number of vehicles at the junction can also be forecast for future years considering the fact that the number of vehicle at the junction will increase as the number of vehicles in the city increases i.e. it is directly proportional to the number of vehicles in the city. Using the relationship in equation (2)

$$G.P = A = ar^{c-1} \quad (2)$$

Where; A represents the number of vehicles in Akure in a particular year.

Therefore,

$$J_n \alpha A \quad (3)$$

$$J_n = K_n A \quad (4)$$

$$J_n = K_n (ar^{c-1}) \quad (5)$$

Where;

J = no. of vehicles at the junction/minute
k = constant of proportionality
n = integers (1, 2, 3….)

2.5 Software Development

The data collected were carefully analysed to know the design pattern to be used for the software, the arrangement of the mathematical expressions as well as the constant terms which include the commands for the operation of the software.

Fig. 3 shows the flowchart for the software development.

2.5.1 Software design

The data analysed was used to design the software package after knowing the software programming package to be used. This computer software will accept certain data about a road in terms of its purpose and the density of cars ploughing the road per minute. The data were processed to predict required and specific infrastructural facilities on the road particularly at T – junction. The software can also predict the likely number of vehicles that will be at the junction in the future as well as the waiting time for the vehicles.

The software design is divided into two phases/sides namely; Server side (Database) and Client side (User).

