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An AI-driven Approach to Traffic Congestion Prediction in Port Harcourt City Using Naïve Bayes

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Authors' contributions

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Four important intersections Location Junction, Rumuokoro Junction, GRA Junction, and Rumuokwuta Junction will be the focus of this study's investigation into the persistent problem of traffic congestion in Port Harcourt, Nigeria. In order to provide insights for improved traffic management, the project also aims to construct a predictive model that forecasts traffic congestion on certain routes using the Naïve Bayes algorithm. The study used both exploratory and descriptive research techniques to gather information about Port Harcourt's traffic congestion. Field surveys were carried out at the four intersections between 7 a.m. and 7 p.m. to collect traffic counts and vehicle footage. The investigation also included data from Rivers State Command, a division of the Federal Road Safety Corps (FRSC). Using this data to find patterns and trends in traffic flow, a Naïve Bayes algorithm was developed to classify and predict the degree of traffic congestion. With a 97% accuracy rate, the algorithm accurately classified 1164 out of 1200 traffic data points, predicting traffic congestion. The predictive algorithm used bar charts to show the traffic conditions; tall, moderate, and tiny bars, respectively, indicated high, medium, and low traffic congestion. The model's efficacy in real-time traffic forecasting was reinforced by the close match between the

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forecasts and observed traffic patterns. According to the study's findings, the Naïve Bayes algorithm can accurately forecast traffic congestion and provides road users and urban planners with useful information. The model can greatly enhance road efficiency by lowering travel times, relieving congestion, and improving traffic management on Port Harcourt's major arteries by accurately predicting traffic conditions.

Keywords: Traffic congestion; Naïve Bayes algorithm; prediction; high traffic; medium traffic and low traffic.

1. INTRODUCTION

Since it allows different regions to communicate and integrate, transportation is crucial to the functioning of every nation (Arosanyin, G. T., 1998). Access to land use activities within the service area and the facilitation of people and goods movement are the two main purposes of transportation (Falcocchio, J. C., and Levinson, H. S. 2015). Despite its importance, the benefits of transportation are frequently only realized when problems occur. Environmental pollution, noise pollution from traffic, accidents, and, most significantly, traffic congestion—which is becoming one of the transportation systems' most studied issues—are typical transportation-related issues. In addition to being location- and time-specific, traffic congestion has a major negative influence on productivity, the environment, and socioeconomic well-being, especially in urban regions (Popoola, M. O., et al., 2013). For instance, in order to address Lagos's severe traffic congestion problems, it was predicted in 2010 that the state would need to invest about $1,067 million, or N166 billion (Ukpata, J. O., and Etika, A. A. (2012). Megacities like Lagos, Port Harcourt, and Abuja are not the only large and medium-sized cities in Nigeria that struggle with this issue (Ogunsanya, A. A., 1984). The government of Nigeria has taken a number of steps to alleviate traffic congestion, but the problem still exists and affects both large cities and smaller metropolitan areas. Increased travel expenses, lost productivity, physical and mental stress, and environmental deterioration are all impacted by traffic congestion. Although the issue of traffic congestion has been previously studied in cities like Lagos, Ibadan, and Port Harcourt, it is still a problem. Consequently, in order to alleviate the issue and direct urban traffic control in cities such as Port Harcourt, a more efficacious prediction model is required. This study employs the Naïve Bayes Algorithm to forecast patterns of traffic congestion on specific routes in Port Harcourt, Nigeria. Field surveys were carried out at strategic intersections throughout the city to gather traffic data, comprising vehicle counts as well as video recordings. Additionally, information from the Federal Road Safety Corps (FRSC) was included. The study attempts to classify and predict peak and off-peak traffic periods using the Naïve Bayes Algorithm, providing insights for improved traffic management.

In Port Harcourt, traffic jams were successfully predicted using the Naïve Bayes algorithm. The model yielded information on projected traffic patterns to road users as well as planners by classifying traffic circumstances into three categories: high, medium, and low. With an accuracy of 97%, the forecasts closely matched the observed traffic data, indicating the model's efficacy in predicting traffic trends. Because traffic congestion lengthens travel times, uses more fuel, and pollutes the environment, it seriously impairs urban life. Congestion can be effectively managed and lessened by road users and urban planners by creating a dependable predictive model, like the Naïve Bayes Algorithm.

The methodology used in this study offers a data-driven solution to a continuing issue in Nigerian cities, with the potential to increase traffic efficiency and lessen congestion-related problems. The study is limited to particular roads in Port Harcourt, Nigeria, and use the Naïve Bayes Algorithm to forecast traffic congestion. Although the study offers insightful information about patterns of traffic congestion, it does not investigate long-term infrastructure modifications or other viable traffic-calming measures. On the other hand, it provides a starting point for further studies on predictive traffic modeling and its implementation in other Nigerian cities.

2. LITERATURE REVIEW

Numerous studies have been conducted in the past on traffic jams in Nigerian cities. Using a GIS technique, he investigated traffic congestion in Akure, Nigeria. The study found that the increase in motor vehicles without a commensurate upgrade in transportation infrastructure, such as the road network and traffic management strategies, leads to traffic congestion. One of the factors contributing to the city's traffic jams was identified by the study as unauthorized roadside parking. Lagos, Nigeria's intraurban traffic congestion issues were researched (Bashiru, A. R., & Waziri, O. O. 2008). According to their research, traffic congestion causes 57% of commuters and drivers to spend between 30 and 60 minutes on the road. The researchers also determined that the following factors contribute to traffic congestion in Lagos: potholes and poor road conditions; trading activities; on-street parking; passenger loading and unloading; illegal bus stops; flooding and inadequate drainage; vehicle breakdowns; and a lack of parking spaces and traffic lights at certain intersections. According to a study on the impacts of urban traffic congestion on drivers in Ado-Ekiti, Nigeria, road traffic congestion mostly has psychological and mental repercussions on the health of the local population (Awosusi, A. O., and Akindutire, I. O. 2010). Therefore, the study suggested that the area's numerous alternative transportation systems, wise city design, and the building of interchanges and overhead bridges would be the best ways to reduce urban traffic congestion.

