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Performance Study of University of Ado Ekiti (UNAD) Transit Shuttle Buses

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Abstract: Traffic engineering uses engineering methods and techniques to achieve the safe and time efficient movement of people and goods on roadways. The safe and time efficient movement of people and goods is dependent on the transit system performance, which is directly connected to the traffic characteristics. The main parameters of performance of transport shuttles are traffic volume, speed, density and revenue; and all these are evaluated in this study. In the absence of effective planning and traffic management, current road infrastructure will not be able to cater for the future needs of the University. Students, staff and vehicle volumes have increased significantly in the last decade in the Institution, yet the performance of the transport shuttle have been dismal and unable to achieve its objectives. Findings of the study show that the morning peak period (8.00am to 9.00am) has 234 vehicles/hr, evening peak period (2.00pm to 3.00pm) has 284 vehicles/hr, while the off-peak period (11.00am to 12.00pm) has 156 vehicles/hr. The journey time from the Post Office bus stop to the University campus, measured as 34.01 minutes, was too long for the distance of 15.0km road which according to the Nigeria Highway Code should not be more than 18 minutes. The average stopping time was 6.55 minutes, average interval between arrivals of motorists was 16.40 seconds, the average queue length was 14.23 people, and the average waiting time at the bus-stop 4.17 minutes. These values were obtained using the queuing theory and shows much commuters time is lost on transit queues. The financial condition of the transit unit shows that amount generated is less than the amount expended by the transit operators. This means, in effect, that the shuttle bus operators are operating in deficit.

Keywords: Traffic Studies, Journey Time, Shuttle Performance, Queuing Theory, Revenue

1. Introduction

Transportation problems remain one of the most nagging problems in urban societies today. All over the world, attempts have been made to tackle the problems, yet the situation seems to get worse [1]. Transport infrastructures have to be rationally developed to ensure that movement of people and goods takes place speedily, economically, safely, comfortably and in an environmentally-friendly manner [2] and this can only be achieved by increased transportation performance. Among the various modes of transport, the road transport (which is the predominant mode in Ekiti State, as at present) seems to be the most important especially in the developing countries because to a large extent, a substantial percentage of people, goods and services are moved by roads from one geographical area to another [3]. This is also the case with the University of Ado Ekiti which depends majorly on road transport using the University shuttle buses for the movement of the students, staffs and other members of the Institution to and from the University on a daily basis.

According to [4], the urban transit system before 1988 had some deficiencies, which included general inadequacy of supply relative to demand, disorganized private operators of Para-transit transport, defective public-owned transport companies in the few cities where they existed, traffic congestion and defective traffic management in bigger cities thereby the need to understand how this reflects in the transport services of the University of Ado Ekiti shuttle system. The challenges leading to the under-performance of the University of Ado–Ekiti transit shuttle are further

reflected in the study by [1], where he stated that among the most notable transportation problems are traffic congestion and parking difficulties; longer commuting; public transport inadequacy; difficulties for non-motorized transport, less of public space, environmental impacts and energy consumption, accident and safety, land consumption and freight distribution and all these impacts the performance of the University transport shuttle.

Generally, the transport shuttle service in the University is far from achieving its stated objectives of providing quality and affordable transport service for the University community. [5] attributed some of the transportation problems confronting cities in developing countries to increasing and rapid urbanization as they experience rapid population growth (typically between 3 and 5 percent) per year and this is same for UNAD as the transport demand in the Institution has continued to increase beyond the capacity of the programme due to the ever increasing population of students and other members of the University leading to inadequate and insufficient service delivery. The commuting time from the University campus to the town center in Ado Ekiti has increased considerably and this is similar to the findings of [6] which posited that the commuting distance within selected areas of Lagos increased from 20km in 1970 to 35km in 1995 while that of selected areas within Kaduna increased from 6km to 10km during the same period [7]. In Akure, the commuting distance within selected increased from 5.2km in 1966 to 6.4km in 1976, 10.5km in 1986, 13km in 1996 and 19km in 2006 and the increase in commuting distance has impact on trip attraction, fare paid by commuters and traffic build-up in some land use areas thereby impacting on transportation systems performance [8]. According to the [9], the commuting distance is higher when considering the speed limits for the different types of vehicles in different operating environments (Build up areas, highways and expressways) and this is as shown in Table 1.