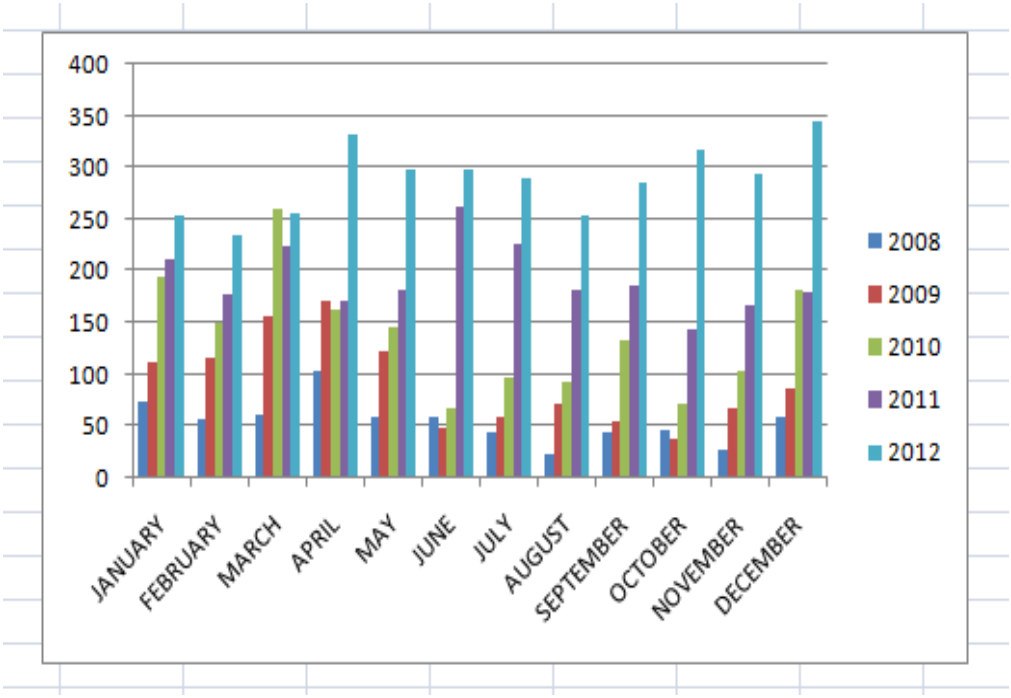

Fig. 2. Graph of total no of vehicles against years

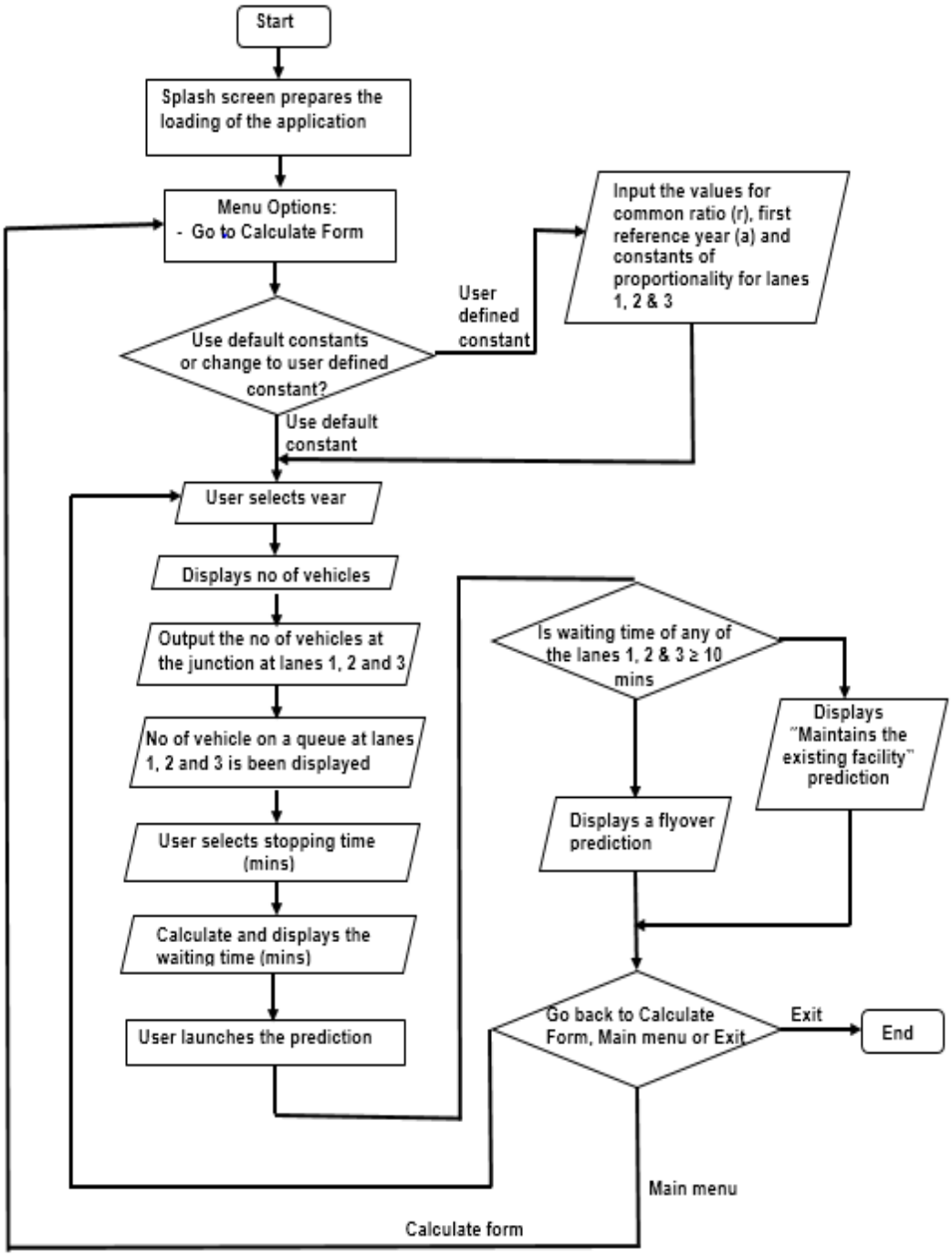

Fig. 3. Flowchart for the software development

2.5.2 Server side

This is the side/part of the software that contains the database, this side is not open to the user i.e the user cannot manipulate it but can only have access to it through sending and retrieving of data which is based on the command from the interface as provided by the software programmer. It is controlled and monitored by Database Administrator.

The name of the software package used here is WAMP (Windows Apache MySQLPHPM Admin) inside which DBMS (Database Management

System) was used to setup and manage the database.

2.5.3 Client side

This side/part is also called Graphical User Interface (GUI), it is the side that the users can be accessed, it is users friendly and the users can send or retrieve any information to or from the database using the commands available on this interface. Visual studio 2010 is the software package used in this side out of which c# (C sharp) programming language is used to write the programme command.

2.5.4 Software application

Figs. 4 to 8 show software interface of the splash screen, menu page, calculation page and infrastructure prediction page.

2.5.5 The splash

The splash screen is also called the loading page of the software. It prepares the loading of the software anytime the programme is lunched. It is shown in Fig. 4.

2.5.6 Menu page

This is the page that shows the menu options for the user guide. By clicking on the ***View bar and selecting the calculate form.*** The menu page allows the users the directives and also allows the user to command the programme or make request.