According to a study on traffic congestion at road crossings in Ilorin, Nigeria, parking issues and traffic wardens are the main contributors to traffic congestion and delays at these crossroads. (Aderamo, A. J., and Atomode, T. I., 2011). In order to emphasize the significance of traffic flow features like flow, density, and speed to the planning, design, and operation of urban highways, the study emphasized the basic hypothesis of traffic flow. Just 18.57% of the sampled commuting demographic in another study conducted in Abuja (Agbonika, F. O., 2011). resided in the city center. The heavy traffic in the city at eight in the morning and six in the evening is a major cause of congestion as conducted research on the impacts of traffic and the fluctuation of travel times along Nigeria's Abuja Keffi Corridor (Biliyamin, I. A., and Abosede, B. A., 2012). According to their research, the best way to lessen traffic along this corridor is to implement a policy pertaining to the availability of bus stops. It is suggested that in order to lessen the traffic impact in Abuja's outer ring corridor, the Federal Capital Territory Administration (FCTA) should create more precise policy tools. Numerous scholarly investigations have explored traffic patterns and strategies for mitigating traffic congestion in Nigerian urban areas (Ajibade, M. K., Mohammed, H. 2016). Research conducted in Ghana has also determined the origins and potential impacts of traffic congestion on the community. (Agyapong, F., and Ojo, T. K. 2018) evaluated the causes, consequences, and management options for traffic congestion at Ghana's Accra Central Market from the standpoint of the user. According to the survey, the main reasons of traffic congestion are narrow roads and the negative attitudes of drivers and merchants. While the primary effects of congestion were found to be time-consuming and productivity loss. (Takyi, H., Kofi, P., and Anin, K. E. 2013) evaluates the degree to which Kumasi Metropolis, Ghana, traffic impacts the productivity of its workforce. According to their findings, Kumasi Metropolis's limited mobility is caused by traffic, which can lead to increased travel delays, especially during peak hours, and lower productivity. (Apeh, J. J., and Ojochenemi, P. A. 2023), used a geographic information system (GIS) to conduct research on the geographic examination of traffic congestion in the Federal Capital Territory (FCT) of Abuja in order to identify the primary reasons of the congestion in the study region. The authors sampled a well-organized set of 384 surveys using descriptive analytic techniques like averages, percentages, standard deviations, and structured Likert scales. According to the study, the primary cause of traffic congestion in the study area is an excessive number of taxis, while the primary cure is road repair. (Adigun, J. O., et al., 2020) a case study of Sango T Junction in Ibadan, Oyo State, was carried out for a review of traffic congestion on Nigerian roads. To analyze the data gathered for the study, mean plot, t-test, and examination of variances were employed. The study's conclusions indicate that the morning is when traffic is at its worst and that the evening is when drivers must wait the longest. The adverse effects of traffic congestion can be lessened by properly planning the road infrastructure, according to the study. investigated the causes of traffic congestion on the road corridor in (Akinyemi, Y. C., and Obadina, E. O. 2018), conducting study on evaluation of traffic congestion on Lagos/Abeokuta Expressway-Agege Motorway in Lagos Metropolis. The degree of road connectedness was assessed using a network index based on graph theory, and data on traffic congestion along the road corridor was gathered through a cross-sectional survey including 384 commuters. According to the research report, Ikeja has more volume vehicle traffic (VVT) than other areas like Alimosho, which has 21.5%, and Oshodi, which has 16.2%. (Okoko, E. 2006), conducted research on the use of traffic lights to anticipate the right-of-way for traffic streams. At intersections, street lights with electrical devices that run on time were installed. It has the ability to manage car streams by displaying Green (GO) or Red (STOP).

(Agaviezor, D. T., et al., 2022) examined traffic congestion and demand management strategies in Port Harcourt metropolis. Data were gathered from both primary and secondary sources. A total of 400 structured questionnaires were distributed to various road users, including private and commercial drivers, passengers, pedestrians, and traffic officers across six traffic zones in Port Harcourt, Rivers State, Nigeria. Traffic counts during peak hours were conducted to estimate the population of road users on the selected routes. The study utilized both descriptive and inferential statistics, with all analyses performed using SPSS version 24.0. Results revealed that 36.8% of respondents made early trips between 6 and 7 am, while 53.7% typically took private trips, and 46.3% used public transportation. The main causes of traffic congestion were identified as non-functional traffic lights (35.5%), vehicle accidents, particularly involving trailers (15%), overcrowding due to excessive use of cars (14.7%), insufficient road capacity (11.3%), poor road conditions (1.3%), drivers' behavior (3.2%), and lack of alternative routes (18.9%). Key challenges in transport management included poor urban planning (58.7%), weak enforcement of planning regulations (70.8%), an inefficient transport management system (62.9%), lack of traffic light maintenance (69.5%), inadequate driver training (52.6%), and poorly constructed roads (46.6%). (Chwiałkowski, C., and Zydro, N. A., 2022). identified factors influencing route usage, such as trade corridors and transport link quantities, which are important for analyzing the spatial characteristics of transport routes. The similarity of route networks in terms of central functions and complementary attributes, as well as changes in one network, can impact movement patterns and the structure of individual routes.

2.1 Study Area

The British government of Nigeria created Port-Harcourt between 1912 and 1914. Its coordinates are 6º 52' 7.2" and 7º 7' 37.7" east longitude and 4º 44' 58.8" and 4º 56' 4.6" north latitude. The weather of Port Harcourt is hot and muggy, with lengthy, frequent wet seasons and short, dry ones. The municipality experiences ample of sunshine and temps between 25°C and 28°C, according to (Ogbonna, D. N., et al., 2007). The Port Harcourt urban area's estimated 2016 population was 1,865,000, a considerable rise from the 1,382,592 estimated in 2006. The unique geography of this area makes road development extremely difficult.

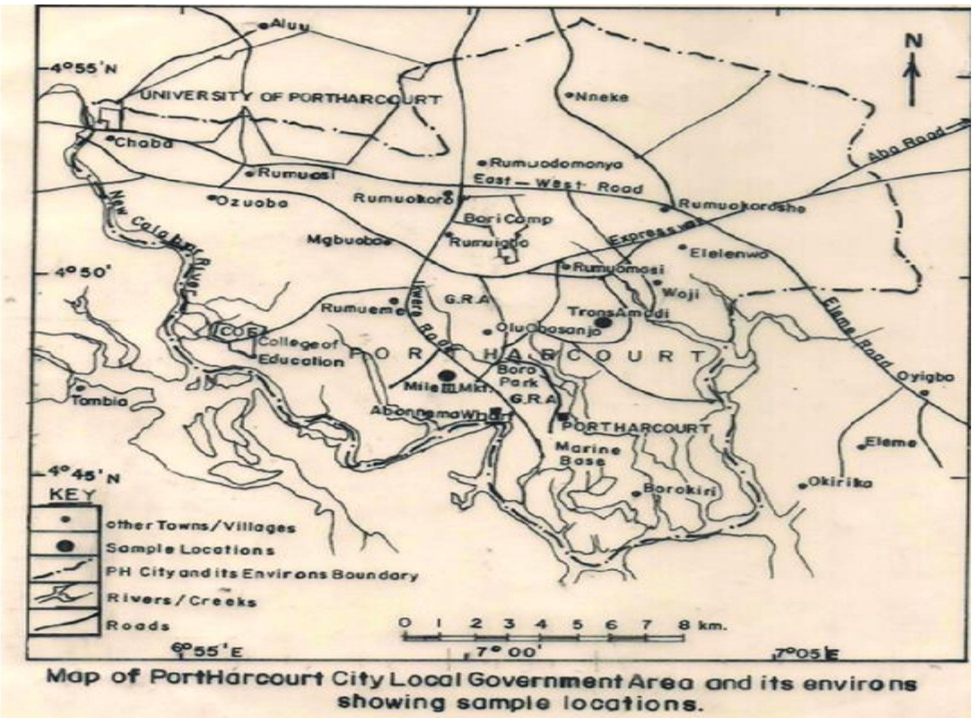


Fig 1. Street Map of the port harcourt showing study
Source: National Research Development Agency

