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Assessment of Traffic Parameters at Oloko Intersection, Akure, Ondo State, Nigeria

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Abstract: The growth of traffic at an intersection on many streets and highways is a major concern to travelers, administrators, merchants, developers and the community at large. Its detrimental impacts in terms of longer journey times, higher fuel consumption, greater transport costs and changing investment decisions are increasingly recognized and felt across Akure Metropolis. Intersection reduces the effective accessibility of residents, activities and jobs resulting in lost opportunities for both the public and business. This issue is now a great concern for Nigeria and major cities in Akure Metropolis. This project assessed the traffic at an intersection within Akure metro\polis namely Oloko which takes its course from Ife road named Leg A Owo/Ado road, named leg B and Cathedral road named leg C. Traffic census was carried out for period of 5 days (Monday-Friday) between 7:30 am-8:30 am-10:00-11:00 and 3:30 pm-4:30 pm daily. Level of service and congestion measure using Microsoft Excel Package Software and travel time and cost of congestion analysis were done for the congested intersection. Accordingly traffic volume, flow and delay were estimated. The maximum safe speed (85th percentile) was 68.17 km/h which can be used for determination of safe sight distance and design speed. Also the minimum safe speed at 15th percentile was 43.27 km/h. From the derived data, vehicle occupancy of car/taxi has the highest percentage occupancy which is 71.49% followed by buses and mini-trucks which is 16.34% because of the vehicle connecting the main empress Akure road. It was established that the intersection is close to the free flow saturated as the degree of saturation gotten is 0.89<1 and closed to be uniform flow. Furthermore, an average delay data collected during the peak period is 3.62 sec while during the off peak period is 4.23 sec.

Key words: Oloko, congestion intersection, traffic volume, flow, delay, safe speed

INTRODUCTION

An intersection is an at grade junction where two or more roads meet or cross. Intersections maybe classified by number of road segments, traffic controls and lane design.

Traffic congestion is a condition on transport networks that occurs as use increase and is characterized by slower speeds, long trip times and increased vehicular queuing (McGroarty, 2010). The most common example is the physical use of roads by vehicles, when traffic demand is great enough that the intersection between vehicles slows the speed of the traffic stream. This results in some congestion (Anonymous, 2001; 2010; 2014).

As demand approaches the capacity of a road (or of the intersection along the road), extreme traffic congestion set in when vehicles are fully stopped for periods of time. This is colloquially known as a traffic jam or traffic snari-up, traffic congestion can lead to drivers becoming frustrated and engaging in road rage (Hobb, 1974; Chandra and Sikdar, 2000).

Mathematically, congestion is usually looked at as the number of vehicles that passes through a point in a window of time or a flow. Congestion flow lead itself to principle of fluid dynamics (Haregewoin, 2010).

Traffic congestion occurs when a volume of traffic or modal split generate demand for space greater than the available streak capacity, this point is commonly termed saturation, most of this reduces the capacity of a road at a given point or over a certain length or increase the number of vehicles required for a given volume of people or goods.

Traffic delay, the additional travel time experience by a driver, passengers or pedestrian due to circumstances that impede the desirable movement (Lomax *et al*., 1997) of traffic, it is measured as the time difference between

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actual travel time and free flow time. Traffic volume studies are conducted to determine the number, movement and classification of roadway vehicles at a given location. These data can help identify critical flow time period determine the influence of large vehicles or pedestrians on vehicular traffic flow or document traffic volume trends (Schrage, 2006). The length of the sampling period depends on the type of count being taken and the intended use of the data recorded. For example, an intersection count may be conducted during the peak flow period. If, so, manual count with 15 min intervals could be used to obtain the traffic volume data (Robertson and Hummer, 1994). The count period should avoid special event or compromising weather conditions (Sharma and Leng, 1994).

The intersection movement is through, left turn and right turn. The observer records the intersection movement for each vehicle that enters the intersection (Homoburger *et al*., 1996).

Definitions of terms

Delay: The additional travel time experience by a driver, passengers or pedestrian due to circumstances that impede the desirable movement of traffic, it is measured as the time difference between actual travel time and free flow time.

Headway: This is the time spacing between successive vehicles in the traffic stream. Headway are interval in time from head to head or bumper to bumper of successive vehicles as they pass a given point on a roadway. Headway can also be defined as the probability that no vehicles arrive at a given time interval between two vehicles. Method of measuring headway can be manual, semi-automatic or automatic (Owolabi, 2009).

