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Reliable Travel Time for the Public Transportation System along Port Harcourt-Aba Expressway Road in Port Harcourt City

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Abstract In a steadily growing city such as Port Harcourt, there are already several measures being put in place to tackle real time transportation challenge. Being one of the most populous cities in Nigeria, the roadways of this city is also characterized by road accidents, congestions, and delays especially on major link roads connecting rural communities to Port Harcourt. Travel Time Reliability is one of the key performance indicators for transport systems in urban cities. Hence, this study was conducted using the Moving Car Observer method. Using this method to ascertain the average volume of traffic along the Port Harcourt Aba Expressway route, it was observed that the average flow for public vehicles during peak and off-peak periods are 1595.53PCUs/hr and 1774.995PCUs/hr respectively. Further analysis showed that the average journey time using the public transport system, were 35.865mins and 24.595mins during the peak and off-peak periods of the day. The increase in delays experienced along the Port Harcourt-Aba expressway were as a result of certain factors; Pavement failures on some sections of the road, improper alighting of passengers at bus stops, Increase in vehicle-pedestrian interactions and lack of proper control systems at intersections. In conclusion, 40 minutes Journey time in any direction along the route is recommended for a public transport vehicle to allow for proper planning of movements. The journey time will drastically reduce if the causes of delays are resolved as recommended in this study.

Keywords Travel Time, Congestion, Traffic, Reliability**,** Off-peak period, Peak period

1. Introduction

The amount of time required for a traveler to move between two positions can be referred to as journey time. Regardless of the inherent variations among them, this definition is unquestionably applicable to any transportation mode (or combinations of them). Travel time is commonly thought of as a one-dimensional quantity or variable, hence this is to be expected. Additionally, depending on the analyst, there are several components that make up journey time. Public transportation journey times, for instance, are frequently divided into waiting time, in-vehicle time, transfer time, and other times that can be observed (Carrion & Levinson 2012).

Travel time in road networks can be divided into two parts: free flow time and extra time. The former describes how long it takes a driver to reach his or her destination when there is no or very little traffic. The latter phrase describes every increase in journey time brought on by changes in the traffic situation. These fluctuations can be expected (like peak-hour congestion) or unexpected (like car accidents).

Whether they are motor vehicle drivers, transit passengers, freight shippers, or even air travelers, journey time reliability is important to many users of the transportation system. Travelers on both personal and professional trips prefer dependability because it enables them to use their own time more effectively. Predictable journey times are necessary for freight carriers and shippers to remain competitive. A key service that can be offered on privately financed or privately run highways is reliability. Travel time reliability should be a primary performance indicator for transportation planners and decision-makers due to its significance for users of the transportation system.

Travelers generally make the required modifications to balance the delays (e.g., leaving earlier to prevent being late for work) as a result of the predictable variations, which are events (such as traffic congestion) that they anticipate. Traffic congestion is one of the unbearable conditions of urban areas because of the sudden increment in the private transport sector which is affecting urban society and economy (Kumar & Sing, 2017). According to Kumar and Sing (2017) Congestion stops the movement of traffic leading to unbearable increase in travel time. Traffic congestion generally leads to increment in transportation cost due to increased time spent on routes and extinguishment of consumables (fuel, diesel e.t.c) in most cases and in other cases leads to stress, delays and inability to accurately forecast travel time along such routes. Factors responsible for traffic congestion include physical, technical, land use and human factors (Uwadiegwu, 2013).

For the unpredicted variations that makes travel time uncertain, Wong and Sussman (1973) divided it into three: variations caused by changes in travel conditions brought on by weather, wrecks, or events, differences according to the perspective of each traveler, and variations according to the seasons and days of the week. fluctuations in the link flows and fluctuations in capacity are listed by Nicholson and Du (1997) as additional components of uncertainty. As a result, the unpredictable fluctuations in a transportation system can be traced to both the supply side (such as traffic signal malfunction) and the demand side (such as travelers' diverse behavior).

