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EFFICIENCY OF PASSENGER CAR UNITS IN ANALYSING URBAN ROAD TRAFFIC CONGESTION IN NIGERIA.

BY

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Abstract

Traffic congestion is a phenomenon leading to undesirable consequences in most cities of the world. Passenger car unit (PCU) or equivalent was developed for different countries across the globe but the application determines its uniqueness and how systematic, measured, accurate, reliable, and technically feature in a real-life situation. Due to the uniqueness and natural settings of economic characteristics and requirements of mobility in addition to the normal urban road congestion, Nigerians faced a typical road congestion problem that warrants this research. This paper aimed to analyse the efficiency of passenger Car units or equivalent in an urban road congestion study. The objectives of this research are two-fold. First, reviewed relevant literature related to the study and their output suitability. Secondly, assess the intensities of road congestion and the level of services (LOS). Inadequacy of road connectivity was also observed as one of the major setbacks in Nigeria. The study notes that, 15% - 20% of route diversion from the high-level congestion road or minor road at evening peak period. The study revealed a significant relationship between the intensity of road congestion and the level of services. This pilot study justifies the requirement to effectively analyse and application of PCU for further research in their related traffic area under investigation.

Keywords: *Passenger car units, Intensity of flow, Level of service, Peak hours, Route diversions.*

1. Introduction

The Passenger Car Unit value is a widely employed technique for converting heterogeneous traffic volume into heterogeneous traffic volume. The passenger car unit (PCU) is a unit of measurement used in transportation engineering to properly assess the density of traffic on highways. The Passenger Car Unit (PCU) is primarily used to convert a diverse flow of traffic into a single traffic volume [1]. It is a measure of comparative interconnection between a vehicle and a traffic flow about standards within a specific set of roadway and traffic conditions. Traffic is a situation where demand surpasses the road highway capacity, leading to fuel expenditure costs, transit costs, health, and the environment [2].

The time safety and rise in daily human activities constitute vehicular traffic flow along city and major highways which is inevitable, indistinguishable, and cannot be separated [3]. A passenger car unit is a technique for the transformation of mixed traffic modes to a specified unit of measurement using a passenger car unit for assessing heterogeneous and homogeneous traffic streams with varied static and dynamic characteristics moving along a uniform route without lane divide [4].

The major causes of traffic congestion Abuja-Kugbo-Nyaya axis down to Keffi include road capacity, an unrestrained situation of roads, informal activities, poor road network connectivity, on-street parking, insufficient public transit, and military checkpoints. mixed land use [5], and the level of traffic congestion varies from 5.3% to 96.1% the between Kugbo-Nyanya axis. Growth and movement of people led to transport demand, slums, and sprawl [6]. Traffic congestion causes delay, inconvenience, and economic losses to drivers as well as air pollution [7]. Traffic congestion is an impedance

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of vehicles imposed on each other due to the speed flow relationship in conditions where the use of a transport system approaches capacity [8].

Existence of heavy and slow vehicles within the traffic stream, the traffic capacity is significantly reduced and reduction is a higher participation rate in the flow of moving large vehicles than passenger cars It's slow [9]. Traffic flow comprises of broad diversification of different cars under dynamic features such as high and low performance [10] to determine traffic parameters such as road headway capacity, density, and level of service which are the main basis for design, planning, operation, and street layout section.

Traffic congestion occurs as a result of an increase in the number of cars and is measured by speed, increase in travel time, and lengthening of vehicular queuing [11];[12]. Loss of productivity, car accidents, high emissions, and environmental pollution caused by traffic congestion take huge and persistently large burden delays in urban activities [13]. Many hours are wasted due to the high traffic congestion on roads in highly populated cities with relatively, loss of labour productivity [14].

The availability of the resource potential and population in the metropolitan areas results in the occurrence of large transport needs and when these needs are met at the same time, the phenomenon of congestion occurs [15]. Traffic congestion on highways has increased significantly as a result of rapid growth in industrial and economic activities across both developed and developing countries [16]. Urbanisation is the main factor for cites expansion leading to a high number of both public and private cars therefore, investment in the transport sector makes a city functional [17]. The study evaluates the operational performance of current road infrastructure, the causes and the outcome of traffic congestion, and as well as the strategies to improve habitual traffic congestion on city roads [18].

