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REVIEW ARTICLE

ANALYSIS OF THE LOCATION PATTERN AND PATRONAGE OF BUS STOPS IN ILESA, NIGERIA

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ABSTRACT

The aim of this article is to examine the location as well as the pattern of patronage of bus stops in Ilesa. The objectives of the study were to identify the location of bus stops, examine the impact of these locations on traffic flow, examine the level of patronage and the appropriateness of these locations to planning standard. Data were located using random sampling and hierarchical sampling for the commuters and operators respectively. The GIS technique was also used to site the location of bus stops in the study area. The data were analyzed using SPSS package and ArcGIS 9.3. The results of the findings show that the bus stops were sparse in some areas while other areas were closely located in terms of spatial location. It also revealed that occupation type and distance of residence to work place of the respondents influenced the patronage of the bus stops. It was recommended that the accessibility to bus stops should be considered by standard spacing and walking distance. It also recommended that the master plan (if existing) must incorporate the location pattern of bus stops if the living standard of the people is to be substantially improved upon.

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INTRODUCTION

Transportation is an important key for the survival of modern society without which there would be no life in the city (Onokala, 2001). As an essential service in urban centers, transport enables people, firms and other organizations to carry out their activities at sites selected for these purposes in separate locations in the cities. Transport provides a key to the understanding and operation of many other systems at many different scales and is an epitome of the complex relationships between social and political activities and the level of economic development (Buchannan, 1969; Hoyle and Smith, 1992). Within Nigeria, the rate of increase in the transport system is such that demand on it has led to rapid expansion in the city structure. Due to the continuous rise in population base, demand on transport system, the location pattern and the patronage of facilities, there has been rapid expansion in the structure of our cites. Transportation network which can be rightly stated as the lifelines of the people that connect both urban and rural areas has also demanded for expansion (Wikipedia, 2011). The location of various facilities in the urban centers determines and influences their patronage. The accessibility of each urban facility determines the impact of such facility on the environment (Wikipedia, 2012). Within cities in Nigeria, the few available facilities in some urban centers face high patronage due to the high population concentration, thus facing problems of congestion and overcrowding among others. Ilesa suffers from inadequate facilities that could ensure smooth urban movement. This is because the rapid growth of cities anywhere in the world has impact not only on the land use but also on the spatial expansion and the commuting distance. The increase in commuting distance has impact on trip attraction, fares paid by commuters and traffic build-up in some land use areas. It also shows the need for different modes of transportation.

Various researchers have carried out transport related problems with application of GIS tools are numerous and gave basis to this study. Some of them include Ogunbodede (2006), who based his study on "Assessment of Traffic Congestion in Akure (Nigeria) using GIS approach: Lessons and Challenges for Urban sustenance. Mohammed (2010) addressed GIS and performance of the transport system while Ali (2010) gave a detailed study on assessment of the quality of intra-urban bus services in the city of Enugu, Enugu state, Nigeria also with the application of GIS tools. However these studies were not on location pattern of bus stops. On the other hand, of more relevance is the research work carried out by Agbolade (2012).

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He based his research on spontaneous location of bus terminals in Ilesa, addressing the location and factors prompting the emergence of these terminals but his study did go further to rightly locate these terminals using appropriate standards. This study tries to fill the gap in knowledge of his study with the application of GIS in analyzing the location pattern of bus stops in Ilesa and also applying planning standards.

Also, this present study is crucial to Ilesa because of the increasing demand on the transportation system in the study area. The provision of operational bus stops will ease the emerging transportation problems because bus stops are crucial to easing the transportation problems since cars are not supposed to park illegally. Also the spacing of bus stops should be such that areas are adequately served using appropriate planning standards. An ideal spacing for bus stops is approximately 400m, although a closer spacing in town centre and residential areas may be necessary to meet passenger requirements, and enough space provided for more than one bus to access and serves the stop at the same time (Bus Priority Team, 2010).

This study therefore contributes to empirical studies on the analysis of the location pattern and patronage of bus stops in Ilesa, Nigeria.