Port Harcourt - Aba expressway from Isaac Boro Park to Eleme junction is 12.75Km. It is one of the most used routes in the city of Port Harcourt. This paper seeks to establish a reliable travel time while considering mobility during peak and off-peak hours of the day for public transport system users. Along this road, there are business activities, markets, educational establishments and major intersections linking other major and minor roads in the city. According to Otto and Ogboda (2022), some intersections along this road suffer congestion as a result of poor parking facilities, lack of pedestrian crossing facilities, and poor driver habit. The main causes of congestion at some roundabouts (like the Slaughter roundabout) within the city were identified in research by Otto and Simeon (2022). Also, Otto and Awarri (2022) identified causes of delays along Ikwerre road in Port Harcourt. The causes in both studies were: the presence of unlawful trading near the crossroads, the actions of drivers, the absence of pedestrian crossing infrastructure, the lack of pavement markings, and the absence of packing facilities. These factors affect travel time during peak and off-peak periods. Therefore, a reliable travel time considering these factors will help road users plan their trips effectively.

2. Materials and Methods

2.1 Materials

The materials in this study include; A test car, Stop watch/clock, Recording journal, Ball pen and Excel spreadsheet.

2.2 Methods

The Moving Car Observer Method was employed to gather the necessary data. This approach is favored because it allows the researcher to observe some of the causes of congestion along the targeted route as well as gain first-hand experience with the dynamism of travel time. The moving car observer method is a technique that is frequently used to calculate the average traffic flow and travel time on a road link using information gathered from moving vehicles. The method was created by the road research laboratory in the United Kingdom, U.K., and was first published in a study by Wardrop and Charlesworth (1954).

Using this technique, a number of runs were made with a test vehicle (the boarded public transportation bus) while driving both "with" and "against" traffic for a one-year period. Along with the four (4) field observers, there were other passengers on the bus who were going alone. The number of opposing vehicles encountered by the test vehicle (bus) was counted by one enumerator, the number of vehicles the test vehicle passed and overtook, as well as the number of vehicles that overtook the test vehicle while it was moving, were counted by another enumerator, and the journey time and delay time of the test vehicle were timed for each run by an enumerator using a stopwatch. Traffic flow is computed from the gathered data using the pertinent equations below. The key benefit of using the moving car observer method is that the calculation can be used to determine flow, average journey speed, average running speed, and average delay. With at least three observers and a test vehicle, it has the benefit of obtaining the entire state. With the Moving Car Observer technique, data on both speed and traffic flow are gathered in a single trial. Only the week days were used for the investigation.

The following equations were used in this study;

$$q_n = \frac{x_s + y_n}{t_n + t_s} \quad (2.1)$$

$$v = \frac{l}{\bar{t}} \quad (2.2)$$

$$\bar{t}_n = t_n - \frac{y_n}{q_n} \quad (2.3)$$

Where;

q_n is the volume of all moving vehicles traveling north.
t_n is the amount of time it takes to travel in the north direction.
t_s is the amount of time it takes to travel in the south direction.
x_n represents the amount of opposing traffic that is encountered when a test vehicle is traveling north
y_n equals the number of vehicles passing the test vehicle minus the number that the test vehicle has passed.
V is the mean journey speed.
L is the length or distance travelled.
$\bar{t}_n$ is the mean travel time.

Table 1: Intersection with their Section Marks and Distances

Intersection	Section Mark	Distance (m)
Eleme Junction	EJ	
	EJ-OM	482
Oil Mill	OM	
	OM-RK	1287
Rumukwurushi	RK	
	RK-SH	160
Shell RA	SH	
	SH-AR	1770
Artillery	AR	
	AR-MJ	1287
Market Junction	MJ	
	MJ-FB	644
First Bank	FB	
	FB-AF	482
Air Force	AF	
	AF-RU	1287
Rumuola	RU	
	RU-GR	1126
GRA	GR	
	GR-WL	804
Water Lines	WL	
	WL-GA	1287
Garrison	GA	
	GA-CFC	1126
CFC	CFC	
	CFC-MI	960
Mile One	MI	

3. Results and Discussions

3.1 Traffic data for Public Transport System during Peak Periods.

The result of the traffic study carried out during peak period using public transport system is presented in Table 2, Table 3, Figure 1 and Figure 2.