Peak hour factor: The relationship between volume for its peak hour and the peak rate of flow within the peak hour. (Owolabi *et al*., 2015).

Peak volume: The total vehicle counted per hour.

Traffic volume: The number of vehicles that pass through a given point on a roadway within a specified period of time within 1 h. It is measured in vehicle per hour (Owolabi, 2010).

Volume: The number of vehicles which pass a point on a highway or a given lane or direction of a highway during a specified time interval (usually 1 h). It is expressed in unit of volume per hour (Owolabi, 2010).

Flow rate: It is used to represent the number of vehicles passing through a point in a highway or lane in a period of time <1 h but expressed in hourly rate (Owolabi, 2009).

Peak period: It signifies a period or during a period where there is maximum (high) volume of traffic (Owolabi, 2009).

Off peak period: shows the period of lesser traffic volume. i.e., least volume of traffic during the duration of data collection. For the purpose of this study, peak period was between 7:30 am-8:30 am while off peak period was between 11:00 am to 12:00 pm (Owolabi, 2009).

MATERIALS AND METHODS

Data collection: The data collected for the assessment of traffic at Oloko intersections are: traffic volume count was conducted normally at approaches to the intersection. The following were deduced from the traffic count conducted at the intersection.

- Traffic flow (Q) vehicle/hour
- Passenger Car Unit (PCU)
- Peak hour factor: PHE = Hourly volume/Peak rate of flow within the hour
- If 15 min periods are used, the PHF is computed as:

$$PHF = \frac{V}{4 \times V_{15}}$$

Where:

V = Peak hour volume

V_{15} = Volume during 15 min of flow (veh/15 min)

- Delay

Spot speed studies: This study was carried out at the intersection to know the instantaneous speed at the approaches to the intersection. Information about free speed and speed of movement during congestion gives the delay in time of the intersection.

Procedure for spot speed studies: Select a section of roadway that includes the point where vehicles would enter the road from an existing or proposed intersection. The section should not be <60 m in length and not more than 150 m. Sections shorter than 60 m make timing difficult and it can be hard to see another person at a distance >150 m.

Post an observer at each end of the section. Be certain that a person standing at one end of the section is visible to the observer standing at the other end. Please wear bright orange garments and stay well back from the flow of traffic. Standing close to traffic flow is dangerous and if drivers see you near the road they will tend to slow down and this will adversely affect the observation. Each observer should have:

- An orange flag, a white handkerchief or some objects which can be clearly seen at the other end of the section
- A watch with a timer function

When a vehicle passes an observer at one end of the section the observer signals the person at the other end of the section. This second person then starts counting the time required for the vehicle to reach their position. This time is recorded on the traffic speed data record form. Continue recording the time required for vehicles to travel from one end of the section to the other until 100 speed measurements are obtained for both directions.

Vehicles frequently travel in groups called platoons by. Measure the travel time for only the first vehicle in each platoon. Generally, speed measurements should be mad during that portion of the workday rush-hour when speeds are highest. Continue the observation until you've timed a hundred. Next, rank the speeds from faster to slowest. The speed 85th from the bottom (slowest) is the 85th percentile speed and it is this speed that you use for determining safe sight distance.

Analysis: Data collected was fed into the computer and Microsoft Excel package was used for analyzing table, charts and graphs.

RESULTS AND DISCUSSION

The descriptive statistics of traffic volume count for the intersections studied during peak and off peak, periods are shown in Table 1-5.

Table 1: Summary of traffic volume at Oloko intersection on Monday, 6th November, 2017

	IFE approach LEG A (km/h)			ADO/OWO approach LEG B (km/h)			Cathedral LEG C (km/h)		
Vehicle classification	Morning peak 7:30-8:30	Afternoon 10:00-11:00	Evening 3:30-4:00	Morning peak 7:30-8:30	Afternoon 10:00-11:00	Evening 3:30-4:00	Morning peak 7:30-8:30	Afternoon 10:00-11:00	Evening 3:30-4:00
Types of vehicle	am	pm	pm	am	pm	pm	am	pm	pm
Motor cycle/tri cycle	33	32	35	104	73	22	131	68	40
Passanger cars	435	201	312	421	321	484	602	204	325
Mini bus (<20 seats)	165	31	33	101	43	33	102	29	13
Mini bus (>20 seats)	16	12	12	22	6	12	12	18	2
Single unit trucks (2 axle)	14	18	1	19	4	4	4	14	2
Heavy vehicles (3-4 axle)	26	13	2	21	2	2	5	10	1
Heavy vehicle (5 axle)	5	2	1	4	2	1	2	1	
Heavy vehicles (6+axle)	3	4	1	2	2	1	2	0	1