Table 1. *Speed Limits for Vehicles in Km/Hr.*

Types of Vehicles	Build Up	Highway	Expressway
Motorcycles	50	50	-
Private Cards	50	80	100
Taxis and Buses	50	80	90
Tankers and Trailers	45	50	60
Tow Vehicle (While Towing)	45	45	45
Tow Vehicle (While Not Towing)	50	60	70

All these go to show the importance of the evaluation of the performance of transit systems as they provide information needed for transportation and traffic design and planning.

There are many factors considered in the evaluation of the performance of shuttle buses. These are: human factors, physical factors, traffic consideration, economic, social and environmental factors. Human factors consist of the driver personal habits and the decision-reaction time of the drivers. The physical factors consist of the appurtenances related to the highway which affect the design and ultimately the capacity utilization of the highway such as the geometric features, speed change lanes, sight distances, and angle of intersections amongst others. The traffic consideration factors are factors that relate strictly to the vehicular classification of the road users and include the vehicle speeds, design and actual capacity of road, size and operating characteristics of vehicles and the design hour turning movements. Finally, the economic, social and environmental factors which influence the final decisions on transportation projects to achieve the need for fast, safe and efficient public transportation facilities and they include air and noise pollution as a result of the transportation activities, cost of maintenance of shuttle buses cost of improvement of transit buses amongst others.

2. The Study Area

University of Ado – Ekiti is located in Ado-Ekiti, the capital city of Ekiti state in Nigeria and is located between latitudes $7^{0}34^{1}$ and $7^{0}41^{1}$ north of the Equator and Longitudes $5^{0}11^{1}$ and $5^{0}6^{1}$ east of the Greenwich Meridian. Ado – Iworoko road, the study road, is a trunk B road and is a single carriageway undergoing upgrade. The road has a flexible pavement, narrow carriageway, and has been severally patched during various governments but the road still fails, hence the need for a major renovation on the road. The road consists of series of small culverts, bends, summit, and valley curves which affects traffic characteristics especially on the Ado Ekiti – Campus corridor which is the study area. Figure 1 shows the google earth image of the study route from the starting to the end locations, with its equivalent kilometers and estimated time duration for the journey.

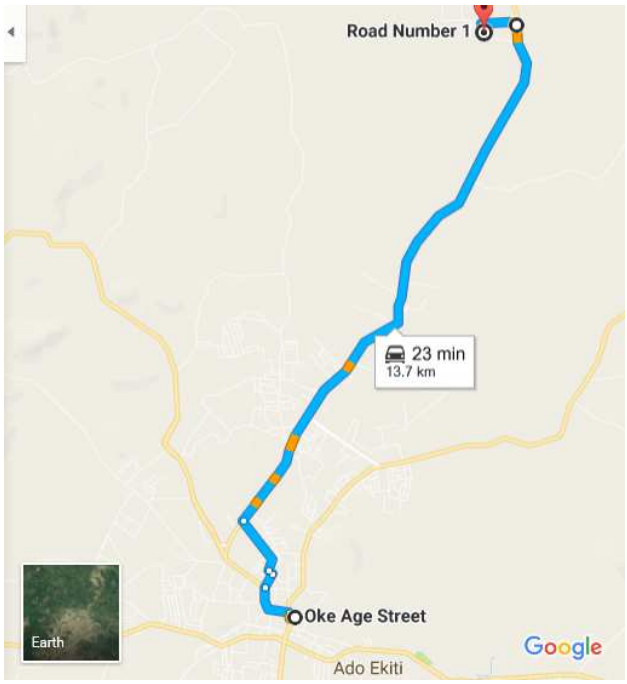

Figure 1. *Google Earth Image of the Study Route.*

3. Study Methodology

The methodology involved obtaining data on the shuttle

buses at strategic points along the study route. The data obtained include the traffic volume to determine the peak and off peak traffic volume, speed studies by evaluating the average and the spot speeds, delay studies, Queue studies employing the Queuing theory, occupancy studies using the Gordon-Count method and revenue studies. Data were obtained using combination of manual and automatic counts.

