

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****ASSESSMENT OF BUS STOPS AND ITS EFFECTS ON MAJOR ROADS IN
IBADAN METROPOLIS, OYO STATE, SOUTHWEST NIGERIA****Fatunmibi O**

Department of Surveying and Geoinformatics, The Polytechnic Ibadan, Nigeria

DOI: 10.5281/zenodo.1336654

ABSTRACT

Bus stops play an important role as it serves as the transit service points of contact between the passenger and the bus. This study aimed at mapping bus stops locations and showing the effects on major roads in Ibadan. Google earth satellite imagery was used to determine the spatial location of various major bus stops within Ibadan metropolis. Nineteen nine (99) bus stops were determined through the Google earth satellite imagery. Secondly, Oral interview based on the effects of bus stops on the major roads. Further analysis was done using ArcGIS 10.2.1 software application package and frequency distribution tables and simple percentage technique was used in analyzing data collected in the field. Structured questionnaires administered to a sample of 220 respondents which was randomly selected from the each local government area that makes up the metropolis making up a total of 220 respondents. 180 were returned out of 220. The Questionnaire was administered based on the data elicited from the respondents were analyzed through non-parametric method of Chi-square. Three (3) research hypotheses consisting of three (3) questions were formulated for this study which was all rejected; showing that school locations had significant effects on students/pupils, parents, and teachers. From the road map of Oyo state, the road map of Ibadan was extracted by digitization process using ArcGIS 10.2.1 software. Composite map showing the general distribution of various bus stop were generated. The results showed the scattered position of the major bus stops at various locations. Generally from the results of this study, it can be concluded that, regulatory body should be put in place by the government for proper location of new bus stops by the government and also relocation of some that are not properly maintained by the users.

Keywords: Passenger, major roads, Google Earth satellite imagery, Interview, Hypotheses, Chi-square.**I. INTRODUCTION**

Bus-stop is an integral component of the transport infrastructure; it plays a crucial role in the management of traffic and congestion (Allison, 2002). Bus stop design and location is recognised as a crucial element in the drive to improve the quality of bus services and public transport in general. The concept of 'Total Journey Quality' recognises that bus passengers are also pedestrians at each end of the bus trip and requires that all aspects of the journey are considered. The convenience and comfort of bus stops must not be overlooked (Bus priority team, 2006). However, illegal parking and abandoned motors at bus stops (Rodrigo and Tyler, 2004) as well as the un-spacious nature of bus-stops in Nigeria are the challenges that make the usage of bus stops ineffective and this hinders the flow of traffic along them. These challenges are more prevalent within the city of Lagos (Olaogbebikan, kpechukwu, Akinsulire and Okoko, 2013).

In planning for the provision of bus-based transit service, accessing a bus stop is considered to be achieved mainly by walking. Based on an assumed average walking speed of about 1.3 m/s, 5 minutes of walking is considered reasonable in urban areas, which is about 400meters in terms of walking distance (Levinson 1992). Most transit firms consider 400meters an acceptable access/egress standard (Ammons 2001). Salvo and Sabatini (2005) suggested a more spatial approach for identifying optimal stop locations. Bus stop access coverage is a critical measure for evaluating the stop location by estimating the covered area and population lying within a suitable access distance from the bus stop (Foda and Osman 2008). This means that proximity to stops must be interpreted creatively, which is possible using the powerful GIS network analysis functions (Foda and Osman 2006). The implementation of bus lane schemes and traffic signal priority are the most used solutions on this field (Waterson *et al.*, 2003; Jepson and Ferreira, 1999; Hounsell and McDonald, 1988). The appearance of illegality implies the reduction of the commercial speed and an increase of the congestion making an inefficient use of the infrastructure (according to Willeke, 1984). In order to calculate the travel time effects, the key point

is to evaluate the volume of illegal parking, the total amount of flow as well as the location of it. This calculation will allow to study strategic measures to reduce and mitigate the negative impact that local administrations can implement (as suggested by J.Wang, F.Chien, 2012 and A.Albiol *et al.*, 2015)

Indiscriminate boarding and alighting of passengers, along different routes causes traffic congestions; thereby causing monumental man-hour and economic losses and increased accident risks (Ogunleye, 2004, Adeniyi 1977). Among the component or factors that needed to be considered for proper implementation of public transport system are bus stops or bus stations (Olowosegun and Okoko, 2012). The use of spatial optimization and optimal location of bus stations can support strategic planning by selecting new service/bus stops that provide access to areas currently without sufficient access (Matisziw *et al.* 2006). Scholars have blamed urban traffic situation on the high incidence of auto ownership driver's behavior, road capacity and poor land use planning among others (Ogunsanya, 1993). Optimal locations of stops will be affected by users' value of time, access speed and demand (Chien and Yang 2000). Bowerman *et al* (1994) addressed an improved method that grouped the road nodes into clusters as potential stop locations and then allocated the students in clusters which can be serviced by a single bus route generated consequently (Bowenman, *et al*, 1994). Transportation is defined as the means of movement of persons, goods and services from one point to another. It is however not necessarily the movement of vehicles. Transport on the other hand refers to the link between activity spaces (Obiero, 1992) Urban transport system is also viewed as the system that provides for movement of people and commodities within an urban area and also links the city to its environs (Aligula *et al*, 2005).