An additional problem with traffic congestion is found in Port Harcourt, one of Nigeria's primary centers for industrial as well as crude oil exploration. The oil industry city of Port Harcourt has seen remarkable spatial and population growth. The area's traffic congestion issue has never been improved, despite the addition of new highways and the expansion of old ones by succeeding governments due to the influx of businesses and population. Major thoroughfares in the Port Harcourt municipality are essentially jammed, which negatively impacts the residents of the city (Obinna, V. C., et al., 2018). According to this study, major crossroads affected by traffic congestion include Rumuokoro Junction, Location Junction, GRA Junction, and Rumuokwuta Junction. Movement delays, missed labor hours due to travel time and lost income, social, psychological, and physical problems, air and noise pollution, and an increase in criminal activity are a few effects of traffic congestion in the area. It is expected that the challenges brought on by traffic congestion would increase as Port Harcourt's demographic rises. The region's loose land use planning and regulatory framework exacerbates the situation. To control road traffic and lessen the negative social-economic effects associated with it, some traffic management techniques, such as traffic lights and traffic personnel, are now used to monitor traffic bottlenecks in Port Harcourt.

The prevailing road traffic monitoring system is currently overworked because it cannot handle the amount of traffic congestion that has been observed recently. Fig. 1 shows map of Port Harcourt city.

3. MATERIALS AND METHODS

3.1 Materials

i. Laptop
ii. Camera
iii. Excel Software
iv. HTML
v. MySql

3.2 Methods

i. Naïve Bayes Algorithm

The Naïve Bayes algorithm’s strengths lies in its simplicity, ability to handle uncertainty, efficiency in real-time scenarios, and ease of implementation which makes it highly applicable to traffic flow prediction. It allows for effective classification of traffic conditions and can support dynamic traffic management systems that rely on real-time data. Naïve Bayes is also well-suited for classification problems, and in traffic flow prediction, you often need to classify traffic into categories such as low, medium, or high congestion.

Using a thorough analysis of the body of information already available on road traffic congestion, Naïve Bayes was employed to forecast traffic congestion. The study used exploratory and descriptive designs, which enable data collecting through a variety of channels. To collect traffic counts and video footage of the cars that used these roads between the hours of 7 a.m. and 7 p.m., field surveys were conducted. A portion of the information was also obtained from the Nigerian Federal Road Safety Corps (FRSC), Rivers State Command. For the purpose of traffic study and prediction, the Rumuokwuta, Rumuokoro, GRA, and Location (NTA) junctions provided an hourly average traffic volume each day. Tables 1, 2, 3, and 4 display these facts. This information served as the training set for the Naïve Bayes algorithm, which was used to forecast traffic in these locations.

The Naïve Bayes algorithm establishes the route under investigation's probability status (YES or NO) and congestion level (Congested or not). It is evident that applying the Naïve Bayes algorithm to the collected traffic data in order to anticipate the traffic is important in order to demonstrate the possibility of traffic congestion in the studied regions.

The classification task in Naïve Bayes classifier is performed by evaluating the posterior probability. Given a set of variables $X = \{x_1, x_{2,} \dots x_n\}$, the algorithm attempts to determine the posterior probability of event C_i among a set of possible outcomes $C = \{c_{1,} c_2 \dots \dots c_j\}$. Using this modified Bayes’ rule formular, a new case X is labeled with a class level C_{i} that achieves the highest posterior probability. Mathematically, Naïve Bayes’ classification model is expressed as:

$$P(X/C_i) = P(x_1/C_i) * P(x_2/C_i) * P(x_3/C_i) * \dots\dots * P(x_k/C_i) \quad (3.1)$$

Table 1. Hourly traffic Data from Rumuokwuta junction

N/S	Time interval (hourly)	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total hourly Traffic
1	7-8 am	5225	4248	4068	4803	4263	2936	2689	28232
2	8 - 9	6076	5530	4702	6077	4757	2930	1017	31089
3	9 - 10	5654	4698	3691	5060	3446	3552	2746	28847
4	10 - 11	3818	3975	2397	3377	2411	3478	1425	20881
5	11 - 12	2402	2392	1479	2449	1031	2913	1194	13860
6	12 - 1	2245	936	884	949	598	1804	1166	8582
7	1 - 2pm	986	567	579	685	748	1329	1284	6178
8	2 - 3	1032	857	616	1018	862	1239	1378	7002
9	3 - 4	1841	985	1479	1841	1047	1929	1690	10812
10	4 - 5	2397	2401	2866	2406	1518	2402	2988	16978
11	5 - 6	3777	3749	3792	3777	2872	3989	3270	25226
12	6 - 7	5485	4600	5260	5195	4339	4414	3415	32708
Total		**40938**	**34938**	**31813**	**37637**	**27892**	**32915**	**24262**	

Table 2. Hourly traffic data at Rumuokoro junction

N/S	Time interval (hourly)	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total hourly Traffic
1	7-8 am	5742	6247	7267	4742	5741	2035	1321	33095
2	8 - 9	8349	7831	9341	7349	7349	3022	1821	45062
3	9 - 10	5662	5674	7192	5662	5663	1464	1200	32517
4	10 - 11	5884	4631	5242	5384	5812	1729	1040	29722
5	11 - 12	4282	3143	2241	4082	4182	984	877	19791
6	12 - 1	2999	1234	1300	2699	2699	1272	835	13038
7	1 - 2pm	1174	2550	1627	1104	1164	2552	803	10974
8	2 - 3	1426	2432	1873	1326	1423	2672	1607	12759
9	3 - 4	2214	3433	2276	2014	2314	2020	2942	17213
10	4 - 5	3629	4422	3299	3529	3624	3047	3221	24771
11	5 - 6	5247	5749	6244	5147	5217	4324	4219	36147
12	6 - 7	6831	7621	9355	6617	7369	5247	4521	47561
Total		**53439**	**54967**	**57257**	**49655**	**52557**	**30368**	**24407**	

Table 3. Traffic data at GRA junction

N/S	Time interval (hourly)	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total hourly Traffic
1	7-8 am	11358	9234	8843	10441	9267	2035	1497	52675
2	8 - 9	13208	12021	10221	13211	10341	2022	2211	63235
3	9 - 10	12292	10214	8023	11001	7492	1200	1622	51844
4	10 - 11	8301	8642	5210	7342	5242	1040	924	36701
5	11 - 12	5222	5200	3215	5324	2241	1984	421	23607
6	12 - 1	4880	2034	1921	2063	1300	2835	361	15394
7	1 - 2pm	2143	1232	1258	1490	1627	1803	617	10170
8	2 - 3	2243	1864	1340	2214	1873	1607	821	11962
9	3 - 4	4003	2142	3215	4003	2276	2020	1501	19160
10	4 - 5	5211	5220	6231	5231	3299	3047	2147	30386
11	5 - 6	8211	8149	8243	8211	6244	4324	4934	48316
12	6 - 7	11923	10001	11435	11293	9432	5247	5249	64580
Total		**88995**	**75953**	**69155**	**81824**	**60634**	**29164**	**22305**	