Table 2: Summary of traffic volume at oloko intersection on Tuesday, 7th November, 2017

	IFE approach LEG A (km/h)			ADO/OWO approach LEG B (km/h)			Cathedral LEG C (km/h)		
Vehicle classification	Morning peak 7:30-8:30	Afternoon peak 10:00-11:00	Evening 3:30-4:00	Morning peak 7:30-8:30	Afternoon peak 10:00-11:00	Evening 3:30-4:00	Morning peak 7:30-8:30	Afternoon peak 10:00-11:00	Evening 3:30-4:00
Types of vehicle	am	pm	pm	am	pm	pm	am	pm	pm
Motor cycle/tri cycle	63	52	48	43	12	24	9	32	24
Passanger cars	604	314	577	527	203	372	318	141	572
Mini bus (<20 seats)	32	64	12	20	104	13	49	44	141
Mini bus (>20 seats)	4	12	3	12	18	4	38	3	13
Single unit trucks (2 axle)	38	4	2	1	12	3	12	3	1
Heavy vehicles (3-4 axle)	4	1	1	1	3	1	4	2	1
Heavy vehicle (5 axle)	2	1	2	1	1	0	1	2	1
Heavy vehicles (6+axle)	1	4	1	0	1	1	1	1	1

Table 3: Summary of traffic volume at Oloko intersection on Wednesday, 8th November, 2017

	LEG A (km/h)			LEG B (km/h)			LEG C (km/h)		
Vehicle classification	Morning 7:30-8:30	Afternoon 10:00-11:00	Evening 3:30-4:00	Morning 7:30-8:30	Afternoon 10:00-11:00	Evening 3:30-4:00	Morning 7:30-8:30	Afternoon 10:00-11:00	Evening 3:30-4:00
Types of vehicle	am	pm	pm	am	pm	pm	am	pm	pm
Motor cycle/tri cycle	95	29	48	19	22	43	23	33	24
Passanger cars	301	195	421	294	182	321	217	171	301
Mini bus (<20 seats)	181	18	14	121	13	19	14	9	17
Mini bus (>20 seats)	12	10	2	14	9	3	9	10	4
Single unit trucks (2 axle)	10	4	4	1	2	1	2	1	2
Heavy vehicles (3-4 axle)	4	2	2	2	1	1	3	1	1
Heavy vehicle (5 axle)	1	2	1	1	4	1	4	1	1
Heavy vehicles (6+axle)	0	4	1	1	1	1	2		1

Table 4: Summary of traffic volume at Oloko intersection on Thursday Day 4, 9th November, 2017

	km/h								
Types of vehicle	Morning 7:30-8:30 am	Afternoon 10:00-11:00 pm	Evening 3:30-4:00 pm	Morning 7:30-8:30 am	Afternoon 10:00-11:00 pm	Evening 3:30-4:00 pm	Morning 7:30-8:30 am	Afternoon 10:00-11:00 pm	Evening 3:30-4:00 pm
Motor cycle/tri cycle	38	33	72	22	33	21	12	22	33
Passanger cars	495	109	601	321	114	452	104	221	331
Mini bus (<20 seats)	128	12	103	100	13	111	131	14	65
Mini bus (>20 seats)	12	1	1	12	5	4	24	3	3
Single unit trucks (2 axle)	4	4	5	2	2	6	4	7	4
Heavy vehicles (3-4 axle)	2	4	5	1	1	3	3	2	1
Heavy vehicle (5 axle)	2	3	3	1	4	4	1	1	2
Heavy vehicles (6+axle)	1	2	1	3		2	1	1	1