The formulas detailed below in equation 1-10 were employed in the study.

$$\text{Average cost of fuel/month} = \text{Average cost of fuel/day}) * \text{Number of days} \quad (1)$$

$$\text{Traffic flow} = \frac{Number\ of\ Vehicles}{Time\ taken\ (mins)} \quad (2)$$

$$\text{Average Occupancy} = \frac{Sum\ of\ Passengers}{Total\ No.of\ Samples} \quad (3)$$

$$\text{Average Journey time} = \frac{Total\ journey\ time}{Number\ of\ trips} \quad (4)$$

$$\text{Average interval between arrival} = \frac{1}{\lambda} \quad (5)$$

$$\text{Average interval between service rate} = \frac{1}{\mu} \quad (6)$$

$$\text{Average queue length} = \frac{\lambda^2}{\mu(\mu-\lambda)} \quad (7)$$

$$\text{Average waiting time in the queue} = \frac{\lambda}{\mu(\mu-\lambda)} \quad (8)$$

$$\text{Average time spent in the system} = \frac{1}{(\mu-\lambda)} \quad (9)$$

$$\text{Revenue} = A \equiv M + F + S \quad (10)$$

where A= Average amount generated per month
M =Average amount expended on maintenance
F = Average amount of Fuel
S =Amount paid for administrative and union charges

4. Results and Discussion

Results of traffic data counts and analysis of the performance study of the shuttle buses are detailed below with Table 2 showing the operational bus survey of the university's shuttles.

Table 2. *Operational Bus Survey.*

Total Number of UNAD Shuttle Buses	82
Number of buses functioning	79
Average number of passengers per buses	9
Average number of stops per trip	3
Amount paid for administrative charge per month	₦2,000
Average number of trips made (Bus/day)	24
Average cost of fuel (Bus/day)	₦1,000

4.1. Traffic Survey

This survey is done by vehicle count experiment and this involved observers standing at the midpoint along the test corridor and manually counting vehicles plying the route at a 60 minutes' interval for 3 days (Monday, Wednesday and Friday) between the hours of 7.00am and 6.00pm and traffic flow in both directions were considered and the result is as given in the Table 3 and Figure 2.

Table 3. *Traffic Flow Count Along UNAD-Iworoko Road.*

Time	3 days Average		Total
	To UNAD	From UNAD	
7.00 – 8.00 AM	134	82	216
8.00 – 9.00	126	108	234
9.00 – 10.00	89	135	224
10.00 – 11.00	102	97	199
11.00 – 12.00 PM	73	83	156
– 1.00 PM	91	106	197
1.00 - 2.00	87	92	179
2.00 – 3.00	134	150	284
3.00 – 4.00	101	137	238
4.00 – 5.00	78	84	162
5.00 – 6.00	57	56	113

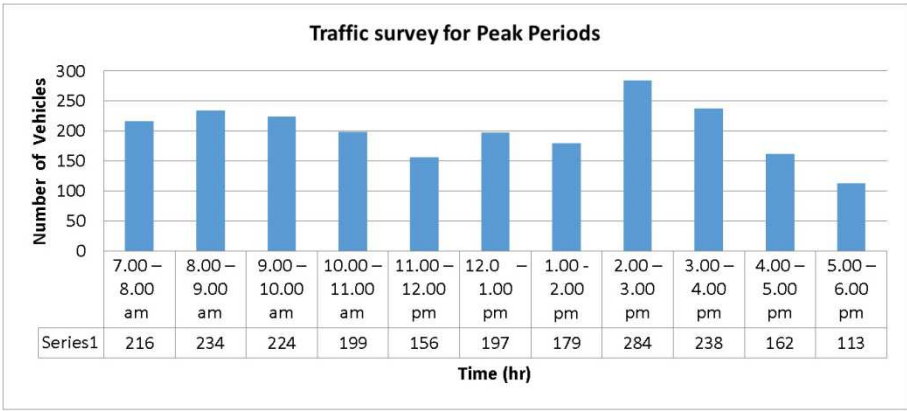

Figure 2. *Graph Traffic Survey for Peak Periods.*

The peak periods of the traffic along the corridor are determined as follows:

(1) The morning peak period is between 8.00am to 9.00am with 234 vehicles/hr
(2) The evening peak period is from 2.00 pm to 3.00 pm with 284 vehicles/hr
(3) The off-peak period is from 11.00am to 12.00pm with 156 vehicles/hr

However, the traffic flow is determined by dividing the number of vehicles by the corresponding period of time.