Table 2: Peak Periods of Public Transport (North Bound)

Mile 1 to Eleme Junction (Peak, Public)							
Running No	**Journey Time (mins)**	**Stoppage Time (mins)**	**Vehicles In Opposing Direction**			**Vehicles In Same Direction**	
			Cars	**Buses**	**Trucks**	**Overtaking Vehs.**	**Overtaken Vehs.**
1	27.9	15.56	1014	204	41	105	92
2	38.5	18.56	1110	213	51	126	130
3	38.5	17.09	1089	221	68	113	122
4	33.2	16.31	1163	167	40	77	127
5	33.7	15.98	1010	181	50	108	125
Total	171.7	83.5	5386	986	250	529	596
PCU				8844			
Average	34.3	16.7		1768.8		105.8	119.2
Flow per min			28.36			PCUs/hr	
Flow per hr			1701.63			PCUs/hr	
M. J. Time			34.82			mins	
J. Speed			21.89			K.P.H	
M. R. Time			18.12			mins	
R. Speed			42.06			K.P.H	

Table 3: Peak Periods of Public Transport (South Bound)

Eleme Junction to Mile 1 (Peak, Public)							
Running No	**Journey Time (mins)**	**Stoppage Time (mins)**	**Vehicles In Opposing Direction**			**Vehicles In Same Direction**	
			Cars	**Buses**	**Trucks**	**Overtaking Vehs.**	**Overtaken Vehs.**
1	42.8	18.5	1268	154	58	113	93
2	36.8	17.2	1275	258	46	100	102
3	35.2	16.2	1148	306	52	133	108
4	37.8	17	1227	266	55	128	133
5	36.5	17	1241	204	77	210	136
Total	189.067	85.8	6159	1188	288	684	572
PCU				10299			
Average	37.8	17.2		2059.8		136.8	114.4
Flow per min			24.82			PCUs/hr	
Flow per hr			1489.43			PCUs/hr	
M. J. Time			36.91			mins	
J. Speed			20.64			K.P.H	
M. R. Time			19.75			mins	
R. Speed			38.59			K.P.H	

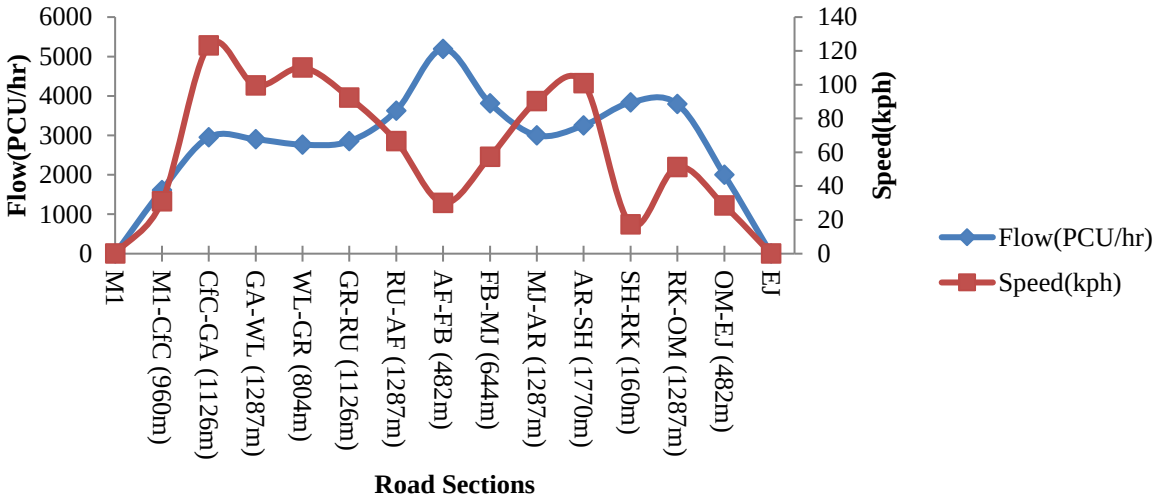

Figure 1: Variation of Average Flow and Speed against Road Sections for Peak Periods of Public Transport (North Bound)