Silva (2001) studied this problem using microscopic traffic simulation model (SIGSIM, Silcock and Crosta (1995) as a tool to help us understand the dynamics of the interactions between buses and traffic 36 at bus stops. Different bus stop layouts can be expected to cause different delays in traffic, both for buses and other vehicles. Reddy *et al.* (2008) studied the effect of on-street parked vehicle on traffic mobility in urban area and found that parking facility with a width of 2.5 m and a length of 30 to 40 m, would reduce speed by 10 to 12 percent in case of motor cycles, autos and cars, and 12 to 15 percent in case of heavy vehicles. Guo *et al.* (2012) developed a cellular automata model to evaluate the interaction between the on-street parking maneuvers and traffic flow Chin *et al.* (2002) studied the effect of various factors such as work zones, crashes, breakdowns, weather and traffic controls on capacity and delay of principal arterials in USA. Haijun *et al.* (2011) considered temporary bottleneck created by accident and proposed a new two-lane traffic model based on the KKW (Kerner-Klenov-Wolf) model. Koshy and Arasan (2005) developed a microscopic simulation model to analyze the influence of bus stops on heterogeneous traffic flow with great attention to reduction in traffic stream speed.

Reddy *et al.* (2008) opined that under moderate to heavy traffic conditions, on-street bus stops can cause substantial delay to vehicular traffic on urban roads. They observed that free flow speed of various vehicles on a stretch with bus stops is about 30 percent less than that on stretch without bus stops on all working days. Tang *et al.* (2009) observed that bus density and the arrival rate of passengers are important factors contributing to the traffic interruption probability resulted by bus stop. Nurdin (2012) concluded that dwell time has a big impact toward the capacity of a bus stop. He noted that when the dwell time is long, few vehicles can be served and vice versa. Therefore, this study aimed at assessing the spatial location of bus stops and their effects on major roads in Ibadan metropolis.

The major causes of improper use of bus stops along the major routes

The major causes of improper use of bus stops along the major roads include-

- i. Inadequate enforcement of rules and regulations by the Government
- ii. Road reserve encroachment by the bus/cab drivers
- iii. Taut/bad drivers
- iv. When there are too many vehicles on the road
- v. When there is no set back between the land use the major roads

II. STUDY AREA

The study area is Ibadan metropolis and is one of the largest cities in tropical Africa and is the capital of Oyo State in Nigeria. It was founded in 1829. It located between geographical longitude 7°2'E and 7°40'E and latitude. 3°35'N and 4°10'N. It is 128 km northeast of Lagos and 345 km southwest of Abuja, the federal capital, Nigeria. It consists of Eleven (11) Local Government Areas grouped together to what is called the Ibadan metropolitan or Ibadan land with six (6) in the outer areas and five (5) in the inner city as shown in (Fig 1). It

has the overall population density of 586 persons per km². The 2006 census show the population of about 2.6 million.

Figure 1:



Digitized map of the study area
Source: (Authors compile)

III. MATERIALS AND METHODS

Material used

Software

1. Google earth imagery 2018 (for extraction of spatial location of schools)
2. ArcGIS 10.2.1 (Arcmap 10.2.1) application software package (for digitizing and graphics production)
3. Microsoft Excel spreadsheet (for data storage)
4. Microsoft word office 2013 (for typing)

Hardware

1. Laptop computer (Hp version for processing)
2. 16 giga-byte hard drive (data storage)
3. Hp Laserjet Printer (for document printing and correction/proof-reading)

Methods

Identification and mapping out of the spatial location/distribution of various major bus stops in Ibadan was carried out in this study. The location of each bus stop was obtained using the Google earth imagery 2018. Google earth satellite imagery was used to determine the spatial location (x, y) coordinates of various bus stop locations. Attributes such as name, Address/Location of the various bus stop were copied and stored in Microsoft excel worksheet. Ninety nine (99) bus stops were determined. Other information was derived from the oral interview and structured questionnaire based on the effects of bus stops on the major roads. Road map of Ibadan was extracted from the road map of Oyo State and lay over the (x, y) data acquired to show the exact position of various major bus stop using ArcGIS 10.2.1 software application package.

Research Questions

During the survey conduct the following question were thrown to the respondent;

- a) At what points along the major road are used in picking or dropping of passengers?
- b) What are the attitudes of drivers at the designated and undesignated bus stops?
- c) What are the major effects of the random stopping along the major roads?
- d) What are some of the suitable solutions to the problem of traffic jams caused by packed vehicle while at bus stops?
- e) What are some of the suitable solutions to the problem of traffic jams caused by packed vehicle while at bus stops?