Quantitatively,

Traffic flow = $\frac{Number\ of\ Vehicles}{Time\ taken\ (mins)}$

For the Morning Peak Period, Traffic Flow = $\frac{234}{60} = 3.9$ vehicles/mins

For the Evening Peak Period, Traffic Flow = $\frac{284}{60} = 4.7$ vehicles/mins

For the Off-Peak Period, Traffic Flow = $\frac{156}{60} = 2.6$ vehicles/mins

Overall average traffic density = $\frac{216+234+224+199+156+197+179+284+238+162+113}{60*11} = \frac{2202}{660} = 3.3$ vehicles/mins

4.2. Occupancy Survey

The Gordon Count method was used in obtaining the average number of passengers carried by a bus per trip and it was conducted at the start and end points of the trips on three different types of the shuttle buses at the morning, evening and off-peak periods and the results are as shown in Table 4.

Table 4. *Occupancy Survey for the Shuttles.*

	Suzuki Lite	**Suzuki Medium**	**Toyota Hiace**	**Volkswagen Bus**
	Morning Peak Period			
Sample 1	10	9	18	18
Sample 2	7	6	17	18
Sample 3	10	8	18	16
Evening Peak Period				
Sample 1	9	10	16	17
Sample 2	10	9	18	16
Sample 3	8	4	15	12
Off Peak Period				
Sample 1	6	5	10	15
Sample 2	8	9	12	12
Sample 3	8	4	12	10
Total	76	64	136	134

(a) Average Occupancy (Suzuki Lite) = $\frac{Sum\ of\ Passengers}{Total\ No.of\ Samples} = \frac{76}{9} = 8$ passengers

(b) Average Occupancy (Suzuki Medium) = $\frac{Sum\ of\ Passengers}{Total\ No.of\ Samples} = \frac{64}{9} = 7$ passengers

(c) Average Occupancy (Toyota Hiace) = $\frac{Sum\ of\ Passengers}{Total\ No.of\ Samples} = \frac{136}{9} = 15$ passengers

(d) Average Occupancy (Volkswagen Bus) = $\frac{Sum\ of\ Passengers}{Total\ No.of\ Samples} = \frac{134}{9} = 15$ passengers

4.3. Journey Time

The journey time is the time taken to complete a journey between defined reference points. The journey time for the morning, evening and off peak periods are obtained for this study and as shown inn Table 5, 6 and 7.

For the morning peak period

Table 5. *Journey Time for the Shuttles at Morning Peak Period.*

Name of Experiment	**Journey Time in Minutes**					
	Post office Bus Stop – Campus Bus Stop			**Campus Bus Stop – Iworoko Bus Stop**		
Vehicle Make	1st Trial	2nd Trial	Mean	1st Trial	2nd Trial	Mean
Suzuki Lite	35.23	29.57	32.40	3.20	3.32	3.26
Suzuki Medium	33.11	35.14	34.13	3.25	3.31	3.28
Toyota Hiace	35.01	36.24	35.17	3.30	3.28	3.29
Volkswagen Bus	34.28	34.12	34.20	3.24	3.32	3.28

For the evening peak period

Table 6. *Journey Time for the Shuttles at Evening Peak Period.*

Name of Experiment	**Journey Time in Minutes**					
	Post office Bus Stop – Campus Bus Stop			**Campus Bus Stop – Iworoko Bus Stop**		
Vehicle Make	1st Trial	2nd Trial	Mean	1st Trial	2nd Trial	Mean
Suzuki Lite	35.28	34.19	34.29	3.21	3.30	3.26
Suzuki Medium	36.18	34.29	35.23	3.27	3.31	3.29
Toyota Hiace	34.02	34.56	34.38	3.29	3.31	3.30
Volkswagen Bus	35.41	34.07	35.06	3.27	3.38	3.33

For the off peak period

Table 7. *Journey Time for the Shuttles at Off Peak Period.*

Name of Experiment	Journey Time in Minutes					
	Post office Bus Stop – Campus Bus Stop			Campus Bus Stop – Iworoko Bus Stop		
Vehicle Make	1st Trial	2nd Trial	Mean	1st Trial	2nd Trial	Mean
Suzuki Lite	30.56	33.38	32.47	3.05	3.10	3.08
Suzuki Medium	33.18	31.59	32.39	3.08	3.12	3.10
Toyota Hiace	34.11	34.16	34.14	3.12	3.15	3.14
Volkswagen Bus	33.19	35.28	34.24	3.14	3.09	3.12

Average Journey Time is deduced by dividing the sum of the mean time by the number of means.