According to J. Raj et al., (2022) to estimate PCU value for urban roads by inculcating the right vehicle behaviour; and interconnectivity. Capacity is the highest number of motorist which a meaningful expectation of passing over a given segment of a roadway in a particular route at a given period within the prevailing direction and traffic situation [20]. When compared to other countries, traffic congestion and passenger car unit varied significantly. Due to the poor nature of traffic constituents at a time. Heterogeneous traffic and slow vehicular movement in areas of study do not accelerate above 30 km/h. The goal of this study was to evaluate the efficiency of PCU on four-lane width in heterogeneous traffic situations.

The study examines vehicular movement to determine the degree of passenger car unit values at three designated points along the dual-carriageway. Data were collected at three different points along the 7.75-meter-wide Masaka-Abuja road. This research is a pilot study to find out the flow of traffic value through the employment of PCU values and assess the effectiveness of variables as well as their distribution for traffic composition at a point in time.

1.2.Background of the Study

Non-signal traffic point is one of the most inefficient and unsafe traffic congestion methods. Insufficient transport infrastructure, persistent rises in vehicular numbers, unsatisfied weather congestion network connection all constitute traffic problem. Nigeria has been one of the most populated countries in Africa and exhibited a high number of both public and private's car ownership accrued to numerous traffic challenges in densely populated cities like Lagos, Port Harcourt, Benin City, Abuja, Kano, Ibadan, and Ilorin. National Bureau of Statistics and Federal Road Safety Corps of the Federal Republic of Nigeria 2020 estimated the total number of vehicles in Nigeria to be 13, 264, 494 representing 49.81% of commercial vehicles; diplomatic vehicles were recorded at 19,101 constitutes 0.14% total vehicle population in the county; in the third quarter 13, 367, 369 vehicles registered. The urban population is predicted to increase to 66% by 2050 [21]; where the rapid urbanisation and increasing congestion are significant challenges today.

Lack of coordinated urban road designs and traffic management systems, Poor road infrastructures, and design quality failed to meet up with the existing traffic and unforeseen traffic situation [3]. Based on an estimated 4.2 million kilometres length of the road network, Indian cities are still facing challenges in providing a better alternative for smooth traffic flow and services [22]. High population increase and rising number of individual, family, community, and public cars contribute to a high volume of traffic conditions.

India occupied 4,32 kilometres of the road network with a density of 1.31 square kilometres of land compared to that of 0.67 United States of America, Australia, Korea, and Sweden 0.67, 0.11, 1.05, and 1.29 respectively [16]. The rapid increase in traffic volume, combined modes of traffic, and poor service lane discipline prevailing on roads, especially in fewer privileged countries require a robotic understanding of traffic movement assessment and interpretation [16]. Congestion not only develops travel times, but travel time simultaneously turns out to be a constituent and flighty as an obstacle [23].

Abolishment of commercial motorcycles and replacement of tricycles (known as Keke Napep in Nigeria) [24] in most towns and cities has brought so many achievements in decongesting traffic and accidents rate as well as urban crimes. The researcher identifies poor road infrastructure, street trading, on-street parking, and an uncoordinated large volume of traffic flow as the most influential causes [18]. The major setback of urban traffic movement is delays cause associated with poor planning, a rise in population density, and poor road situations within urban vicinity [25]. Traffic congestion at the grade separations is due to low capacity where traffic lanes cannot accommodate the volume of traffic [26].

2.0 Literature Review

World Population Prospects highlighted that nine (9) countries will make up more than half the projected growth of

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the global population between now and 2050 including India, Nigeria, Pakistan, the Democratic Republic of the Congo, Ethiopia, the United Republic of Tanzania, Indonesia, Egypt, and the United States of America. In addition, the population of sub-Saharan Africa is expected to double by 2050 (99% increase) while, the world population is expected to reach 8.5 billion by November 2030, 9.7 billion in 2050, and 10.4 billion in 2100 [27]. The researcher examines traffic characteristics and changes in road geometrics and other components [1]. The researchers identified traffic characteristics in Meerut City at a single high-traffic junction using the passenger car unit's value to determine the traffic parameters and intensity of flow [3].

Community-derived satisfaction is the ultimate goal of the general public on sustainable transport across the world towards people-centered development [28]. The researchers examine the workability of PCU for various modes of cars under fixed traffic situations [12]. The study estimates PCU values of multilane highways in Addis Ababa city to determine the influence of traffic volume; and lane width on the value of PCU [29]. The researcher established a method for identifying passenger car equivalent (PCE) for vehicles that operate a manoeuvre for on-street parking [30]. The study reviewed different techniques for estimating PCU within homogeneous and combined traffic situations [31] [32]. The researchers focus on traffic variables such as density, headway, speed, and delay. The researchers adopted the headway method to develop a PCU value for heavy and mini cars at signalised points [24].