Research objectives for the study

- a. To identify the major points along the road that is used to either drop or pick passengers both designated and undesignated.
- b. To identify the behavior of drivers at the bus stops (both designated and undesignated)
- c. To identify some of the effects of the random stopping along the major roads.
- d. To propose solutions to the problem of traffic jams caused by buses while at a bus stop

Research Hypotheses for the study

Hypotheses formulated to guide this study are the following;

1. Bus Stop Location has no significant effect on traffic congestion

H₁: Improper Bus stop location along the major road will cause delay in proper movement of both private and commercial vehicle

H₂: Improper Bus stops location along the major road due to congestion lead to lateness to work

H₃: Improper Bus stop location along the major road due to traffic congestion leads to stress to some private car owner

2. Bus Stop Location has no significant effect on Constant stoppage of Vehicles

H₁: Improper location of bus stops leads to delay in getting to ones destination on time

H₂: Improper location of bus stops leads to queue of both private and commercial vehicles along the road

H₃: Improper location of bus stops and stoppage along the road leads to havoc and loss of life in case of emergency situation

3. Location of schools has no significant effect on Drivers Behavior.

H₁: Improper location of bus stops makes many drivers to misbehave along the major roads

H₂: Improper location of bus stops brings about many taut drivers within the society

H₃: Improper location of bus stops leads to extortion from both private and commercial vehicles by some rogue

Research Design

The instrument used in this study was structured questionnaire, which contains variables to show the response on major bus stop location and its effect on traffic congestion, Constant stoppage, and driver behavior within Ibadan. A Simple random sampling technique was used in selecting 180 samples out of 220 questionnaires from the respondents. The questionnaire was developed using the likert scale of Strongly Agreed (SA), Agreed (A), Strongly Disagreed (SD), and Disagreed (D). Frequency distribution tables and simple percentage technique was used in analyzing data collected in the field. Chi-square (X^2) statistical tool was used in testing the hypotheses so as to achieve the objectives of the study. Below is the formula used.

$$X^2 = \frac{\sum (O-E)^2}{E}$$

Where;

X^2 = chi-square

Σ = Summation/total sum

O = observed frequency

E = expected frequency

Data Analysis

Data analysis was done using non-parametric method of chi-square (χ^2) in order to test for the effects of bus stops on major roads, on traffic congestion, constant stoppage and drivers' behavior.

The degree of freedom (df) or critical value were calculated as follows

Df = (R-1) (C-1). Where R = number of rows = 5

C = number of column = 2

= (3-1) (2-1)

= 2 x 1 = 2

Df = 2

95% level of confidence and 5% level of significance were used in this study. Therefore, the degree of freedom (df) at 2 = 5.99 which is approximately equal to 5.99.

Expected frequency (E) = $\frac{\text{Total Number of respondents}}{\text{No of responses option}}$

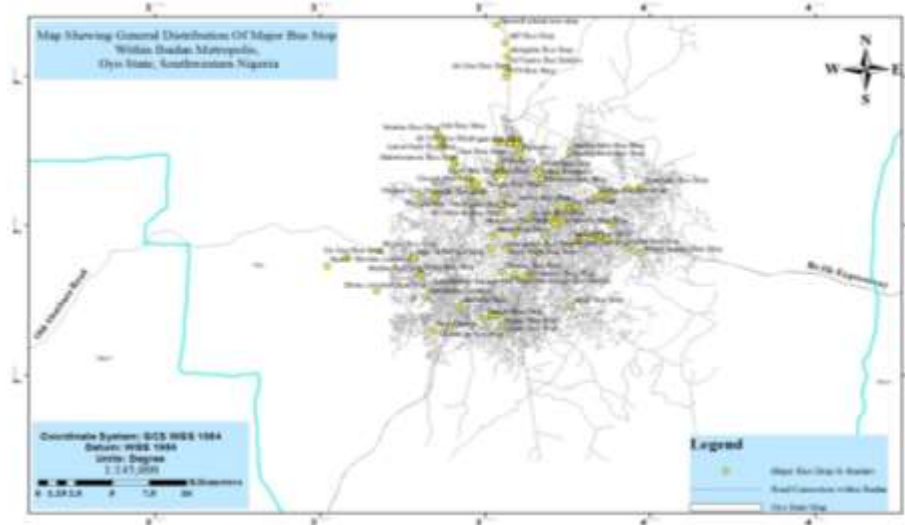
= $\frac{180}{3}$

= 60

IV. RESULTS AND DISCUSSION

The figure, charts and tables Presented in this study are as a result of data acquired on various major bus stop location and their effects. Figure 2 showed the composite map of the general distribution of the major bus stop in Ibadan metropolis. Table 1-3 (a & b) presents the frequency and statistical data/results for the study.

Figure 2:



Composite Map showing the General Distribution of Major Roads In Ibadan

The results showed that in major road such as all bus stops location along Lagos Ibadan Expressway road, Ojoo to University of Ibadan route, Sango to Eleyele route, Mokola to Dugbe/Agodi gate road, Iwo road to Ife road, Iwo road to Iwo route, University of Ibadan to Bodija market route and some other major area under studied. It can be concluded that in all the aforementioned route, bus stop location are not properly established as the drivers uses the edge of the road as their packing space.

Traffic congestion

Location Bus Stops has no significant effect on traffic congestion

Table 1a: Chi-square analysis showing the effect of improper bus stops location on traffic congestion

Variables	SA %	A %	S D %	D %	Row Total
Improper Bus stop location along the major road will cause delay in proper movement of both private and commercial vehicle	95 52.8%	48 26.7%	15 8.3%	22 12.2%	180
Improper Bus stops location along the major road due to congestion lead to lateness to work	91 50.6%	52 28.9%	20 11.1%	17 9.4%	180
Improper Bus stop location along the major road due to traffic congestion leads to stress to some private car owner	86 47.8%	54 30%	18 10%	22 12.2%	180
Column Total	272	154	53	61	540

Sources: Author field work, 2018

Table 1b: Result of the Hypotheses of Bus stops of improper bus stop location on Traffic Congestion