Table 4. Traffic data at Location (NTA) junction with Classifier

S/N	Time (Hour)	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total Volume	congestion
1	7-8 am	3591	4566	4076	3620	2399	6792	2132	**27176**	**YES**
2	8-9am	5742	6247	7217	6742	5760	5418	3321	**40447**	**YES**
3	9-10am	7348	7831	9319	7349	7349	4088	4611	**47895**	**YES**
4	10-11am	6462	5664	7292	5770	6663	3412	3120	**38383**	**YES**
5	11-12noon	4889	4831	6242	6024	7812	2788	2100	**34686**	**YES**
6	12-1pm	4282	3143	3441	4018	4182	2016	1120	**22202**	**NO**
7	1-2pm	3124	1894	1500	2899	3688	1347	918	**15370**	**NO**
8	2-3pm	1174	3440	1638	1204	1175	3557	126	**12314**	**NO**
9	3-4pm	1626	2532	1847	1328	1626	3632	2704	**15295**	**NO**
10	4-5pm	2814	3342	2378	2118	2641	2330	3256	**18879**	**YES**
11	5-6pm	3629	4418	3199	3630	4623	4017	4698	**28214**	**NO**
12	6-7pm	5247	5627	6231	5427	6318	5324	5496	**39670**	**YES**
Total Volume for 12 Hour Per Day		**49928**	**53535**	**54380**	**50129**	**54236**	**44721**	**33602**		
Daily Average Volume		**4161**	**4461**	**4532**	**4177**	**4520**	**3727**	**2800**		

Hence, the Naïve Bayes' classification technique for road traffic congestion

For any given input; x defines as:

The inputs are;

$X = P(x_1 = "Route\ Name = value", x_2 = "Date = value", x_3 = "Time\ of\ congestion = value",$

x_4 = Total Traffic volume=value, x_5 = junction=value, x_6 = Speed=value,

$x_7 = "rain = value")$ (3.2)

Is calculated for each likely output as:

$$P\left(\frac{X}{High}\right) = P\left(\frac{x_1}{High}\right) * P\left(\frac{x_2}{High}\right) * P\left(\frac{x_3}{High}\right) * P\left(\frac{x_4}{High}\right) * P\left(\frac{x_5}{High}\right) * P(x_6/High) * P(x_7/High) \quad (3.3)$$

$$P\left(\frac{X}{Medium}\right) = P\left(\frac{x_1}{Medium}\right) * P\left(\frac{x_2}{Medium}\right) * P\left(\frac{x_3}{Medium}\right) * P\left(\frac{x_4}{Medium}\right) * P(x_5/Medium) * P(x_6/Medium) * P(x_7/Medium) \quad (3.4)$$

$$P(X/low) = P(x_1/low) * P\left(\frac{x_2}{low}\right) * P\left(\frac{x_3}{low}\right) * P\left(\frac{x_4}{low}\right) * P\left(\frac{x_5}{low}\right) * P\left(\frac{x_6}{low}\right) * P\left(\frac{x_7}{low}\right) \quad (3.5)$$

The output probability of traffic congestion is therefore determined as

$$P\left(\frac{High}{X}\right) = P\left(\frac{X}{High}\right) * P(High) \quad (3.6)$$

$$P(Medium/X) = P(X/Medium) * P(Medium) \quad (3.7)$$

$$P(low/X) = P(X/low) * P(low) \quad (3.8)$$

The output is:

$$Y = (P(High/X), P(Medium/X), P(low/X)) \quad (3.9)$$

This output gives the result as High traffic, Medium traffic or Low traffic.

4. RESULTS

Both tabulated and graphical forms are used to present the traffic study and prediction findings for the chosen Port Harcourt City regions. The traffic on the selected city routes is appropriately reflected in these results. For Location (NTA) Junction, Table 5 offers a color-coded traffic assessment for the Monday through Sunday period.

The hourly traffic volumes at Location (NTA) Junction, GRA Junction, Rumuokwuta Junction, and Rumuokoro Junction are graphically represented in Figs. 1, 2, 3, and 4. These diagrams demonstrate how traffic at each of the chosen places varies in intensity throughout the day.

Plates 1, 2, and 3 are screenshots of the application developed using the Naïve Bayes model for classifying traffic congestion. They display the predicted likelihood of congestion during the morning, afternoon, and evening over the course of one week.

Fig. 6 is graphical representation of daily traffic prediction for a period of one week. It indicates the probabilities of traffic congestion at the time of the day.

Table 6 summarized the performance of the developed application. A total number of 1200 traffic data was collected, 1164 was correctly classified while 36 had incorrect classification.

Plates 4 and 5 with red arrow show errors arising from incorrect classification of the traffic data. They are simulated error data.

Table 5. Hourly traffic chart analysis at Location (NTA) junction

Time interval (hourly)	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
7-8 am	Medium Traffic	Medium Traffic	Medium Traffic	Medium Traffic	Free Traffic	Heavy Traffic	Free Traffic
8 - 9	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Medium Traffic
9 - 10	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Medium Traffic	Medium Traffic
10 - 11	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Medium Traffic	Medium Traffic
11 - 12	Medium Traffic	Medium Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Free Traffic	Free Traffic
12 - 1	Medium Traffic	Medium Traffic	Medium Traffic	Medium Traffic	Medium Traffic	Free Traffic	Free Traffic
1 - 2pm	Medium Traffic	Free Traffic	Free Traffic	Free Traffic	Medium Traffic	Free Traffic	Free Traffic
2 - 3	Free Traffic	Medium Traffic	Free Traffic	Free Traffic	Free Traffic	Medium Traffic	Free Traffic
3 - 4	Free Traffic	Free Traffic	Free Traffic	Free Traffic	Free Traffic	Medium Traffic	Free Traffic
4 - 5	Free Traffic	Medium Traffic	Free Traffic	Free Traffic	Free Traffic	Free Traffic	Free Traffic
5 - 6	Medium Traffic	Medium Traffic	Medium Traffic	Medium Traffic	Medium Traffic	Medium Traffic	Medium Traffic
6 - 7	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic	Heavy Traffic