Mankar & Khode, (2016) identify roads' size, parameters, capacity size, and capacity of roads under heterogeneous traffic conditions followed the use of VISSIM software to determine the road lane capacity of complex highways under multiple traffic situations [16]. The researchers assessed the impact of traffic occurrence and find out traffic situations that may result in traffic disasters by employing planung Transport Verkehr PTV Vissim [23].

Srinivasa Rao et al., (2017) examine the relevant models for the development of passenger car units which accomplished homogeneous and heterogenous traffic situations. The study examines the movement of vehicular traffic to determine variations in passenger car units' values among the barriers along the major road [17]. The British Standard PCU values is appropriate in assessing road traffic volume [18]. Alaigba et al., (2017) appraised the impact of traffic congestion on urban land under heterogeneity.

Sugiarto et al., (2018) examine the rate of passenger car units at a four-legged roundabout station on the time occupancy data in a multiplex traffic situation. The headway characteristics of queue vehicles where a declining trend is observed with an increase in car position with a saturation headway of 2.05 seconds per vehicle [4]. Mehar et al., (2014b) investigated the suitability of highway capacity manual (HCM) equations for determining the entry capacity of a four-legged roundabout under mixed traffic conditions Mardani et al., (2015) proposed a methodology for validating and calibrating HCH equations for performance evaluation by determining PCU values of roundabouts under mixed traffic conditions [35].

2.1 Concept of Passenger Car Units

Road traffic composition can be static and dynamic characteristics. The static characteristic refers to a car's dimension, power, speed, acceleration rate, braking efficiency, and manoeuvrability dimension, power, speed, acceleration rate, braking efficiency, and manoeuvrability of cars. Passenger car unit is a comparative load component given to the traffic capacity of an individual vehicle class to account for non-uniformity in complex traffic situations [1]. PCU value can be used for capacity analysis, signal design, traffic management determination of saturation flow rate, and development of traffic flow model [32]. The dynamic characteristic could be transverse or longitudinal space between two categories of vehicle capacity [35].

Table.2.1.1Review Passenger Car Unit Value of Different vehicles

Author	Passenger Car Units Value (PCU)								
	Study area	Pedestrian	Handcart/ Rickshaw	Bicycle	Motor-cycle	Tricycle	Car	Bus	Truck
[33]	Aceh Besar Indonesia	-	0.59	-	0.16	-	1.91	-	3.76
[36]	Chennai city	-	1.00	0.50	-	-	-	1.40	3.00
[29]	Addis Ababa	-	-	-	0.90	-	0.94	0.91	0.97
[37]		-	0.50	0.36	0.50	1.09	1.00	2.90	9.90
[4]	India	-	-	1.00	0.50	1.0	1.00	1.50	3.00
[24]	Abuja, Nigeria	-	-	-	-	0.93	-	-	2.08
[18]	Sango/ Ogun, Nigeria	-	-	-	0.75	0.75	1.00	2.00	4.50
[1]	Literature review	-	0.72	0.720		1.24		1.46	4.70

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[25]	Lagos Nigeria	-	-	-	0.75	-	1.00	3.00	2.00
[26]	Akure, Nigeria			0.50	0.50			1.50	2.00
[11]	Chittagong, Bangladesh	-	2.00	0.75	0.75	1.00	1.25	2.00	3.00
[3]	Meerut city, India	-	4.00	0.50	0.50	0.50	1.00	3.00	3.00

Source: Author's Adaptation 2023.

2.2 Method of Passenger Car Units Estimation

Headway Method [1]

a). Headway method

$$PCU_{Truck} \frac{[(h_{mix}/h_c) - P_c]}{Pr} \quad \text{equation 1}$$

Where:

h_{mix} = Average time headway between two vehicles in mixed traffic stream (s)

h_c = Average time headway between two passenger car (s)

p_c = proportion of passenger cars in the mixed traffic stream

pr = proportion of trucks in the mixed traffic stream

b). Homogeneous coefficient method.