Hypotheses	Options (O)	Exp. Freq. (E)	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$	$(\chi^2) \frac{\sum(O-E)^2}{E}$	Df	Critical value	Remarks
H ₀ 1	95	60	35	1225	20.42	80.64	2	5.99	HO ₁ Rejected
	48	60	-12	144	2.4				
	15	60	-45	2025	33.75				
	22	60	-38	1444	24.07				
Total					80.64				
H ₀ 2	91	60	31	961	16.02	74.58	2	5.99	HO ₁ Rejected
	52	60	-8	64	1.07				
	20	60	-40	1600	26.67				

Total	17	60	-43	1849	30.82				
					74.58				
H ₀ 3	86	60	26	676	11.27	65.34	2	5.99	H ₀ ₁ Rejected
	54	60	-6	36	0.60				
	18	60	-42	1764	29.40				
	22	60	-38	1444	24.07				
Total					65.34				

Sources: Author computation

From table 1(a & b), the calculated chi-square (χ^2) values are; 80.64, 74.58, 65.34 for hypotheses 1,2,3 respectively on environment which indicate a degree of freedom of 2, and calculated chi-square (χ^2) value of 80.64, 74.58, 65.34 is greater than the critical value of 5.99. Since the calculated χ^2 value of 80.64, 74.58, 65.34 was greater than the table value of 5.99 thus, the null hypothesis 1 was rejected. This shows that traffic congestion had significant effect on improper Bus stop location within Ibadan metropolis.

Constant stoppage of vehicles

Location Bus stop has no significant constant stoppage of vehicles

Table 2a: Chi-square analysis showing the effect of improper bus stop location on constant stoppage of vehicles

Variables	SA %	A %	S D %	D %	Row Total
Improper location of bus stops leads to delay in getting to ones destination on time	85 47.2%	57 31.7%	23 12.8%	15 8.3%	180
Improper location of bus stops leads to queue of both private and commercial vehicles along the road	96 53.3%	44 24.4%	24 13.3%	16 8.9%	180
Improper Bus stop location along the major road due to traffic congestion leads to stress to some private car owner	102 56.7%	48 26.7%	14 7.8%	16 8.9%	180
Column Total	283	149	61	47	540

Sources: Author field work, 2018

Table 2b: Result of the Hypotheses of constant stoppage of vehicles on improper bus stop location

Hypotheses	Options (O)	Exp. Freq. (E)	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$	$\frac{\sum(O-E)^2}{E}$	Df	Critical value	Remarks
H ₀ 1	85	60	25	625	10.42	67.14	2	5.99	H ₀ ₁ Rejected
	57	60	-3	9	0.15				
	23	60	-37	1369	22.82				
	15	60	-45	2025	33.75				
Total					67.14				
H ₀ 2	96	60	36	1296	21.60	83.72	2	5.99	H ₀ ₁ Rejected
	44	60	-16	256	4.27				
	24	60	-36	1296	21.60				
	16	60	-43	1849	36.25				
Total					83.72				
H ₀ 3	102	60	42	1764	29.40	99.34	2	5.99	H ₀ ₁ Rejected
	48	60	-12	144	2.4				
	14	60	-46	2116	35.27				
	16	60	-44	1936	32.27				
Total					99.34				

Sources: Author computation

From table 2 (a & b), the calculated chi-square (χ^2) values are; 67.14, 83.72, 99.34 for hypotheses 1,2,3 respectively on peoples health which indicates a degree of freedom of 2, and calculated chi-square (χ^2) value of 67.14, 83.72, 99.34, is greater than the critical value of 5.99. Since the calculated χ^2 value of 67.14, 83.72, 99.34 was greater than the table value of 5.99 thus, the null hypothesis 2 was rejected. The shows that school locations had significant effect on the parents in all the eleven Local Government Area within the metropolis.

Drivers' behavior

Location of Bus Stops has no significant effect on drivers' behavior

Table 3a: Chi-square analysis showing the effect of improper Bus stop location on drivers behavior

Variables	SA %	A %	S D %	D %	Row Total
Improper location of bus stops makes many drivers to misbehave along the major roads	92 51.1%	67 37.2%	6 3.3%	15 8.3%	180
Improper location of bus stops brings about many taut drivers within the society	79 43.9%	65 36.1%	22 12.2%	14 7.8%	180
Improper location of bus stops leads to extortion from both private and commercial vehicles by some rogue	87 48.3%	68 37.8%	7 3.9%	18 10%	180
Column Total	258	200	35	47	540

Sources: Author field work, 2018

Table 3b: Result of the Hypotheses of drivers' behavior on improper bus stop location

Hypotheses	Options (O)	Exp. Freq. (E)	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$	$(\chi^2) \frac{\sum(O-E)^2}{E}$	Df	Critical value	Remarks
Ho 1	92	60	32	1024	17.07	100.24	2	5.99	HO ₁ Rejected
	67	60	7	49	0.82				
	6	60	-54	2916	48.60				
	15	60	-45	2025	33.75				
Total					100.24				
Ho 2	79	60	19	361	6.02	65.78	2	5.99	HO ₁ Rejected
	65	60	5	25	0.42				
	22	60	-38	1444	24.07				
	14	60	-46	2116	35.27				
Total					65.78				
Ho 3	87	60	27	729	12.15	89.44	2	5.99	HO ₁ Rejected
	68	60	8	64	1.07				
	7	60	-53	2809	46.82				
	18	60	-42	1764	29.40				
Total					89.44				