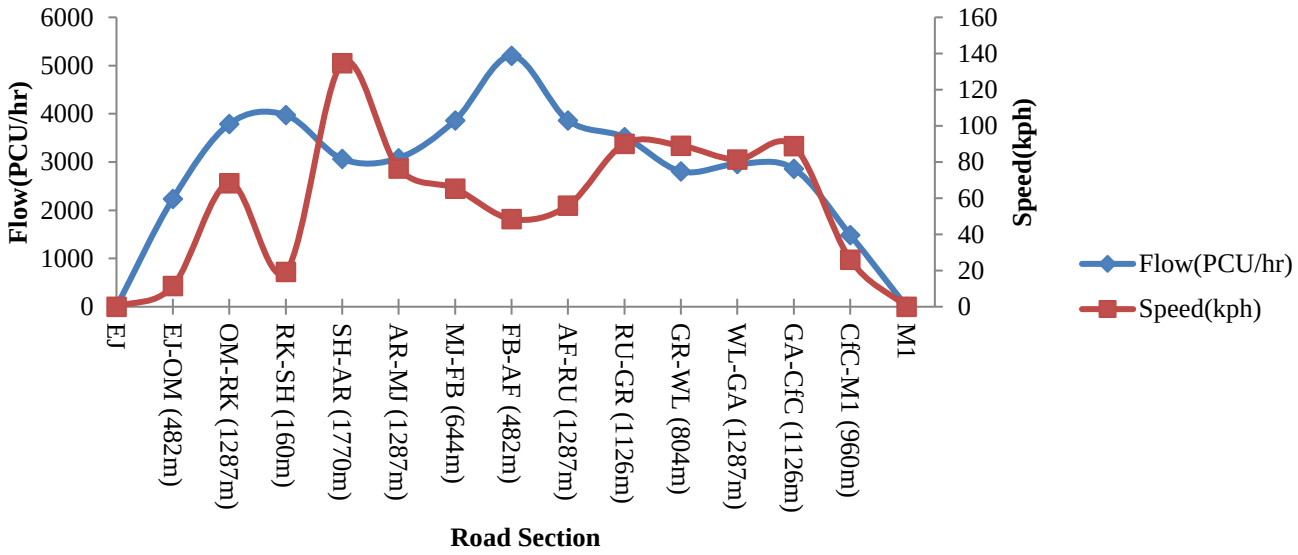

Figure 2: Variation of Average Flow and Speed against Road Sections for Peak Periods of Public Transport (South Bound)

The data in Table 2 shows the traffic counts and flows observed using public transport vehicles while moving from Mile 1 interchange (Isaac Boro Park) to Eleme Junction during peak periods. The mean journey time (M.J Time) was observed to be 34.82mins while the mean running time was observed to be 29.92mins with an average running speed (R. Speed) and journey speed (J. Speed) of 42.06kph and 21.89kph respectively. Also, the flow in this north bound direction is 1701.63PCUs/hr. However, In Table 3, The mean journey time (M.J Time) was observed to be 36.91mins while the mean running time was observed to be 19.75mins with an average running speed (R. Speed) and journey speed (J. Speed) of 38.59kph and 20.64kph respectively. Also, the flow in this south bound direction is 1489.43PCUs/hr.

The journey experienced a lot of delays which was as a result of portholes due to pavement failures, time spent loading and offloading of goods/boarding and alighting of passengers at intersections and bus stops, failure of signalized traffic controlling facilities to aid the regimented movement of vehicles at intersections. Other causes of these delays were also observed in Otto and Ogboda (2022) when studying the traffic flow situation at Garrison intersection along this same road.