Headway Method [1]

Modified method

$$PCUi = \frac{h_i}{h_c} \quad \text{equation 2}$$

Where:

PCUi =PCU of vehicle category '$_i$'

h_i = average time headway between two vehicles of type i (s)

h_c = average time headway between two passenger cars (s)

Determinant of PCU [29] adopted dynamic method PCU for non-lane-based traffic movement of vehicles and heterogeneity of vehicular movement.

$$PCU = ((Vc/Vi)/(Ac/Ai)) \quad \text{equation 3}$$

Where:

Vc = mean speed of a car and Vi = mean speed of vehicle type i.

Ac = projected area of vehicle and Ai = projected area of car vehicle i.

Method adopted [26]

Peak Hour Factor

$$PHF = \frac{\text{volume during peak hour}}{4 \text{ x volume during peak hour k15 min within peak hour}} \quad \text{equation 4}$$

$$PHF = V/(4 \times V15)$$

Where:

PHF = Peak Hour Factor,

V = hourly volume (vph), and

V15 = volume during the peak 15 minutes of the peak hour (veh/15 min)

Method adopted [38] in [32]

$$PCU_k = (V_{car}/V_k)/(A_{car}/A_k)$$

Where PCU_k = PCU of vehicle category k, V_{car} and V_k = mean speeds of passenger car (lesser car) and vehicle category k, accordingly (m/s); and A_k = effective area of passenger car and vehicle type k appropriately (m^2).

3.1 Methodology

The study used Highway Capacity Manual as a guide lines for assessing the PCU value under a highway U-turn in a non-signalised traffic road within an urban area. This study analyses micro elements of queuing vehicles at a non-signalised point. Traffic flow data was analysed to extract PCU values from various modes of vehicles at a particular point in time as well as during peak hour and off-peak traffic periods of the day. The entire traffic was classified and grouped into eight different modes of vehicles, such as trucks, buses, cars, tricycles, motorcycles, bicycles, handcarts, and pedestrians, based on their normal sizes.

The categorisation of the vehicular count was carried out to investigate the traffic characterisation and share of individual vehicle types at each study point. The study adopted headway, density, and homogeneous coefficient techniques to determine the PCU value using a video graphic camera [12]. The used of M/M ∞ queuing model and Greenshield traffic state model to analysed the effect of delay, and the dimension drop induced through manoeuvring [30].

The dynamic PCU value to determine the value and linear regression analysis for model development. [29]. The study found that, as the traffic volume and carriageway width increase, the PCU value also increases as provided in Highway Capacity Manual (HCM). The researchers collected one month traffic data; congestion from occupancy parameter based on traffic flow theory and observation data; GIS to identifies traffic congestion areas/location [39].

Koźlak & Wach, (2018) identify the correlation and regression analysis to determine the relationship between factors that contributed to congestion in urban traffic and the level of congestion in Polish cities The study evaluates macro and microscopic parameters of vehicle length at a signalised junction [4], the researcher further employed a distribution model to calculate departure headway. The effects of carriageway width on passenger car units of various categories of cars can associated with road the mode of transport [35]. Sola, (2015) adopts primary and secondary data to identify the relationship between the traffic model and vehicular flow. The researcher employed a quantitative research method that centered on traffic volume, and road users' perceptions [18]. The volume capacity ratio was adopted to determine the intensity of traffic flow and the degree of density [25]. State et al., (2017) adopted the highway capacity manual 2010 to analyse traffic congestion data. However, the study followed a drone to investigate vehicular traffic at the roundabout and used vehicles time

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occupancy to determine the average time consumed at the congestion points [33].

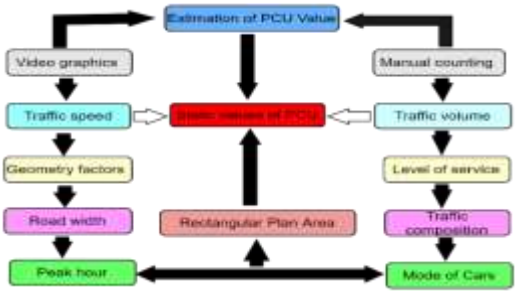

Figure 1. Data Analysis Procedures

4.1 Result and Discussion

The study data were collected at three locations on four-lane express road in Masaka U-turn, Ado junction, and Maraba U-turn, all along Karu Nasarawa State. The traffic counter process was achieved by placing the cameras on electric poles followed by manual extraction of vehicular movement. The study points were selected due to heterogeneity of traffic plying the roads. The selected traffic points are four-lane widths of 7.5 metres. Six androids phone cameras were used to record both entry's and exits vehicles. The study utilises a 12-hour traffic survey (6:30 am to 6:30 pm) on the same day with the aid of 80 trained undergraduate students of Urban and Regional Planning, Nasarawa State University, Keffi involved in the traffic count exercise. The video cameras were placed at a strategic viewpoint considering a coverage of 50 metres for each lane road to ascertain reliable data collection.