Sources: Author computation

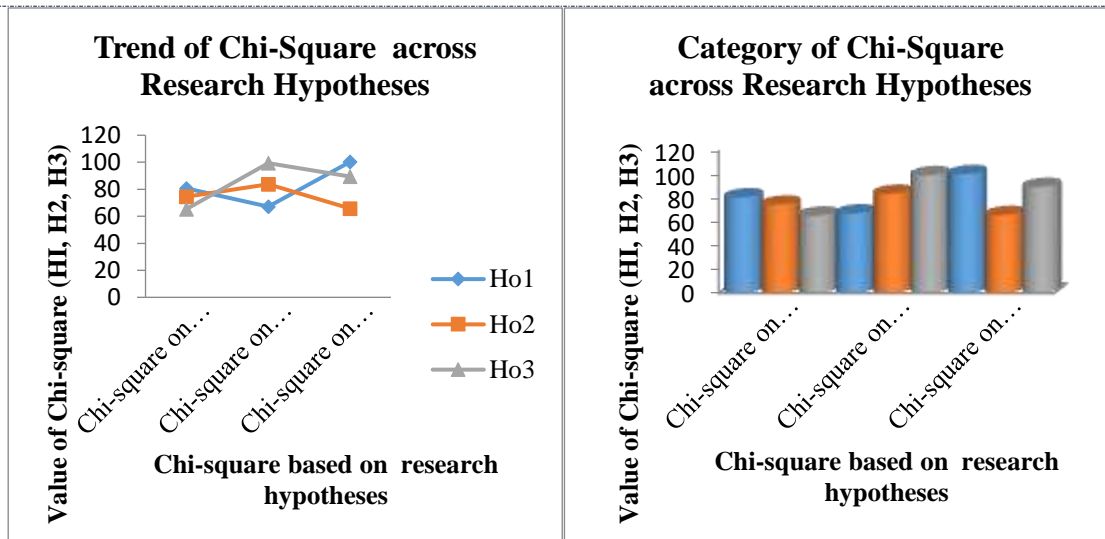


Chart 1: Trend and Categorical based of Chi-square results on research hypotheses

From table 3 (a & b), the calculated chi-square (x^2) values are; 100.24, 65.78, 89.44 for hypotheses 1, 2, 3 respectively indicates a degree of freedom of 12 and shows that the calculated Chi-square (x^2) value of 100.24, 65.78, 89.44 is greater than the critical value of 5.99. Since the calculated (x)² value of 100.24, 65.78, 89.44 is greater than the table value of 5.99 thus the null hypothesis 3 was rejected. This shows that improper bus stop locations had significant effect on drivers' behavior within Ibadan metropolis.

V. CONCLUSION

Bus stop locations within Ibadan metropolis were mapped out and the significant effects on major roads in Ibadan. The effects showed negatively impact based on the research hypotheses of the study. From the findings of this study, it was observed that Bus stop location had several effects on traffic congestion, constant stoppage of vehicles and drivers' behavior. Improper bus stop location along the major road in Ibadan poses serious effects on the selected research hypotheses. Improper location of bus stop cause delay in proper movement of both private and commercial vehicle, lateness to work, delay in getting to ones destination on time, stress to some private car owner, makes many drivers to misbehave along the major roads, brings about many taut drivers within the society, leads to extortion from both private and commercial vehicles by some rogue could be described as the effects of improper location of bus stops within study area. Government should look into the establishment of bus stop location especially along the major road of Ibadan and relocation of the ones that are not properly established.

VI. LIKELY SOLUTION/RECOMMENDATION

The following recommendations were made by the author;

- i. Government should enforce law guiding bus stop locations be it on major or minor roads
- ii. The body controlling bus stop the NURTW AND RTEAN should make sure that all commercial drivers be educated and enlightened on the use of bus stop within their domain
- iii. There should be proper management of all bus stop by the authority controlling available bus stops
- iv. Bus stop should be cited/established not close to the road that there should be set back to the major roads
- v. Government should relocate bus stops that are not properly established within the metropolis
- vi. If a transit stop or route needs to be relocated, appropriate signage and advance notification to passengers must be provided.
- vii. In case of improper location of bus stops along the major roads, government should design proper place for them
- viii. For new bus stops that might likely be established, there should be proper monitoring