Legend

(green)	Free Traffic
(dark red)	Medium Traffic
(red)	Heavy Traffic

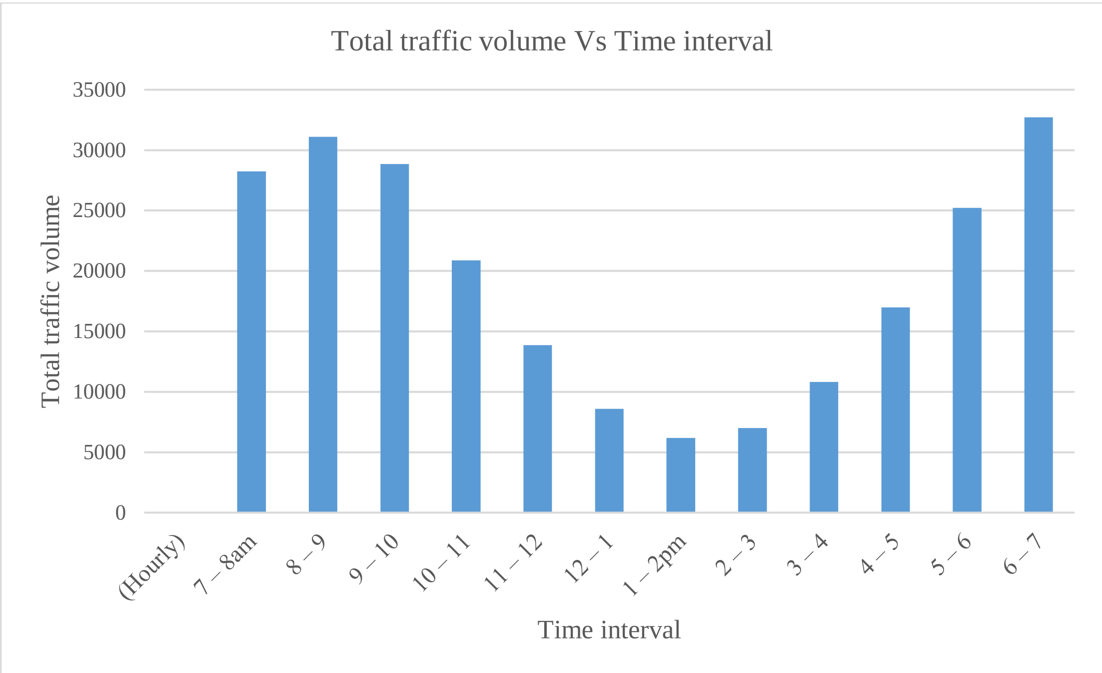


Fig. 2. Graphical representation of total traffic volume against hourly time interval at Rumuokwuta junction

Table 6. System Performance

System Performance	
Traffic Data Classified	1200
Correct Classification	1164
Incorrect Classification	36
Accuracy (%)	97
Percentage Error (%)	3