Table 2. Traffic flow at Masaka U-turn (point 'A')

Time	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm	Total
T/Flow	854	1708	3841	2561	1707	1067	854	854	1494	2134	3201	1067	21338
%	4.0	8.0	18.0	12.0	8.0	5.0	4.0	4.0	7.0	10.0	15.0	5.0	100%

Source: Survey, 2023

Table 3. Traffic flow at Ado U-turn (point 'B')

Time	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm	Total
T/Flow	1080	1865	5072	3403	2290	2290	1963	2094	2094	2879	5432	2258	32720
%	3.3	5.7	15.5	10.4	7.0	7.0	6.0	6.4	6.4	8.8	16.6	6.9	100%

Source: Survey, 2023

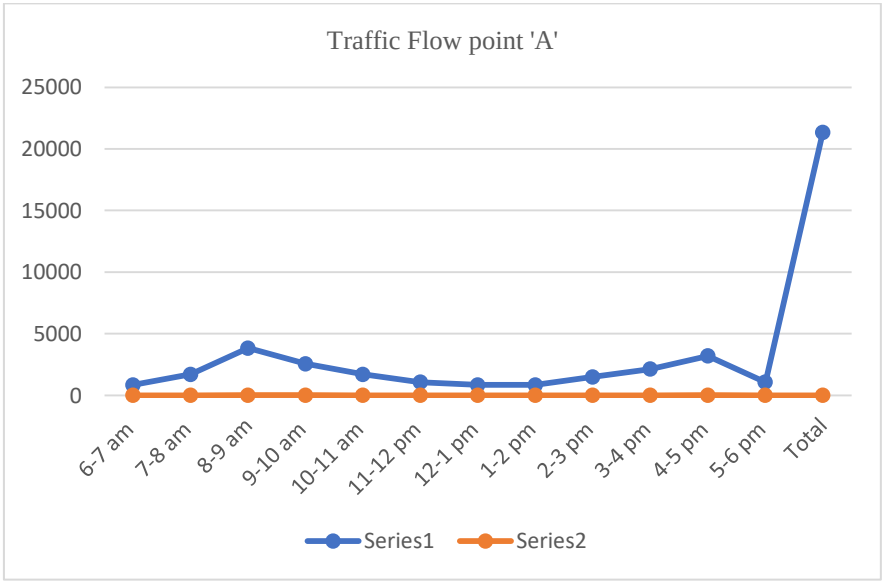

Figure 2. Traffic flow at Masaka U-turn

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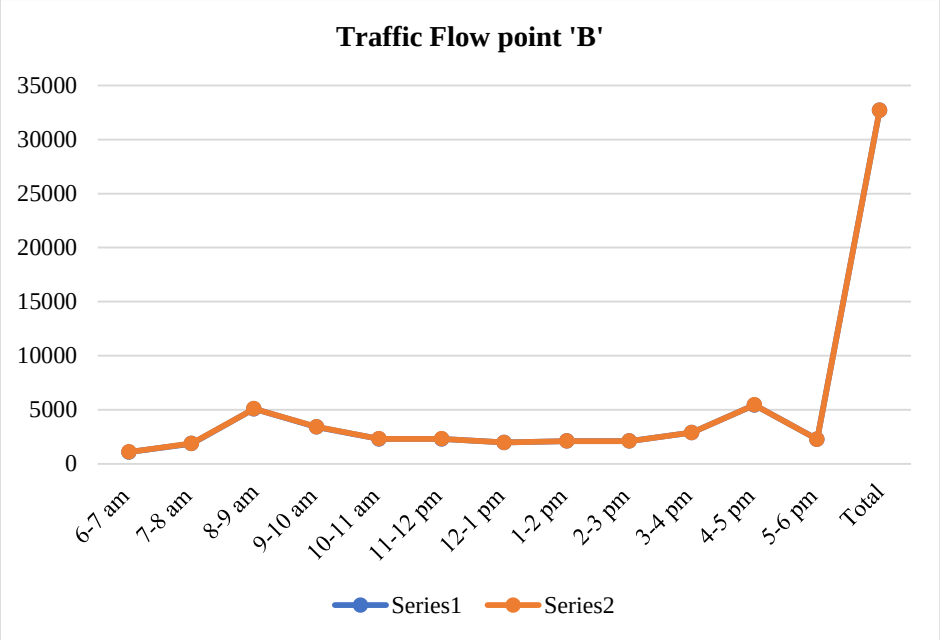