REFERENCES

- [1] Allison, N. (2002). Accessibility and the bus system: from concepts to practice. Thomas Telford, London. Pp.41-50.
- [2] Bus Priority Team,(2006), Accessible bus stop design guidance, Bus Priority Team technical advice note BP1/06,Transport for London, pp2-10.
- [3] Rodrigo, B.M., & Nick, W.L. (2004). Simulation modelling and analysis. An analytic investigation of optimal bus size. *Transportation Research*, 22B, 319- 337 (1988)
- [4] Olaogbebikan, J. E., I kpechukwu N., Akinsulire E. S. and Okoko, E., (2013). Traffic Management Problems in Lagos: A Focus on Alaba International Market Road, Ojo, Lagos State Nigeria. *Journal of Economics and Sustainable Development*. (4)4. 2013. Pp. 144-154 (Online). www.iiste.org ISSN 2222-1700 (Paper) ISSN 2222-2855
- [5] Levinson, H. S. 1992. Urban mass transit systems. In Edwards, J. D. (ed.), *Transportation Planning Handbook*. Prentice Hall, New Jersey.
- [6] Ammons, D. N. 2001. *Municipal Benchmarks: Assessing Local Performance and Establishing Community Standards*, Second Edition. Sage, Thousand Oaks, CA.
- [7] Salvo, G., and Sabatini, S. 2005. A GIS approach to evaluate bus stop accessibility. *Proceedings of the 16th Mini-Euro conference and 10th meeting of EWGT*, Poznan.
- [8] Foda, M. A., and Osman, A. O. 2006. GIS tools to analyze the public bus transit service network, case study: The City of Alexandria. *16th International Conference on Computer Theory and Applications (ICCTA)*, Alexandria, Egypt, 5-7 September 2006.
- [9] Foda, M. A., and Osman, A. O. 2008. A GIS approach to study the bus transit network accessibility, case study: The City of Alexandria. *Journal of Arab Academy for Science, Technology and Maritime Transport* 34(65): 32-39.
- [10] Waterson, B., Rajbhandary, B. and Hounsell, N. (2003) - Simulating the Impacts of Strong Bus Priority Measures. *Journal of Transportation Engineering*, November/December, 642-647.
- [11] Jepson, D. and Ferreira, L. (1999) – Assessing Travel Time Impacts of Measures to Enhance Bus Operations. Part 1: Past Evidence and Study Methodology. *Road and Transport Research Journal* 8(4), 41-54.
- [12] Hounsell, N. and McDonald, M. (1988) – Evaluation of bus lanes, TRRL Laboratory Report 87. Transport and Road Research Laboratory, Crowthorne.
- [13] Willeke, R. (1984) *Soziale Kosten und Nutzen der Siedlungsballung und des Ballungsverkehrs*. Frankfurt.
- [14] J. Wang, F. Chen, (2012). Multi-Vehicle Tracking Based Traffic Illegal Parking Detection, *Advanced Materials Research*, Vols. 532-533, pp. 540-545
- [15] A.Albiol et al. (2015). Detection of Parked Vehicles using spatio-temporal maps. Valencia
- [16] Ogunleye J. S (2004) “Intra Urban Pattern And Acceptability of Bus Station in Ilorin, Nigeria” In Akindele O. A, Ogunleye J. S and Muili A. B. *Global Journal of Arts, Humanities and Social Sciences* 2014. Vol.2,No.8, pp.65-79, October 2014
- [17] Adeniyi (1977) “Intra Urban Pattern And Acceptability of Bus Station in Ilorin, Nigeria” In Akindele O. A, Ogunleye J. S and Muili A. B. *Global Journal of Arts, Humanities and Social Sciences* 2014. Vol.2,No.8, pp.65-79, October 2014
- [18] Olowosegun, A. and Okoko, E. (2012) Analysis of Bus-stops locations using Geographic Information System in Ibadan North L.G.A. Nigeria. *Industrial Engineering Letters*, 2, 28-37. Accessed online February, 2014. <http://www.iiste.org/Journals/index.php/IEL/article/viewFile/1620/1573>.
- [19] Matisziw T. C, Murray A. T and Changjoo K (2006). Discrete Optimization Strategic Route Extension in Transit Networks. *European Journal of Operational Research* 171 p661-673
- [20] Chien Steven and Yang Z (2000) Optimal Feeder Bus Routes with Irregular Street Networks. *Journal of Advanced Transportation*. Vol 34 No 2 pp 213-248.
- [21] Bowerman Robert L, Paul H Calamal, Hall Brent G (1994) the Spacefilling Curve with Optimal Partitioning Heuristic for the Vehicle Routing Problem. *European Journal of Operational Research* Vol 76 No 1 pp 128.
- [22] Obiero S. (1992), *Public Transport and The Peak Hour in Nairobi*, unpublished PhD Thesis, University of Wales, Cardiff.
- [23] Aligula E, Abiero Z, Mutua J, Owegi F, Osengo C. and Olela R. (2005) *Urban Public Transport Patterns in Kenya: A Case Study of Nairobi, KIPPRA, Nairobi, Kenya*
- [24] Silva, P.C.M. “Modelling interactions between bus operations and traffic flow”. PhD Thesis, University of London, 2001

- [25] SIGSIM, Silcock and Crosta (1995). SCOOT control of a simulated road network'. 4th International Conference on Application of Advanced Technologies in Transportation Engineering Capril.
- [26] Reddy R, Rao S., Rao CR (2008) Modelling and Evaluation Patterns on the Impact of On-street Parking in Reference to Traffic Mobility. J Indian Roads Congr 69:101–109.
- [27] Hongwei Guo, Wuhong Wang, and Weiwei Guo (2012) "Micro-simulation study on the effect of on-street parking on vehicular flow (2012). 15th International IEEE Conference on Intelligent Transportation Systems (ITSC DOI: 10.1109/ITSC.2012.6338713.
- [28] Ogunsanya A. A (1993); 'Directions in Urban Transport Studies in Nigeria' in Ikya S. G (ed), Urban Passenger Transportation in Nigeria. Heinemann Educational Books
- [29] Chien, I-Jy., Ding, Y. & Wei, C. (2002), Dynamic bus arrival time prediction with artificial neural networks, Journal of Transportation Engineering, ASCE, 128(5), 429– 38.
- [30] Reebu Zachariah Koshy, V. Thamizh Arasan (2005) "Influence of Bus Stops on Flow Characteristics of Mixed Traffic. Journal of Transportation Engineering 131(8). DOI: 10.1061/(ASCE)0733-947X(2005)131:8(640)
- [31] Tie-Qiao Tang, Yan LI and Hai-Jun Huang (2009) "The Effects Of Bus Stop On Traffic Flow". International Journal of Modern Physics C Vol. 20, No. 6 (2009) 941–952
- [32] Nurdin K. Mushule (2012), Bus Bay performance and its influence on the capacity of road network in Dar-es-Salaam. Dar-es-salaam, Tanzania