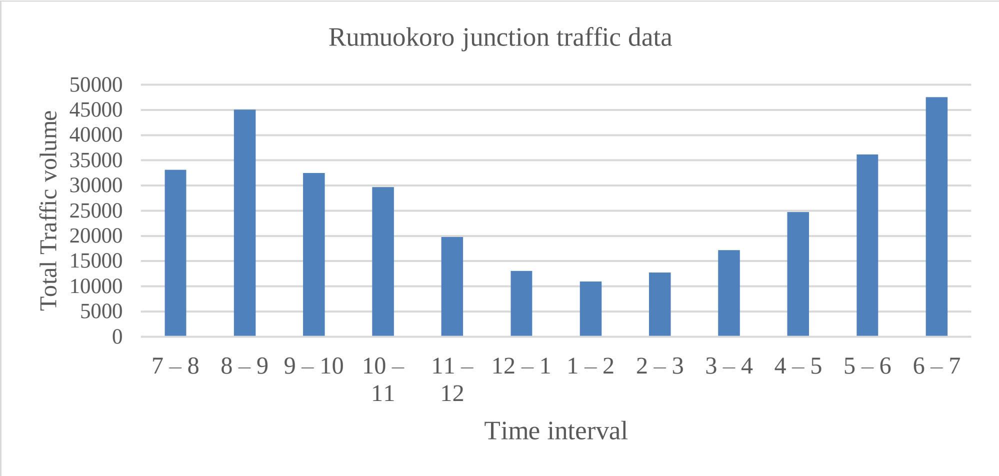


Fig. 3. Hourly traffic volume along Rumuokoro junction, Port Harcourt

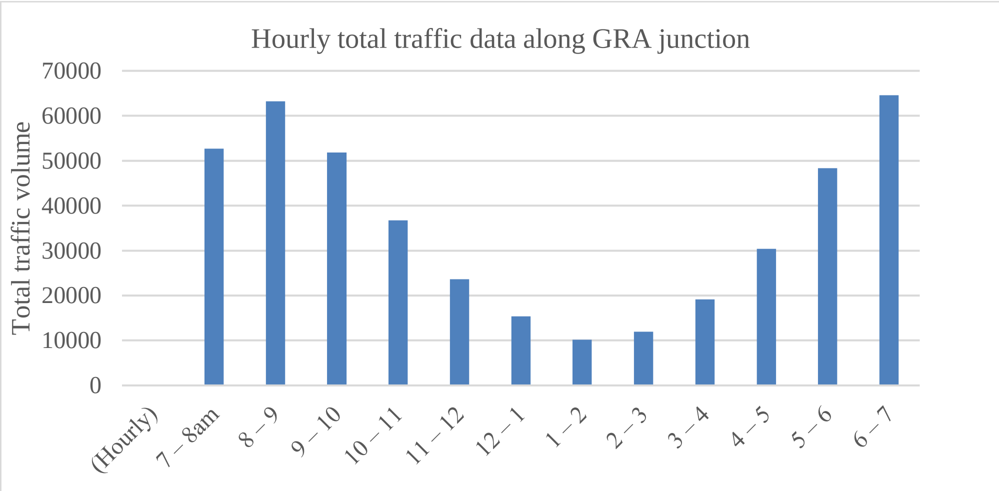


Fig. 4. Hourly traffic volume along GRA junction, Port Harcourt

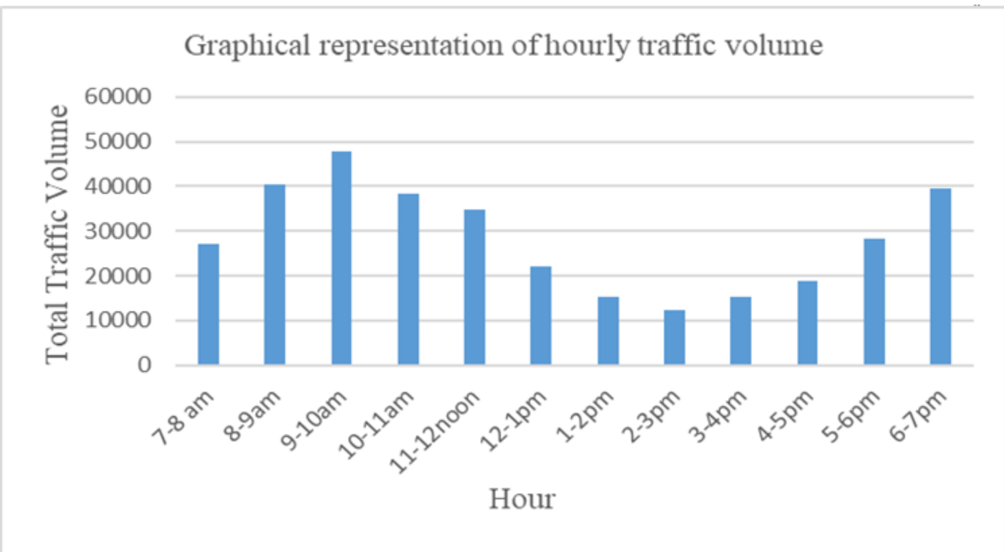
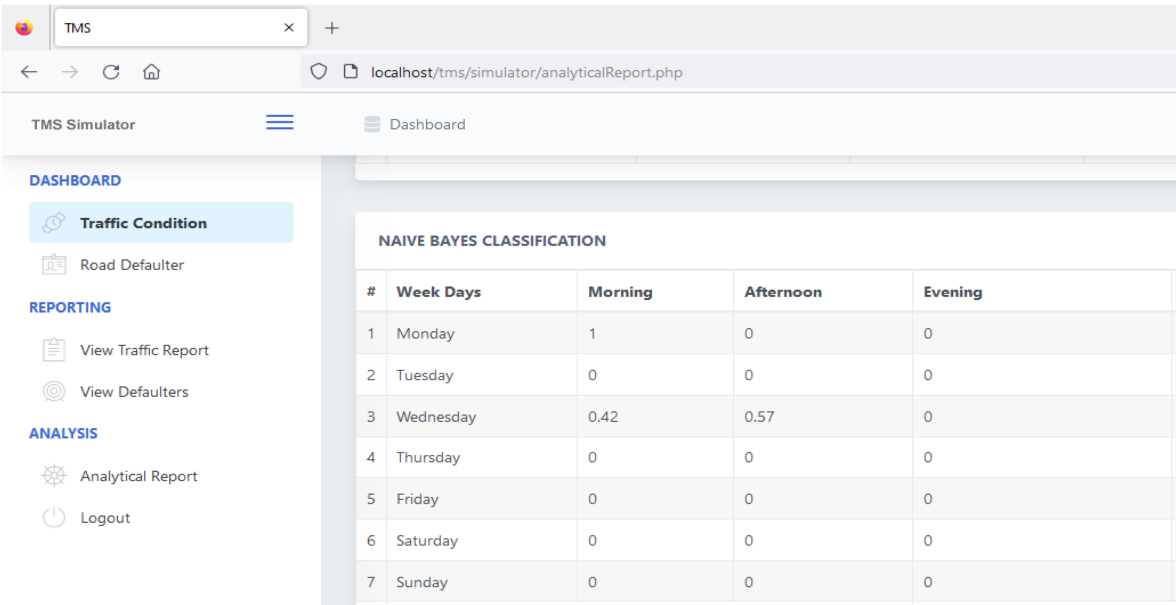
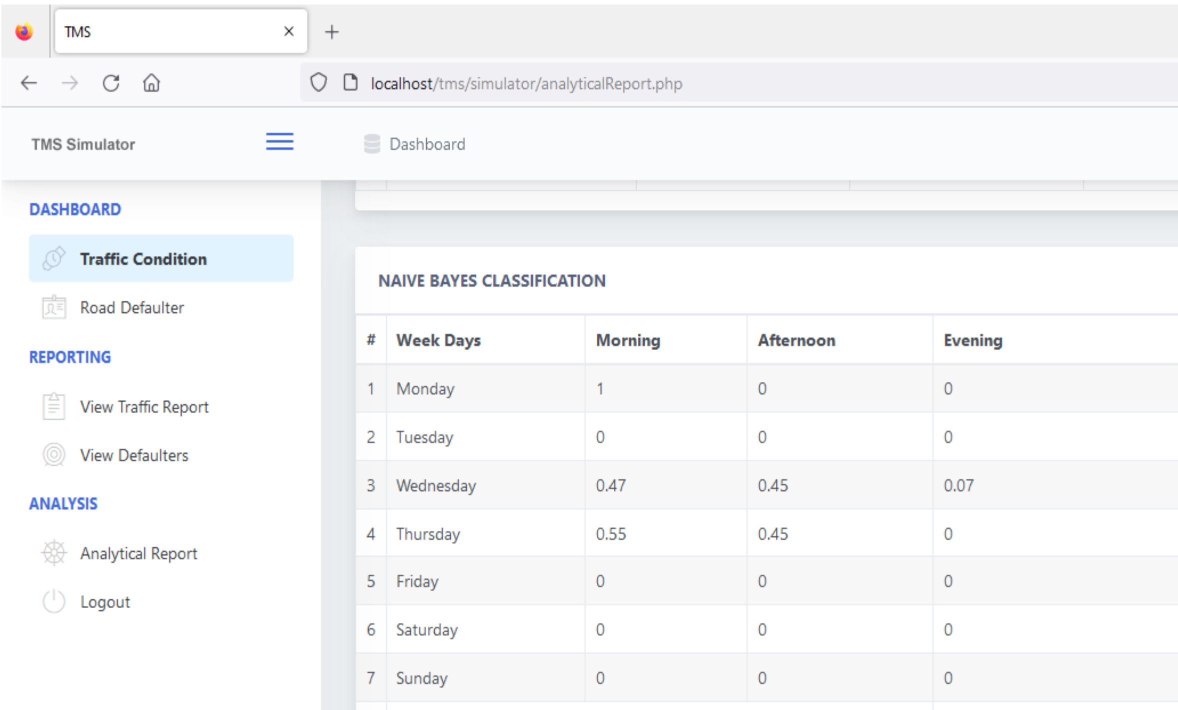