Figure 3. Traffic flow at Ado U-turn

Table 4. Traffic flow at Maraba U-turn (point 'C')

Time	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm	Total
T/Flow	1402	1997	7777	4420	3442	2295	2507	2762	3570	7140	3655	1350	42499
%	3.3	4.7	18.3	10.4	8.1	5.4	5.9	6.5	8.4	16.8	8.6	3.6	100%

Source: Survey, 2023

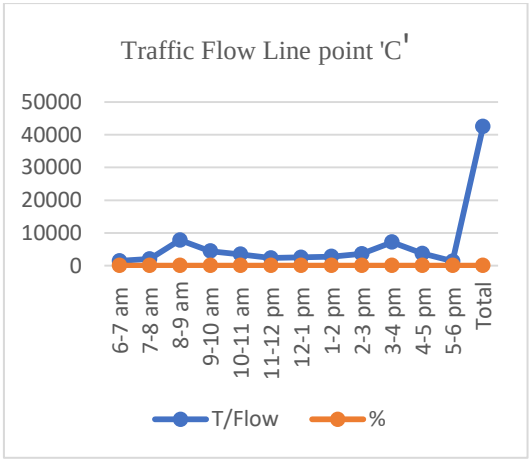

Figure 4. Traffic line graph at Maraba U-turn

Figure 5. Traffic flow at Maraba U-turn

Figure 6. Traffic congestion along Ado Road Abuja

Figure 7. Traffic congestion along Ado road

4.2 Capacity Estimation Procedure for Four-Lane Road Under Mixed Traffic Situation

Determinant of PCU [29] adopted dynamic method PCU for non-lane-based traffic movement of vehicles and heterogeneity of vehicular movement.

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PCU = ((Vc/Vi)/(Ac/Ai))
Where:
Vc = mean speed of a car and Vi = mean speed of vehicle type i.
Ac = projected area of a vehicle and Ai = projected area of car vehicle i.
PCU = ((Vc/Vi)/(Ac/Ai))
PCU = [(15/20)] = 0.75 = 1.07
[(5.92/8.46] 0.70
PCU = [(15/20)] = 0.75 = 1.88
[(8.46/23.53] 0.40
PCU = [(15/20)] = 0.75 = 2.68
[(8.46/30.50] 0.28
PCU = [(15/20)] = 0.75 = 0.61
[(30.50/24.74] 1.23
PCU = [(15/20)] = 0.75 = 0.09
[(24.74/2.94] 8.41
PCU = [(15/20)] = 0.75 = 0.42
[(2.94/1.65] 1.78
PCU = [(15/20)] = 0.75 = 0.50
[(1.65/1.11] 1.49
PCU = [(15/20)] = 0.75 = 0.36
[(1.11/0.54] 2.06
PCU = [(15/20)] = 0.75 = 3.57
[(0.54/2.56] 0.21
The method adopted [26]
Peak Hour Factor
PHF = volume during peak hour
4 x volume during peak hour k15 min within peak hour
PHF = V/ (4 x V15)
Where:
PHF = Peak Hour Factor,
V = hourly volume (vph), and
*V*15 = volume during the peak 15 minutes of the peak hour (veh/15 min)
Point 'A' PHF = 3841 = 3841 = 0.25
4 x 3841 15,364
Point 'B' PHF = 5072 = 5072 = 0.25
4 x 5072 20,288
Point 'C' PHF = 7777 = 7777 = 0.25
4 x 7777 31108

Table 5. Estimated Number of Traffic Flow Per Passenger Car Unit (P.C.U)