Appendix

Name of Bus Stop	Latitude	Longitude	Address/Location
7up Bus Stop	7.412	3.95	Ibadan, Nigeria
Abayomi Bus Stop	7.403	3.94	Iwo Road Ibadan Nigeria
ABC Transport Bus Stop	7.394	3.967	New Ife Road Ibadan Nigeria
Abebridge Iwo Road Bus Station	7.404	3.943	Basorun Akobo Road, Ibadan Nigeria
Academy Bus Stop	7.406	3.946	Iwo Road Ibadan Nigeria
Agbowo	7.448	3.921	Ibadan Nigeria
Ago Taylor bus stop	7.378	3.857	Ibadan-Abeokuta Rd Oluyole Ibadan Nigeria
Agodi Gate Bus Stop	7.395	3.919	Agodi Gate Road Ibadan Nigeria
Airport Bus Stop	7.393	3.97	Alakia, Ibadan Nigeria
Ajibode Bus Stop	7.457	3.908	Oyo Rd Ibadan Nigeria
Akingbile Bus Stop	7.513	3.913	Federal Trunk Rd A1 Ibadan Nigeria
Akinwale Bus Stop	7.411	3.951	Iwo Rd Ibadan Nigeria
Aladejubelo Bus Stop	7.449	3.951	Ibadan, Nigeria
Aladejubelo Bus Stop	7.449	3.951	Ibadan Nigeria
Alakia Ibadan Bus Stop	7.381	3.994	Alakia Old-Ife Road, Ibadan Nigeria
Alakia Iyana Church Bus Stop	7.4	3.976	Alaakia Iyana Church Rd Ibadan Nigeria
Alakia Junction Bus Stop	7.391	3.974	Ibadan - Ife Expy Ibadan Nigeria
Alakowe Bus	7.346	3.884	51 Felele Road Ibadan Nigeria
Aliwo Bus Stop	7.393	3.905	IbadanNigeria
Apata / Bembo Junction	7.373	3.804	Ibadan-Abeokuta Rd Ibadan Nigeria
Aregbesola Bus Stop	7.429	3.893	Polytechnic Main Road Ibadan Nigeria
Ariyo Bus Stop	7.346	3.952	Akaran Road Ibadan Nigeria
Awolowo Bus Stop	7.417	3.911	Kenneth Dike Rd Mokola Hill Ibadan Nigeria
Ayoola Bus stop	7.456	3.916	Ibadan, Nigeria
Bank Bus Stop	7.432	3.89	Polytechnic Main Road Ibadan Nigeria
BCGA Bus Stop	7.383	3.836	IbadanNigeria