The average speed and flows along the sections of the road are shown in Figure 1 and Figure 2. In Figure 1, the highest speed and flow were observed to be 123.19kph and 5192.7PCUs/hr in the north bound direction while in the sound bound direction the highest speed and flow were observed to be 134.72kph and 5200.7PCUs/hr. In Figure 1 and 2, the flow and speed relationship has clearly shown that the density or concentration of vehicles are higher between RU and FB sections when traveling from MI to EJ and AR and RU sections when traveling from EJ to MI. This is true because of the business, activities and residential areas adjacent to the area.

3.2 Traffic data for Public Transport System during off-peak period

The result of the traffic study carried out during off-peak period using public transport system is presented in Table 3, Table 4, Figure 3 and Figure 4.

Table 4: Off-Peak Periods of Public Transport (North Bound)

Mile 1 to Eleme Junction (Off-Peak, Public)							
			Vehicles In Opposing Direction			Vehicles In Same Direction	
Running No	Journey Time (mins)	Stoppage Time (mins)	Cars	Buses	Trucks	Overtaking Vehs.	Overtaken Vehs.
1	28.37	14.56	907	169	38	72	81
2	22.2	11.56	802	244	60	102	123
3	22.2	13.09	838	188	54	96	100
4	22.93	12.31	720	167	40	91	80
5	21.72	13.98	721	172	26	85	66
Total	117.42	65.5	3988	940	218	446	450
PCU				7244			
Average	23.48	13.1		1448.8		89.2	90
Flow per min			29.7			PCUs/hr	
Flow per hr			1782.3			PCUs/hr	
M. J. Time			23.5			mins	
J. Speed			32.4			K.P.H	
M. R. Time			10.4			mins	
R. Speed			73.2			K.P.H	

Table 5: Off-Peak Periods of Public Transport (South Bound)

Eleme Junction to Mile 1 (Off-Peak, Public)							
			Vehicles In Opposing Direction			Vehicles In Same Direction	
Running No	Journey Time (mins)	Stoppage Time (mins)	Cars	Buses	Trucks	Overtaking Vehs.	Overtaken Vehs.
1	25.8667	13.47	987	197	31	115	86
2	34.0833	16.23	821	203	44	124	92
3	27.5167	14.19	988	143	68	137	120
4	22.7333	13.98	826	147	54	140	100
5	23.05	12.95	766	176	35	113	90
Total	133.25	70.82	4388	866	232	629	488
PCU				7450			
Average	26.65	14.164		1490		125.8	97.6
Flow per min			29.46			PCUs/hr	
Flow per hr			1767.69			PCUs/hr	
M. J. Time			25.69			mins	
J. Speed			29.66			K.P.H	
M. R. Time			11.53			mins	
R. Speed			66.1			K.P.H	