Fig. 5. Hourly traffic volume along Location (NTA) junction, Port Harcourt



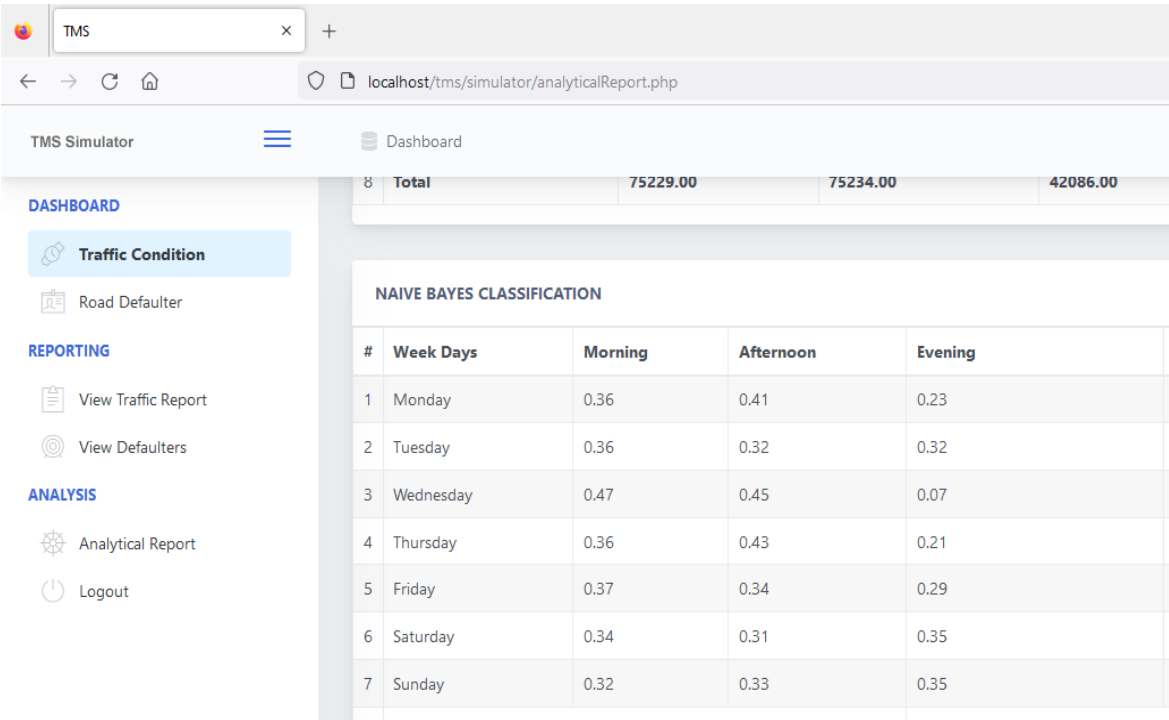
#	Week Days	Morning	Afternoon	Evening
1	Monday	1	0	0
2	Tuesday	0	0	0
3	Wednesday	0.42	0.57	0
4	Thursday	0	0	0
5	Friday	0	0	0
6	Saturday	0	0	0
7	Sunday	0	0	0

Plate 1. Naïve Bayes' model predicted high congestion in afternoon than morning on Wednesday



#	Week Days	Morning	Afternoon	Evening
1	Monday	1	0	0
2	Tuesday	0	0	0
3	Wednesday	0.47	0.45	0.07
4	Thursday	0.55	0.45	0
5	Friday	0	0	0
6	Saturday	0	0	0
7	Sunday	0	0	0

Plate 2. System predicted high traffic on Thursday morning than afternoon



#	Week Days	Morning	Afternoon	Evening
8	Total	75229.00	75234.00	42086.00
1	Monday	0.36	0.41	0.23
2	Tuesday	0.36	0.32	0.32
3	Wednesday	0.47	0.45	0.07
4	Thursday	0.36	0.43	0.21
5	Friday	0.37	0.34	0.29
6	Saturday	0.34	0.31	0.35
7	Sunday	0.32	0.33	0.35