Bodija Market Bus Stop	7.434	3.912	Kenneth Dike Rd Ibadan Nigeria
Boluwaji Bus Stop	7.34	3.907	Boluwaji, Ibadan Nigeria
breweries bus stop, ibadan	7.394	3.965	New Ife Road Ibadan Nigeria
Bus Stop	7.432	3.906	Oyo Rd Ibadan Nigeria
Challenge bus stop	7.332	3.879	Challenge, Ibadan Nigeria
Church Bus Stop	7.427	3.895	Sango Eleyele Road Ibadan Nigeria
Dominican Community Bus Stop	7.433	3.907	Oyo Rd Ibadan Nigeria
Elebu Junction Bus Stop	7.356	3.834	Elebu Junction Road Ibadan Nigeria
Elero Meta Bus Stop	7.386	3.912	Elero Meta, Ibadan Nigeria
Eleyele Bus Stop	7.419	3.86	Eleyele Ibadan Nigeria
Fanawole Junction Bus Stop	7.452	3.874	Apete, Ibadan Ibadan Nigeria
Fas-Fas Bus Stop	7.39	3.953	Old Ife Rd Ibadan Nigeria
Favos Bus Stop	7.418	3.911	Kenneth Dike Rd Ibadan Nigeria
Fijabi Bus Stop	7.453	3.921	Ibadan Nigeria
Forte Oil - Olunde Olomi	7.396	3.917	Olomi Olorunsogo 200212 Ibadan Nigeria
Gblekale Junction	7.352	3.863	Adefioye Crescent Oluyole Ibadan Nigeria
Go Gay Bus Stop	7.379	3.816	Ibadan, Nigeria
Hope bus stop	7.385	3.986	Ibadan, Nigeria
Idi Faanu Bus Station	7.506	3.913	Federal Trunk Rd A1 Ibadan Nigeria
Idi Oro Bus Stop	7.454	3.874	Apete, Ibadan Nigeria
Idiape Bus Stop	7.404	3.926	Iwo Rd Ibadan Nigeria
Idi-Ose Bus Stop	7.502	3.913	Federal Trunk Rd A1 Ibadan Nigeria
Idito Bus Stop	7.427	3.89	Poly Road, Ibadan Nigeria
Ife Osogbo Bus Station	7.402	3.944	New Ife Road Iwo Road Ibadan Nigeria
IITA Bus Stop	7.499	3.913	Federal Trunk Rd A1 Ibadan Nigeria
Iyana Adeoyo Bus Stop	7.385	3.903	Ogunmola Street Ibadan Nigeria
Iyana Ajibode Bus Stop	7.455	3.874	Apete, Ibadan Ibadan Nigeria
Iyana Barracks	7.437	3.932	Iyana Barracks Ojoo, Ibadan Nigeria
Iyana Church Bus Stop	7.422	3.976	Iyana Church Iwo-Road, Ibadan Nigeria
Iyana-Cele Bus Stop	7.457	3.873	Ibadan, Nigeria
J&P Bus Stop	7.522	3.912	Federal Trunk Rd A1 Moniya Ibadan Nigeria
Jagun Junction Bus Stop	7.392	3.96	Old Ife Rd Ibadan Nigeria
Junku Bus Stop	7.414	3.943	Ibadan Nigeria
Lagos Bus Station	7.401	3.942	Iwo Road Ibadan Nigeria
Lagos-Ibadan Expressway Bus Stop	7.34	3.904	Lagos-Ojoo Expressway Ibadan Nigeria
Maintenance Bus Stop	7.441	3.882	The Polytechnic Ibadan Nigeria
MFM Bus Stop	7.437	3.932	Expressway1 Ibadan Nigeria
Mobil Bus Stop	7.368	3.861	New Gra Ibadan Nigeria
Mobile Bus Stop	7.367	3.861	MKO Abiola Way Ibadan Nigeria
Monatan Bus Stop	7.413	3.955	Iwo Rd Ibadan Nigeria
New Garage	7.33	3.868	New Garage, Ibadan
Olopomewa Bus Station	7.419	3.871	Eleyele Ibadan Nigeria

Olori Bus Stop	7.445	3.881	The Polytechnic Ibadan Nigeria
Olorunsogo Bus Station	7.365	3.926	Expressway1 Ibadan Nigeria
Oluseyi Bus Stop	7.419	3.869	Eleyele, Ibadan, Nigeria
Omoluabi Bus Stop	7.455	3.919	Ibadan Nigeria
Omowumi Bus Stop	7.366	3.924	Ibadan Nigeria
Onibu Ore Bus Stop	7.419	3.967	Onibu Ore Iwo-Road, Ibadan Nigeria
Onipepeye Bus Stop	7.392	3.937	Ibadan Nigeria
Oremeji-Agugu Bus Stop	7.382	3.933	Oremeji, Ibadan Nigeria
Orita Aperin Garage Bus Stop	7.367	3.918	Orita Aperin, Ibadan Nigeria
Orogun Express Bus Stop	7.458	3.919	University of Ibadan, Road, Ibadan Nigeria
Orogun Junction Bus Stop	7.455	3.907	Oyo Rd Ibadan Nigeria
Oyediji Bus Stop	7.433	3.942	Ibadan Nigeria
Oyeniyan Bus Stop	7.426	3.994	Oyeniyan Iwo-Road, Ibadan Nigeria
Power House Bus Stop	7.436	3.933	Ibadan Nigeria
Preboye's	7.439	3.908	Opposite Conoil filling station, Ibadan
Rainbow Bus Stop	7.431	3.934	Expressway1 Ibadan Nigeria
Right Way Bus Stop	7.455	3.914	Ibadan Nigeria
Sagari Bus Stop	7.332	3.909	Olomi Road, Ibadan Nigeria
Sagari Bus Stop	7.332	3.909	Ibadan Nigeria
Sango Bus Stop	7.423	3.899	Oyo Rd Ibadan Nigeria
Sanyo Bus Stop	7.338	3.9	Sanyo, Ibadan Nigeria
Sawmill abiola bus stop	7.534	3.907	Ibadan Nigeria
Secretariat Bus Stop	7.409	3.911	Federal Trunk Rd A1 Mokola Hill Ibadan Nigeria
Shop Mesan Bus Stop	7.42	3.97	Iyana Church Iwo-Road, Ibadan
Tokunbo Ojo Bus Stop	7.455	3.915	Ibadan, Nigeria
Total - Sango Service Station	7.433	3.883	Old Oyo Road, Poly Junction, Sango, Ibadan
Town Planning Bus Stop	7.442	3.881	N/Campus, Polytechnic Bookshop Road Ibadan
Wesley Bus Stop	7.369	3.91	Isale Aperin, Ibadan Nigeria
Wofun Olodo Bus Stop	7.425	3.987	Along Olodo, Iwo-Road Ibadan Nigeria
Yekebu Bus Stop	7.461	3.871	Apete, Ibadan Ibadan Nigeria
Yidi Bus Stop	7.462	3.871	Apete, Ibadan Ibadan Nigeria

CITE AN ARTICLE

Fatunmibi, O. (2018). ASSESSMENT OF BUS STOPS AND ITS EFFECTS ON MAJOR ROADS IN IBADAN METROPOLIS, OYO STATE, SOUTHWEST NIGERIA. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, 7(8), 1-12.