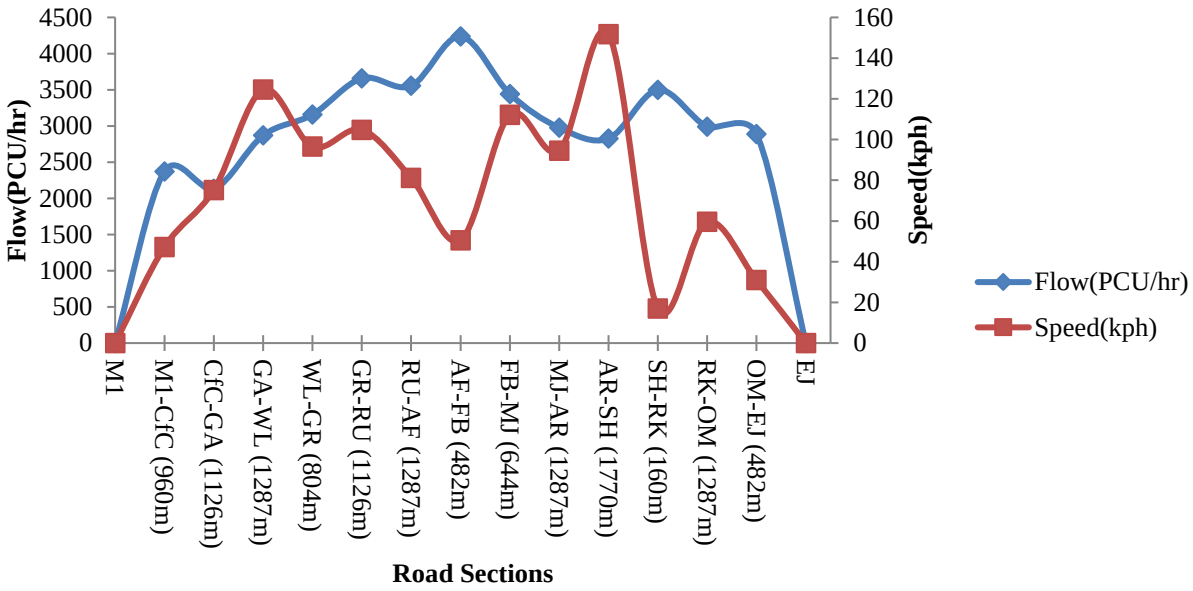

Figure 3: Variation of Average Flow and Speed against Road Sections for Off-Peak Periods of Public Transport (North Bound)

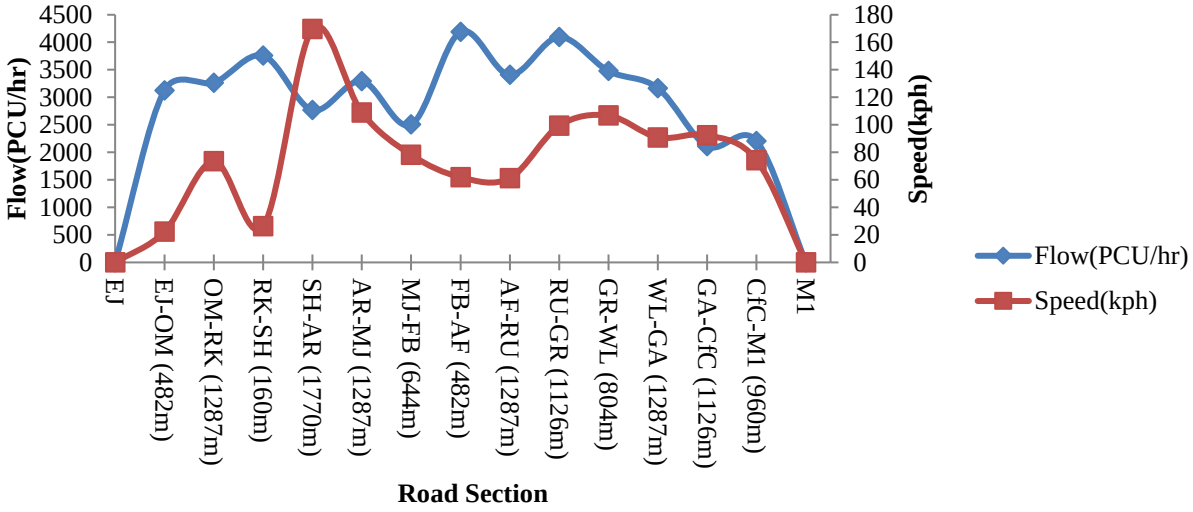

Figure 4: Variation of Average Flow and Speed against Road Sections for Off- Peak Periods of Public Transport (South Bound)

The data in Table 4 shows the traffic counts and flows observed using public transport vehicles while moving from Mile 1 interchange (Isaac Boro Park) to Eleme Junction during off-peak periods. The mean journey time (M.J Time) was observed to be 23.5mins while the mean running time was observed to be 10.4mins with an average running speed (R. Speed) and journey speed (J. Speed) of 73.2kph and 32.4kph respectively. Also, the flow in this north bound direction is 1782.3PCUs/hr. In contrast, In Table 5, the mean journey time (M.J Time) was observed to be 25.69mins while the mean running time was observed to be 11.53mins with an average running speed (R. Speed) and journey speed (J. Speed) of 66.10kph and 29.66kph respectively. Also, the flow in this south bound direction is 1489.43PCUs/hr.