From this page, users can proceed to calculate page or exit and close the programme. The ***Exit bar*** is for the users to terminate and exit the software. The response of the software when the user clicks on the commands from the ***Menu Page*** is shown in Fig. 5.

2.5.7 Calculation page

By clicking on the command ***calculate form*** from above, the user will have access to the page where the user can make calculation for any selected year and get the respective results to each command such as number of vehicles in the town, number of vehicles at the junction, number of vehicles on the queue for each lane and also the users can select the desired stopping time to get the consequent waiting time for vehicles on each lane. Fig. 6 shows the software calculate form page.

2.5.8 Prediction page

This page shows the predict when the user clicks on the command predict from the calculate page which allows the user to know what infrastructural facilities is required to be put in place and from this page the user can go back to the ***menu page*** as well as the ***calculate page.***

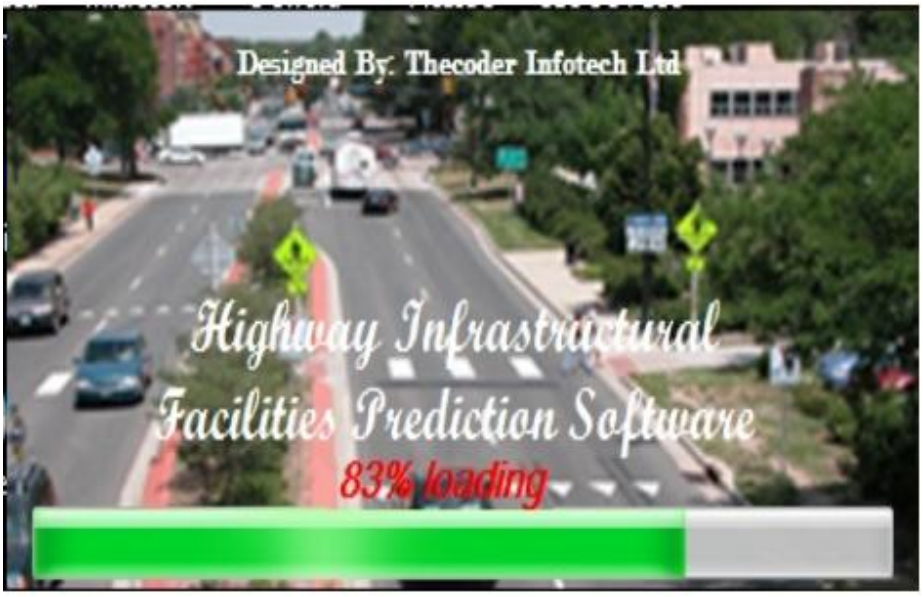

Fig. 4. The Software splash screen

Fig. 5. The software menu page

Fig. 6. The software calculation page

Fig. 7. The page displaying the result of the prediction

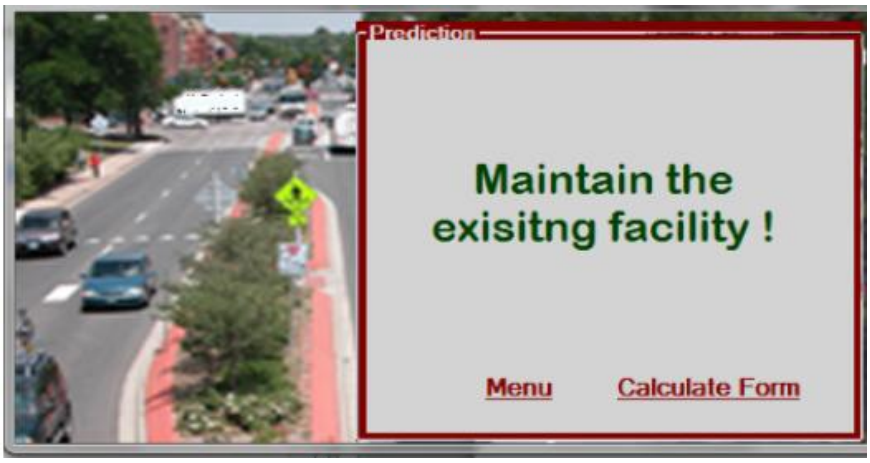

Fig. 8. The page displaying the result of the prediction

3. RESULTS AND DISCUSSION

Year 2015 was selected to evaluate the performance of the software developed. The possible number of vehicles that will be in the city by the year 2015 was forecast to be 7,894. The total no of vehicles at the junction waiting in lane 1 would be about 38, 30 for lane 2 and 45 for lane 3 respectively. Hence with this software, we can forecast for any particular year the possible number of vehicles that will be in the city, the possible number of vehicles that will be at the junction, the possible number of vehicle that will be on the queue, as well as their waiting time whenever they are stopped for a specified stopping time.