Point 'A' (Masaka U-turn)					Point 'B' (Ado U-turn)				Point 'C' (Maraba U-turn)			
Direction	Total Both Direction		P.C. U	Total	Total Both Direction		P.C. U	Total	Total Both Direction		P.C. U	Total
	NO	%			NO	%			NO	%		
Trucks	128	0.60	4.38	384	102	0.24	4.85	306	173	0.69	3.68	519
Cars	2747	12.87	2.80	2747	3129	7.36	3.00	3129	3896	15.45	2.55	3896
Bus	221	1.04	3.25	332	361	0.85	3.85	542	312	1.24	2.45	468
Tricycle	1063	4.98	0.80	904	182	0.43	0.75	155	155	0.61	0.94	132
Motorcycle	11774	55.18	0.65	5887	31880	75.01	0.95	15940	16931	67.16	0.88	8466
Bicycle	36	0.17	0.43	11	123	0.29	0.50	37	71	0.28	0.68	21
Handcarts	647	3.03	0.62	485	487	1.15	0.75	365	186	0.74	0.95	140
Pedestrian	4722	22.13	0.46	472	6235	14.67	0.52	624	3486	13.83	0.63	349
Total	21338	100	-	11222	42499	100	-	21098	25210	100	-	13991

Source: Author's, 2023

Table 6. The estimated Capacity of Four-lane highway divide

Traffic point	Carriageway width (m)	Total capacity (PCU/hr)
'A'	7.75	21338
'B'	7.75	42499
'C;	7.75	25210

Source: Author's 2023

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Table 7. Passenger car unit for different type of vehicle on different traffic points

Traffic Points	Carriage way	Truck	Car	Bus	Tricycle	Motorcycle	Bicycle	Hand cart	Pedestrian
'A'	7.75	3.46	1.25	2.20	1.15	0.40	0.28	0.70	0.10
'B'	7.75	3.50	1.52	2.50	1.85	0.50	0.30	0.75	0.10
'C'	7.75	3.57	1.88	2.68	1.88	0.61	0.36	0.42	0.15

Source: Survey, 2023

4.3 Discussion

This study analysed the PCU values of four-lane highways comprises of Masaka, Ado, and Maraba all along Abuja road to determine the intensity of traffic volume and road geometry on PCU values. The interactive PCU value was used to calculate the PCU value, and linear regression analysis was used to develop the model. According to the study, as traffic volume and carriageway width increase, so does the PCU value. Furthermore, the results of the PCU value were higher than those provided in the Highway Capacity Manual (HCM).

The traffic flow at each point convergent to a respondent's road congestion within traffic movement circumstances is that the basis for the PCU values during this study. However, because of the variety of the traffic points' composition, the regularly adjusted traffic-related movement of every point was different. The slow traffic point had an occasional traffic flow because of an oversized number of vehicles present at the time, whereas the fast-moving traffic point had the next traffic rate of flow due to a better proportion of moving cars. The study revealed that; the diversion of 15% – 20% of the total traffic from the high-level congested roads to the results of least or lesser congested roads into a higher level of service (lower congestion), an increase in speed by 15km/h to 20km/h from the current speed levels, and decrease in travel time by 10% to 15% respectively. The PCU methods employed indicates that [29] is miore accurate and reliable than [26] which homogenous.

4.4 Findings

• The estimated PCU values vary from one point to another as presented in table 5 depending on the modes of vehicle and traffic characteristics plying the road.

• Passenger car unit significantly affects traffic flow and road efficiency as well as road infrastructures.

• Road dimension has a remarkable effect on road capacity with an increase in traffic volume within carriageway capacity.

4.5 Validity of Research Outcome

This study observed that PCU values for most kinds of vehicles analysed through different method varied. To investigate the validity method of PCU analysis, a reliable method was employed. The capacity analysis through speed-flow relationships.

5.0 Conclusion

This study analyses the efficiency of PCU values for various mode of vehicles under traffic situations. In developing nation like Nigeria, there is high level of heterogeneous traffic flow leading to interference of non-influential vehicles. The study revealed that traffic volume and length of queue increase as the long and heavy vehicles operate in the same lane. The study revealed that traffic volume and length of queue increase as the long and heavy vehicles operate in the same lane. The discharge nature of vehicles on congestion was analysed using headway method to determine the position where departure headway changes with decrease or increase in vehicular traffic flow on saturation headway of 2.55 per vehicle. Different PCU method were tested though, headway method proves better.

Recommendation

Estimated variables for heterogeneous traffic, almost different. Most of the researchers based their findings on homogeneous traffic while; this study based its findings on heterogeneous traffic. Integration of vehicles on increased traffic volume and weakened lane discipline, makes heterogeneous traffic a complex one and more unique. Dynamic PCU values is more understandable and influence vehicle type of traffic stream over most traffic flow situation. Headway method of estimation is more advantageous in PCU analysis.

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