The journey experienced a lot of delays as stated earlier. The average speed and flows along the sections of the road are shown in Figure 3 and Figure 4. In Figure 3, the highest speed and flow were observed to be 125.51kph and 4237.4PCUs/hr in the north bound direction while in the sound bound direction the highest speed and flow

were observed to be 169.69kph and 4188.9PCUs/hr as shown in Figure 4. During the off-peak period, the density was reduced as a result of the reduction in traffic volume and increase in speed. This is expected. Nevertheless, both movements experienced similar densities from beginning to the end of the journey unlike that of the peak period.

4. Conclusion

The study investigated the travel time from Mile 1 interchange (Isaac Boro Park) to Eleme Junction along Port Harcourt -Aba Express Road for Peak and Off-Peak periods using public transport systems. From the results of the traffic survey along the route, and based on the analysis and discussions, the conclusions are drawn as follows;

i. The average journey time using the public transport system is 35.865mins and 24.595mins during peak and off-peak periods respectively.
ii. The congestion experienced along the route is caused by pavement failures along certain sections of the road, improper alighting of passengers at bus stops, increased pedestrian-vehicle interactions and irregularities of signalized traffic lights at intersections.
iii. The average flow for public vehicles during peak and off-peak periods is 1595.53PCUs/hr and 1774.995PCUs/hr respectively.

Based on the findings and conclusions drawn, it is important to make the following recommendations:

i. The reliable journey time of 40minutes is recommended for public transport system users along this route for proper planning.
ii. Road Pavements should be maintained regularly so as to reduce the formation or portholes and bad spots on road sections.
iii. The provision of parking facilities to curb incessant parking around the intersections and hence increase traffic flow.
iv. Pedestrian crossing facilities should be constructed; these footbridges will reduce the pedestrian-vehicle interaction and thereby increase traffic flow.

References

[1]. Kumar, A. & Sing, R. R. (2017), Traffic Congestion and Possible Solution in Urban Transport System. International Journal of Advance Research in Science and Engineering. 6(7), 630-634.
[2]. Nicholson, A., & Du, Z., (1997). Degradable transportation systems: an integrated equilibrium model. *Transportation Research Part B* 31, 209–223.
[3]. Otto, C. G. & Simeon, B. (2022). Capacity Assessment of Slaughter Rotary Intersection. *Journal of Newviews in Engineering and Technology.* 4(1), 14 – 21.
[4]. Otto, C. G. & Awarri. A. W. (2022). Public Transport Sector Development in Port Harcourt, a Road Map for Reducing Traffic Congestion. *International Journal of Research in Engineering and Science*. 10(8), 160 – 164.
[5]. Otto, C. G. & Ogboda, C. E. (2022). A Survey of Traffic Congestion Measure Towards a Sustainable Flow At Garrison Intersection, Port Harcourt, Nigeria. Journal of Newviews in Engineering and Technology. 4(1), 14 – 21.
[6]. Uwadiegwu B. O (2013). Factors Responsible for Traffic Congestion in Nigeria, A Case Study of Major Bus Stop and Coal Camp Along Agbani Road in Enugu City, Nigeria. Journal of Environment and Earth Science. 3(3), 71-78
[7]. Wardrop, J.G. & Charlesworth, G. (1954) A method of estimating speed and flow of traffic from a moving vehicle. Proceedings of the Institution of Civil Engineers, Part II, 3: 158-171.
[8]. Wong, H., & Sussman, J., (1973). Dynamic travel time estimation on highway networks. *Transportation Research* 7, 355–370.