Table 5: Summary of traffic volume at Oloko intersection on Friday Day 5, 10th November, 2017

	km/h								
Type of vehicle	Morning 7:30-8:30 am	Afternoon 10:00-11:00 pm	Evening 3:30-4:00 pm	Morning 7:30-8:30 am	Afternoon 10:00-11:00 pm	Evening 3:30-4:00 pm	Morning 7:30-8:30 am	Afternoon 10:00-11:00 pm	Evening 3:30-4:00 pm
Motor cycle/tri cycle	48	22	21	49	13	12	40	49	38
Passanger cars	396	504	599	421	411	396	601	621	611
Mini bus (<20 seats)	74	151	106	117	97	94	147	131	114
Mini bus (>20 seats)	18	19	48	11	12	13	33	62	33
Single unit trucks (2 axle)	18	24	21	23	21	11	14	48	18
Heavy vehicles (3-4 axle)	14	12	12	9	4	2	4	12	13
Heavy vehicle (5 axle)	2	4	3	3	2	1	6	2	6
Heavy vehicles (6+axle)	5	2	4	7	2	1	3	4	3

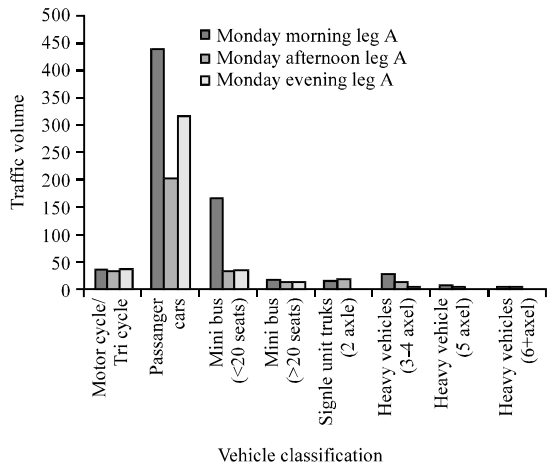

Fig. 1: Summary of traffic volume count on Monday morning leg A

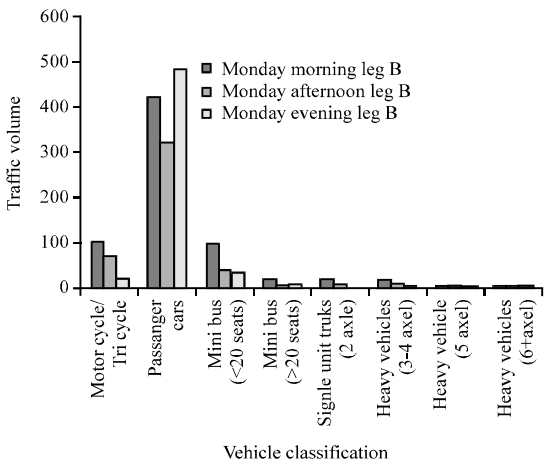

Fig. 2: Summary of traffic volume count on Monday afternoon leg B

The various data collected in the form of vehicle counting is represented as per the following bar graph, (Day 1-5) in Fig. 1-15.

Flow (Q) Veh/hour is defined as the number of vehicles that pass a unit point on a road per unit time under the prevailing roadway and traffic conditions. It is measured in vehicle per seconds. It can be determine manually by establishing a point on a roadway, counting and recording the number of vehicles on a prepared data sheet and compartmentalize the record to every 15 min and automatically by the use of traffic counter.

From Adams formula which states that a systematic study of the delay problem really begins with the classic paper of Adams dealing with the Stochastic character of the traffic stream (Narayanan *et al*., 2003). This applies to arrival of pedestrians or a single vehicle on the side street. When traffic is light, the arrival patterns of vehicles can be assumed to be random (poisson arrival) which gives rise to an exponential distribution of headways. It has been shown earlier that in such a case the probability of headway equal to or greater than t second is:

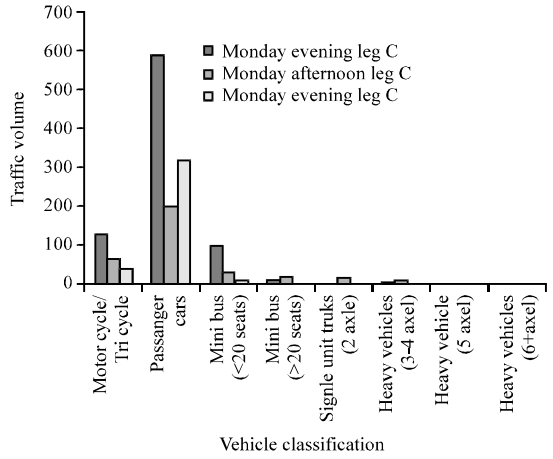

Fig. 3: Summary of traffic volume count on Monday evening leg C

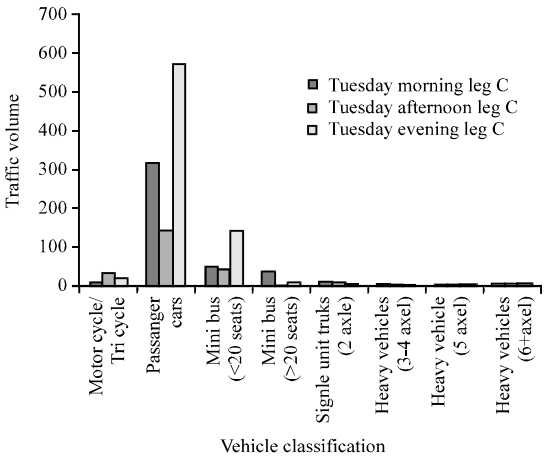

Fig. 6: Summary of traffic volume count on Tuesday evening leg C

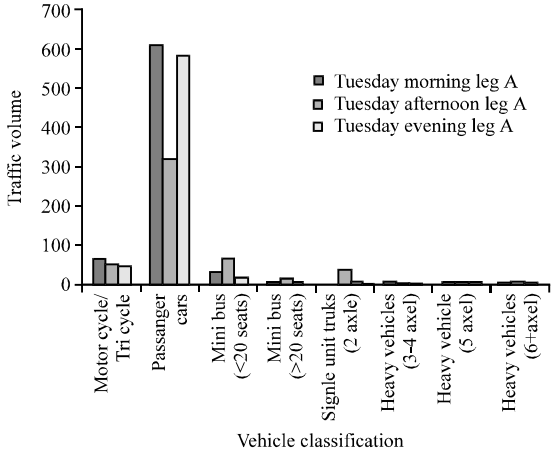

Fig. 4: Summary of traffic volume count on Tuesday morning leg A

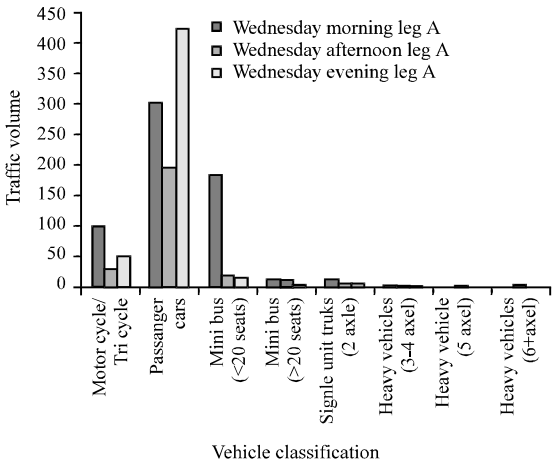

Fig. 7: Summary of traffic volume count on Wednesday morning leg A

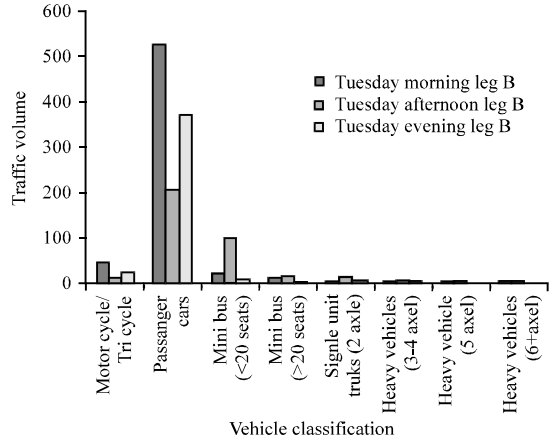

Fig. 5: Summary of traffic volume count on Tuesday afternoon leg B

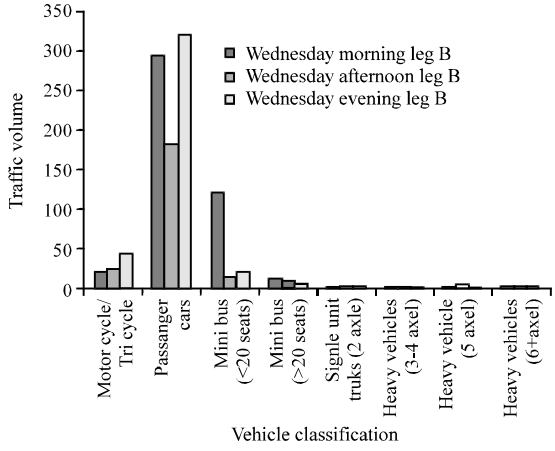

Fig. 8: Summary of traffic volume count on Wednesday afternoon leg B

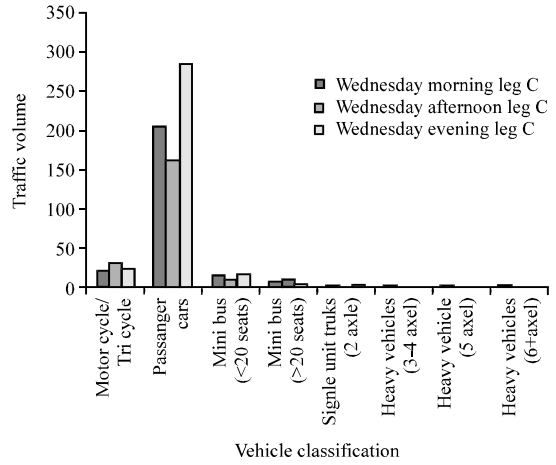

Fig. 9: Summary of traffic volume count on Wednesday evening leg C

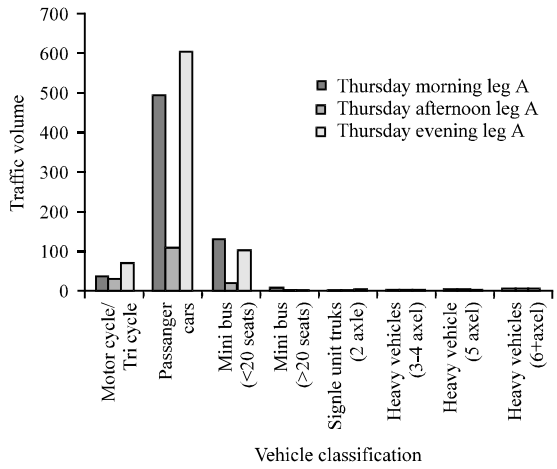

Fig. 10: Summary of traffic volume count on Thursday morning leg A

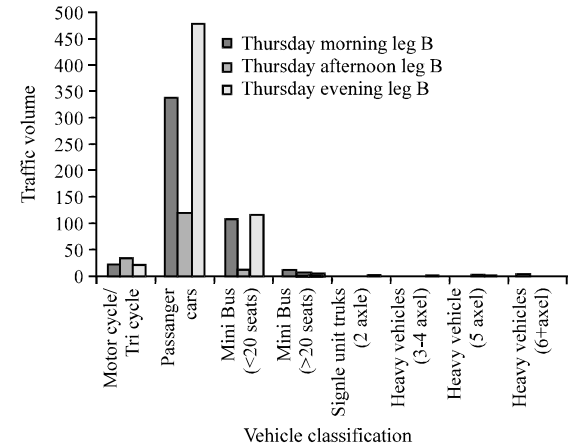

Fig. 11: Summary of traffic volume count on Thursday afternoon leg B

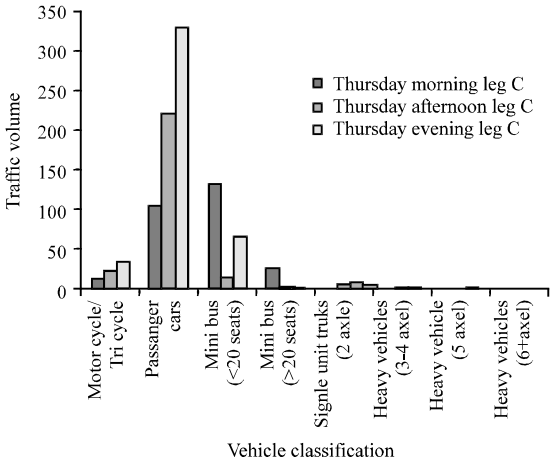