Plate 3. Naïve Bayes' traffic congestion prediction for daily session

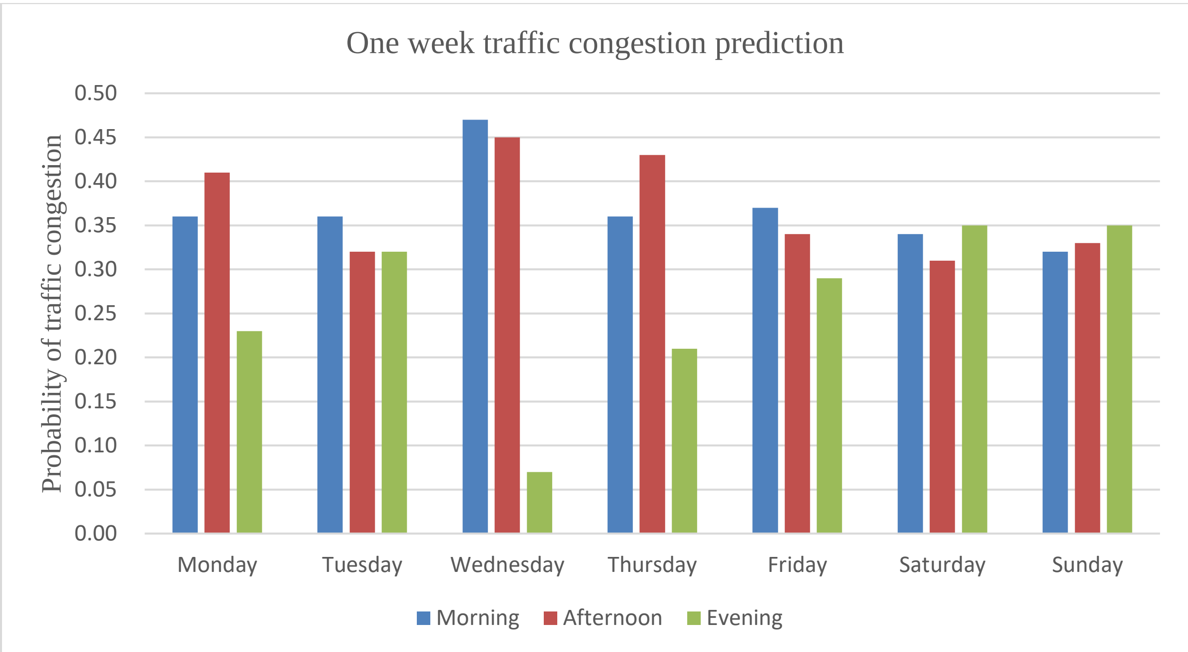


Fig. 6. Naïve Bayes' traffic congestion prediction for daily session

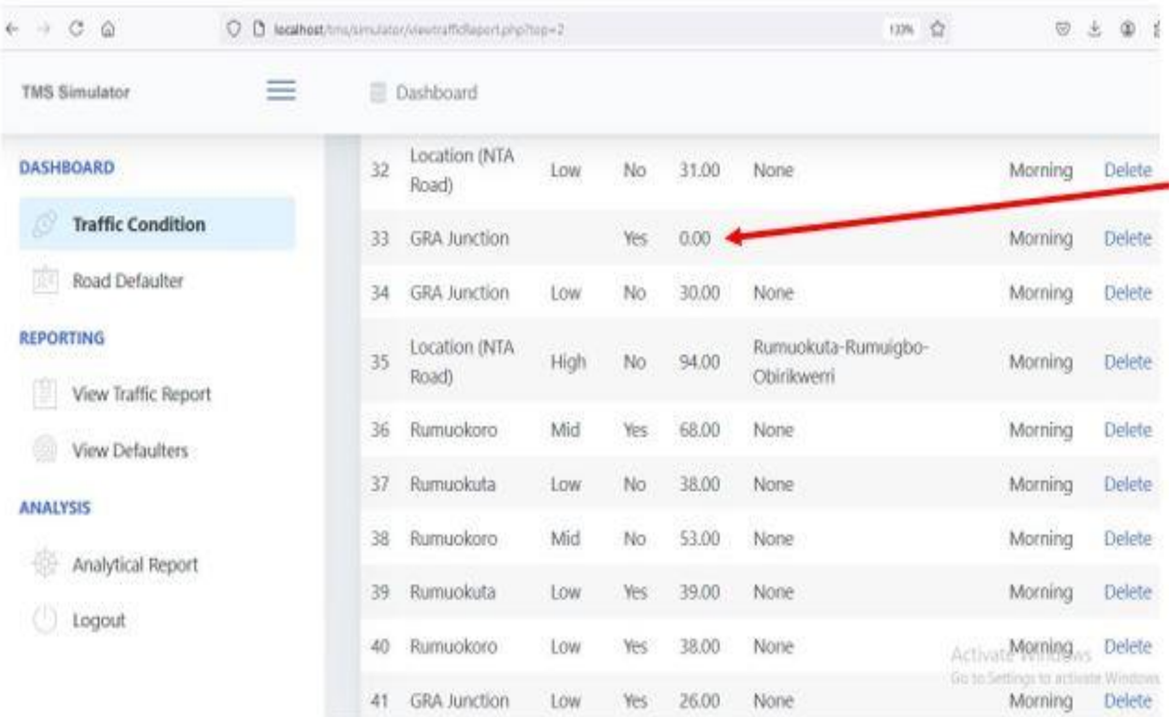


Plate 4. Simulated error data at GRA junction

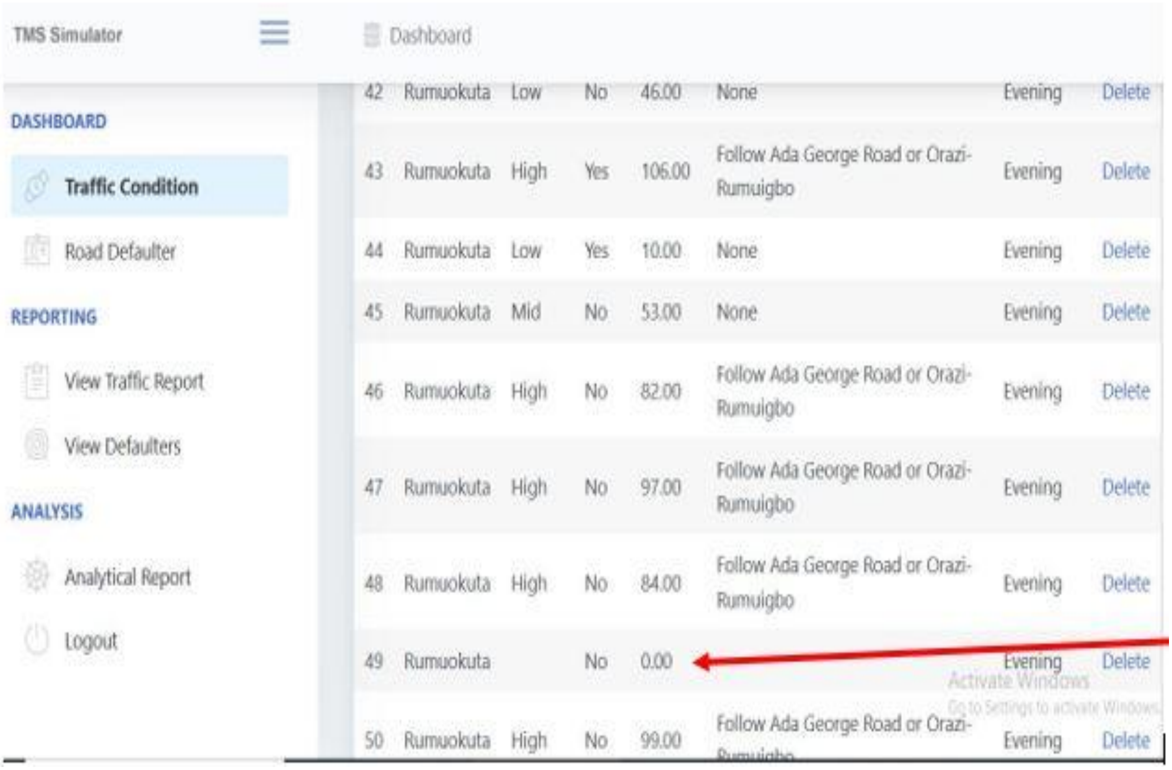


Plate 5. Simulated error data at Rumuokwuta junction

5. DISCUSSION

Table 5 presents an hourly assessment of traffic patterns at the NTA Junction in Port Harcourt, based on field survey data. The colors are used to categorize the traffic conditions: light red denotes medium traffic, dark red denotes heavy traffic, and green denotes free-flowing traffic. There is medium traffic between 8 and 9 am on Monday through Thursday, and free-flowing traffic on Friday. This is when there is a lot of traffic on Saturday, but there is none on Sunday at this hour.

Mondays are heavy traffic days due to commuters rushing to work and students heading to school. According to Table 5's statistics, traffic congestion peaks between 7 and 11 am, having begun to increase from 7 am. Following this time, traffic congestion progressively lessens until it virtually disappears between the hours of 2 and 5 pm, facilitating easy traffic movement. But starting at 5 p.m., traffic starts to pick up again, and by 6 p.m., there is noticeably more congestion.

Figs. 2, 3, 4, and 5 illustrate the daily trend of heavy traffic in the morning, decreasing in the afternoon, and increasing in the evening. Similar traffic patterns are seen from Tuesday to Sunday.

The predictions of the Naïve Bayes algorithm for traffic congestion at various times of the day are shown in Plates 1, 2, and 3. The model predicts heavier traffic congestion in the afternoon on Wednesday compared to the morning on Plate 1, and more substantial traffic congestion in the morning on Thursday compared to the afternoon on Plate 2. Fig. 6 shows a visual representation of Plate 3, which summarizes traffic projections for each day's morning, afternoon, and nighttime hours.

The effectiveness of the Naïve Bayes system, which classified 1,200 traffic data points in total, is shown in Table 6. Of these, 1,164 were classified properly, resulting in a 97% accuracy rate; 36 misclassifications led to a 3% error margin. The Naïve Bayes algorithm was employed to forecast traffic conditions on roads, providing important information to drivers about anticipated traffic trends and assisting them in making travel plans appropriately.

6. CONCLUSION

The effectiveness of the Naïve Bayes algorithm in predicting traffic conditions was demonstrated by the study's ability to successfully estimate traffic congestion at the chosen Port Harcourt junctions. Hourly traffic data study showed regular patterns of congestion, with morning and evening peak hours experiencing the most traffic, and afternoon peak hours experiencing less traffic. The predictions made by the Naïve Bayes model, which demonstrated an impressive 97% classification accuracy, matched observed traffic patterns. This high accuracy demonstrates the model's dependability in forecasting traffic jams and offers useful information for drivers to make the most of their travel schedules. Predicting traffic conditions can greatly improve traffic management tactics, cut down on travel time, and ease congestion, all of which improve overall road efficiency. The results support the ongoing application and advancement of predictive traffic approaches to urban planning and management.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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