1. Average Journey time (Post office Bus Stop – Campus Bus Stop)

$$= \frac{32.40+34.13+35.17+34.20+34.29+35.23+34.38+35.06+32.47+32.39+34.14+34.24}{12}$$

$$= \frac{408.10}{12} = 34.01 \text{ minutes}$$

2. Average Journey time (Campus Bus Stop – Iworoko Bus Stop)

$$= \frac{3.26+3.28+3.29+3.28+3.26+3.29+3.30+3.33+3.08+3.10+3.14+3.12}{12}$$

$$= \frac{38.69}{12} = 3.23 \text{ minutes}$$

According to the Nigeria Highway Code, for a distance of 15.0km with the speed limit for buses and taxis in build-up areas which is this study area at 50km/hr

Standard Average Journey time (with no delays) = $\frac{Distance}{Speed\ Limit} = \frac{15km}{50km/hr} = 0.3$hr

= 0.3 * 60 minutes = 18 minutes

4.4. Stopping Time

Stopping time refers to the total time duration the bus spends at the bus stop. The stopping time is made up of sometime components.

(a) The boarding stop time "A" This is also made up of three other components.

(1) The time taken to close the door = 15 seconds

(2) The time taken by the driver to check the traffic before take-off = 5 seconds

(3) The time taken to park the bus and open the bus for commuters = 5 seconds

(4) A = (15+5+5) = 25 seconds

(b) Average boarding time per passenger = "B_1" = 23 seconds

(c) Number of passengers boarding = $n_{1 =}$ 16 passengers

Hence mathematically, stopping time T = A + B_1* n_1

Stopping Time = (25 + (23*16)) = (25+368) = 393 seconds

Stopping time = 6.55 minutes

4.5. Waiting Time (Delay)

This is the length of time spent by the passengers at the bus stop before boarding a bus. The queuing theory is employed in this study.

(a) Average arrival rate (ƛ) = 220 passengers/hour

$\frac{220}{3600} = \frac{11}{180}$

(b) Average service rate (μ) = 234 passengers/hour

$\frac{234}{3600} = \frac{11.7}{180}$

(c) Average interval between arrival = $\frac{1}{ƛ} = \frac{1}{11/180} = \frac{180}{11}$ = 16.40 seconds

(d) Average interval between service rate = $\frac{1}{\mu} = \frac{1}{11.7/180} = \frac{180}{11.7}$ = 15.39 seconds.

(e) Average queue length = $\frac{ƛ^2}{\mu(\mu-ƛ)} = \frac{(\frac{11}{180}^2)}{\frac{11.7}{180}(\frac{11.7}{180}-\frac{11}{180})} = \frac{0.0037}{0.065\ (0.065-0.061)}$

$= \frac{0.0037}{0.065\ (0.004)} = \frac{0.0037}{0.00026} = 14.23$ people

(f) Average waiting time in the queue = $\frac{ƛ}{\mu(\mu-ƛ)} = \frac{(\frac{11}{180})}{\frac{11.7}{180}(\frac{11.7}{180}-\frac{11}{180})} = \frac{(0.0611)}{0.065(0.065-0.061)}$

$= \frac{0.0611}{0.00026} = 235$ seconds $= \frac{235}{60} = 3.92$ minutes

(g) Average time spent in the system = $\frac{1}{(\mu-ƛ)} = \frac{1}{(\frac{11.7}{180}-\frac{11}{180})} = \frac{1}{0.004}$

Average waiting time at the bus top = $\frac{250}{60}$ seconds = 4.17 minutes

4.6. Revenue

The data on revenue is carried out to analyse how much an average driver makes, and expected income by the operators make after carrying out maintenance, fuelling, and other administrative charges incurred in the operation of the transportation shuttles. To achieve this, 6 drivers were selected at random and the average amount they generated for 5 weeks are given in table 8.