Fig. 12: Summary of traffic volume count on Thursday evening leg C

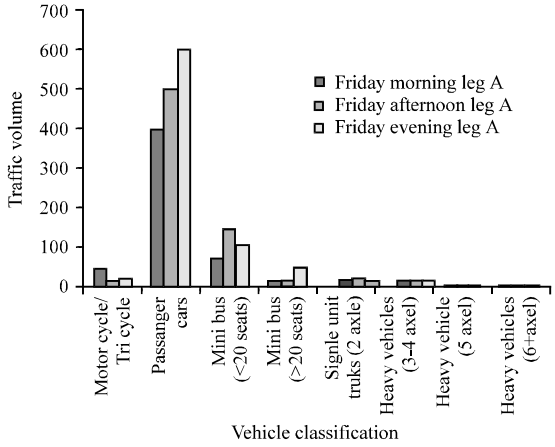

Fig. 13: Summary of traffic volume count on Friday morning leg A

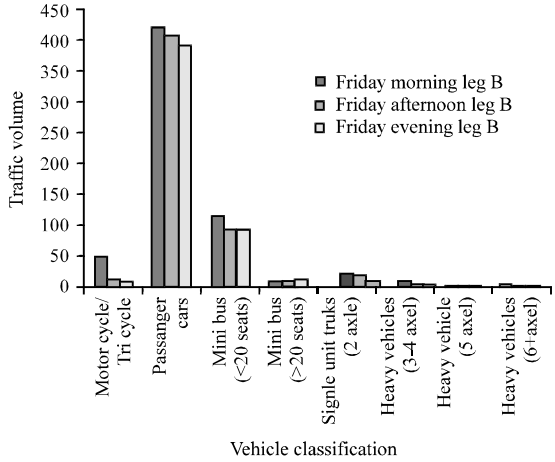

Fig. 14: Summary of traffic volume count on Friday afternoon leg B

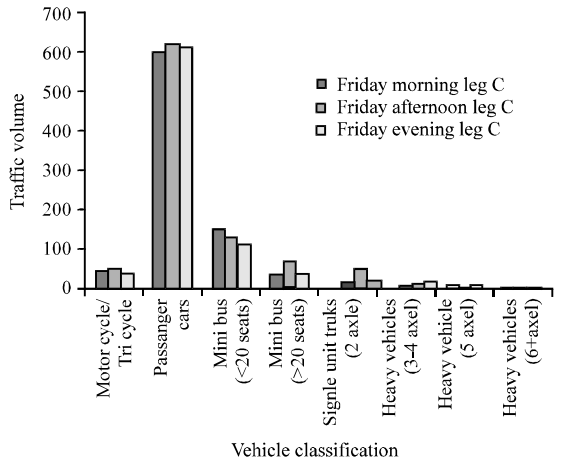

Fig. 15: Summary of traffic volume count on Friday morning leg A

$$P(h \geq t) = e^{-\lambda t}$$

Where:

e = Base of natural logarithms
• = Average rate of arrival per unit time = v/T veh/sec
t = Time interval in seconds
v = volume of vehicles arriving in time T seconds
T = time interval in seconds

$$\text{Mean delay} = \frac{\sum fx}{\sum f} = \frac{3595.2}{848} = 4.23 \text{ sec}$$

Average rate of arrival per unit time:

$$\lambda = \frac{v}{T} \cdot \frac{\text{veh/hour}}{\text{time}}$$

(Vehicle per second)

Time for off peak = 4.23 sec

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CONCLUSION

An appraisal of Oloko intersection has indicated that the major contributors to traffic are motorcycles and passengers cars. The two vehicles have a very high traffic volume.

The maximum speed was 68.17 km/h which can be used for determination of safe sight distance and design speed. Also, the maximum speed at 15th percentile was 43.27 km/h.

From the derived data, vehicle occupancy of car/taxi has the highest percentage occupancy which is 71.49% followed by buses and mini-trucks which is 16.34% because of the vehicle connecting the main express Akure road. It was established that the intersection is close to the free flow saturated as the degree of saturation gotten is 0.89<1 and closed to be uniform flow. Furthermore, an average delay data collected during the peak period is 3.62 sec while during the off peak period is 4.23 sec.

This study has provided an insight to the major contributors to traffic in Oloko intersection and therefore, a proper traffic control system is needed at that point.

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