Fig. 9 indicates the waiting time on each lane in case the vehicles on a lane are stopped for a specific time. The result from this will help in predicting the high way infrastructural facilities that will be necessary to reduce waiting time as appropriate in order to make judicious use of precious time that would have been wasted. Fig. 10 shows the predicted infrastructure for year 2015.

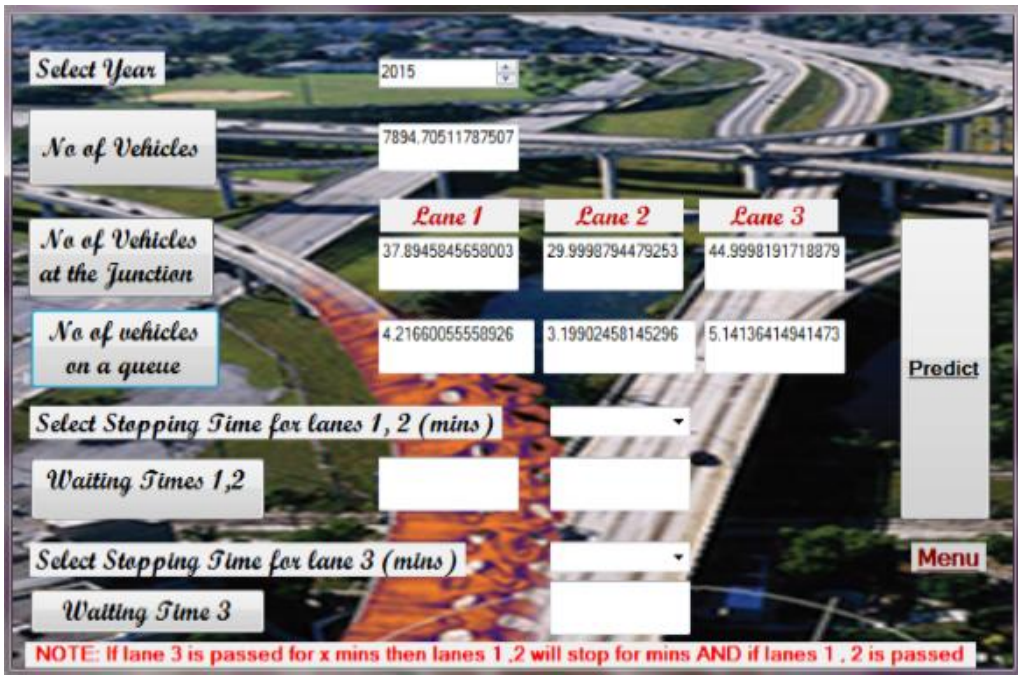

Fig. 9. Calculation page showing the results for the selected year 2015

Fig. 10. Prediction page showing the predicted infrastructure for the year 2015

4. CONCLUSION

Software for monitoring traffic flow and the prediction of high way infrastructural facilities in Nigeria has been developed. While WAMP (Windows Apache MySQLPHPM Admin) was used to set up and manage the database, Visual studio 2010 (C sharp) was used to write the programme command. The result of predictions from the software interface shows that by the end of year 2015, the total no of vehicles at the junction, waiting in lane 1 would be about 38, 30 for lane 2 and 45 for lane 3 respectively. The study indicates that there is a significant relationship between the development of highway infrastructural facilities and the number of vehicles in a particular place at a specific location. It was clearly observed in this work that modelling this expressway will help to foresee its future needs, and as well predicting the required facilities for this highway will eventually solve some of these problems. Hence, the result generated from the validation of this model shows clearly that this software is an important tool in solving some of the road problems in major highways, as it will help to prepare for the present and the future as to know what is required infrastructures needed on the roads. This software will further help in reducing traffic jam as well as bringing road accident to the barest minimum. Worthy of note is the fact that the computer software that has been developed can be used to predict for the future the expected vehicles at the junction. Moreover, the software can be applied on any T – junction road anywhere in the world as long as the required data is supplied.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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