Table 8. *Average Amount Generated Per Week (₦).*

Average Amount Generated per Week (₦)					
Driver	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**
A	5350	7480	4800	5900	4500
B	6800	5800	7900	4100	3600
C	7800	3800	4860	5220	5000
D	3200	7000	4100	3200	5000
E	5420	3680	5000	4625	6500
F	6000	5200	2800	4900	3980
Total	34,570	32,960	29,460	27,945	31,680

Average amount generated per month (A) = $\frac{₦(34570+32960+29460+27945+31680)}{5}$ = ₦ 31,323

Average amount expended on maintenance (M) = 58% of average amount generated (A)

Estimate of 58% of cost is spent on maintenance (M) = 0.58 * ₦31,323 = ₦18,167.54

Average amount of Fuel (F) = ₦13,000

Amount paid for administrative and union charges (S) = ₦2,000

The financial condition of the transit unit is obtained from the formula below:

If A > M + F + S = the transit unit is making a profit

If A < M + F + S = the transit unit is in deficit

M + F + S = ₦ (18167+13000+2000) = ₦ 33,167

A (₦31,323) < (M + F + S) ₦ 33,167

Since the Amount generated is less than the Amount expended, this means in effect that the shuttle bus operators are operating in deficit. This is called transit deficit. If all the lapses and shortcomings are corrected, the efficiency and performance of the shuttle buses will increase. This will increase the amount of money generated by drivers (as the maintenance costs will reduce drastically), revenue to government and bring about institutional transportation ease.

4.7. Quantitatively for the Traveling Speed

Design speed of the road = 75km/hr

$$\text{Speed} = \frac{Distance}{Time}$$

Distance from Ado Ekiti to Campus = 15km

Average travelling speed on the road = 50km/hr (Speed limits for buses from Highway Code)

Journey time = $\frac{15\ km}{50\ km/hr}$ = 0.25 hours = 0.25*60minutes (Min.) to 0.30*60 minutes (Max.)

Journey time = between 15 minutes to 18 minutes

Percentage increase in journey time = $\frac{34.01-18.00}{5}$ * 100 = 107%

This means that the bad road has caused the journey time along the road to increase by 107%.

A sub experiment done at the Campus bus stop on the Toyota Hiace bus to determine the time taken to rush into a bus and the time taken using the first come, first serve system is as shown below.

T_0 = Average boarding time per passenger * Number of passengers

Average boarding time per passenger = 20 seconds

Number of passengers boarding = 18

T_0 = 20*18 = 360 seconds = 6 minutes

Time taken while rushing to board the bus at peak hours= 6+2 minutes = 8 minutes

Percentage increase in boarding time = $\frac{8-6}{6}$ * 100 = 33.3% increase in boarding time.

5. Conclusion

Findings from the study revealed that the morning peak period was between the hours of 8.00am to 9.00 am with 234 vehicles/hr, the evening peak period is from 2.00 pm to 3.00 pm with 284 vehicles/hr while the off-peak period is from 11.00am to 12.00pm with 156 vehicles/hr. The journey time from the Post Office bus stop to the University campus gotten as 34.01 minutes was too long for the distance of 15.0km road. The condition of the road does not allow motorists to exceed a speed limit of 50km/hr. Also, the average stopping time of 6.55 minutes is too long and does not allow for an efficient transport system as this will make the roads level of service to be of class E. Average interval between arrivals of motorists was found to be 16.40 seconds, the average interval between service rates was 15.39 seconds, the average queue length was 14.23 people, the average waiting time in the queue 0.92 minutes while the average waiting time at the bus top 4.17 minutes. These values were obtained using the queuing theory and it goes to show so much commuters time is lost on transit queues. The financial condition of the transit unit shows that amount generated (A) (₦31,323 is less than the amount expended by the transit operators (M + F + S) ₦ 33,167. This means in effect that the shuttle bus operators are operating in deficit.

Recommendation

Based on the above, the study made the following recommendations: Introduction of a single left turn lane at housing and NOVA junctions which are 4 leg cross intersections as shown in Figure 3 as this will reduce the area of conflict, separate turning vehicles from the through stream, removes slow or decelerating vehicles from through traffic, increase the capacity of the approach by adding an additional approach lane; allow for a wider variety of phasing options thereby increasing safety and reducing journey time on the road. Measures should be put in place to ensure students maintain a coordinated queue at the bus stop and boarding of bus should be on a first come, first serve basis and mandatory tests should be conducted on the drivers to ascertain their mental and physical ability for the job.

Introduction of a strict bus schedule to ensure commuters are not delayed at the bus stops more than necessary with specific bus stop along the route to avoid frequent stops by drivers and ensure the transit shuttle ply the slow moving lane while filled up buses can ply the fast moving lane. The University authority should revive the transit unit in the University to complement the action of the private drivers. Rehabilitation and expansion works on the road pavement along the study route should be given maximum attention.

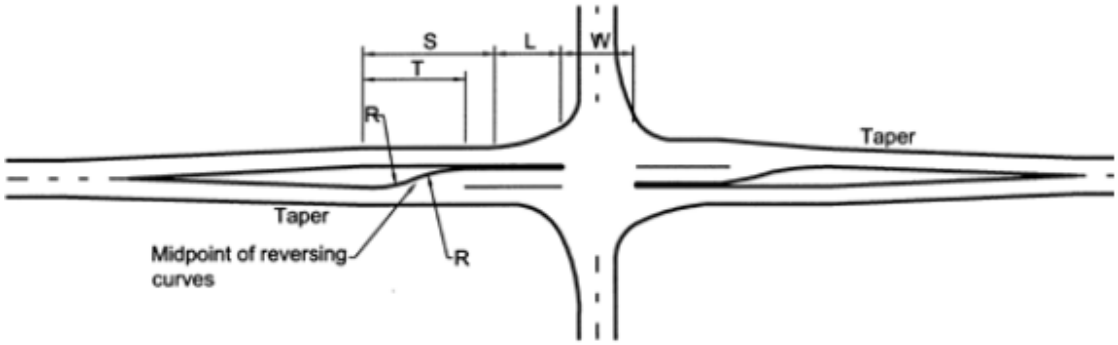

Figure 3. *Diagram of a single left-turn lane.*

Source: FHWA-HRT (2004)
Where: L= Storage length
R = Radius of reversing curve
S = Stopping sight distance for a speed of (0.7)(design speed of highway)
T = Tangent distance required to accommodate reversing curve
W = Minimum distance of 12 m (40 ft)

References

[1] Aderamo, A. J (2012). Urban transportation problems and challenges in Nigeria: A planner's view. *Prime Journals*. 2(3), 198-203.

[2] Sumaila, A. G (2012). *Sustainable Transportation Management for Federal Capital Territory, (FCT)*. Paper Presented at a One-Day Retreat for Staff of FCT Transportation Secretariat, Abuja. 4th August, 2012.

[3] Ogunleye, O. S (2014). Urban Mobility in Ekiti State: Options for Transformation. *American International Journal of Social Science.* 3(5), 200-206.

[4] Bolade, A. T (1993). *The Urban Transport and Related Operations the Journey so far*. A Paper presented at a Management Training Course on Urban Mass Transit Operations Council. Chamber of the Nigeria Institute of Bankers, Lagos October, 22-23.

[5] Gwilliam, K. M. (2011). Urban Transport: Struggling with Growth Africa's Transport Infrastructure, World Bank, Washington, D. C.

[6] Ogunbodede, E. F (2006). *Application of GIS to the Management of Traffic Congestions in Akure, Ondo state, Nigeria*. PGD Project submitted to RECTAS, Obafemi Awolowo University, Ile-Ife, Nigeria.

[7] Ikya, S. G. (1993). The Urban Transportation Problems in Nigeria", in Ikya, S. G. (ed.), Urban Passenger Transportation in Nigeria, Heinemann, Ibadan, pp. 3-27.

[8] Owoputi, A. E (2016). The Impact of Road Development and Expansion on Urban Cities. A Case Study Of Akure Metropolis. *World Wide Journal of Multidisciplinary Research and Development.* 2(6), 46-48.

[9] Nigeria Highway Code (2017). http://www.highwaycode.com.ng/ix-speed-limits-on-different-roads-and-for-different-vehicles.html. Retrieved on 17th May, 2017.

[10] FHWA-HRT (2004). Signalized Intersections: Informational Guide - Individual Movement Treatments **(**FHWA-HRT-04-091). https://www.fhwa.dot.gov/publications/research/safety/04091/12.cfm