The objectives of this study include

a) To identify the location of bus stops in Ilesa using geographical information system
b) To examine the level of patronage of the bus stops;
c) Assess the factors influencing the patronage of bus stops in Ilesa;
d) To examine the impact of location of bus stops on traffic flow; and
e) To specify the appropriateness of the locations using planning standards.

The study area

Ilesa is located in Osun state South Western Nigeria. Osun state is landlocked and occupies 9,251 square kilometers. Osun State shares borders with Kwara State to the North, Oyo State to the West, Ogun State to the South and Ondo and Ekiti States to the East (see Figures 1 and 2).

The present population of Ilesa stands at about 244,058 (NPC, 2006). The road network of Ilesa is mostly concentric in nature having a center that is well connected to every part of the city.

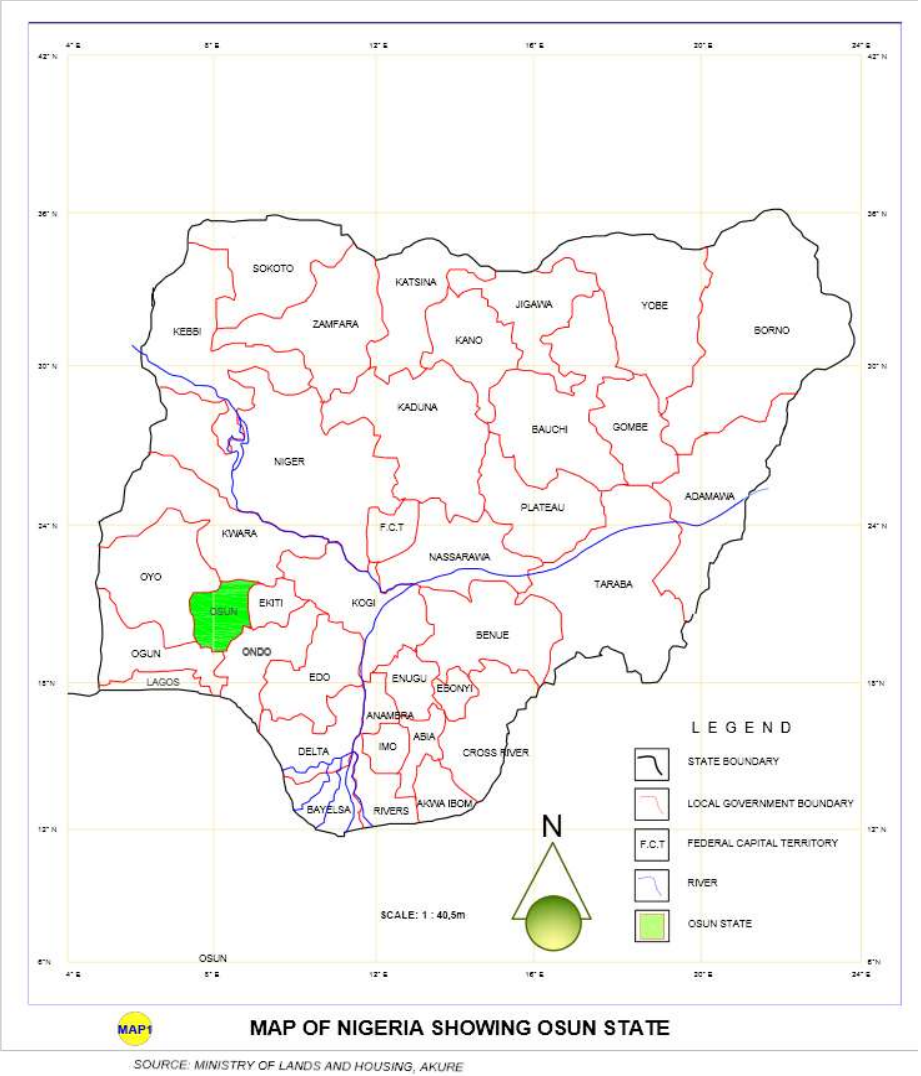

Fig.1. Map of Nigeria showing Osun State

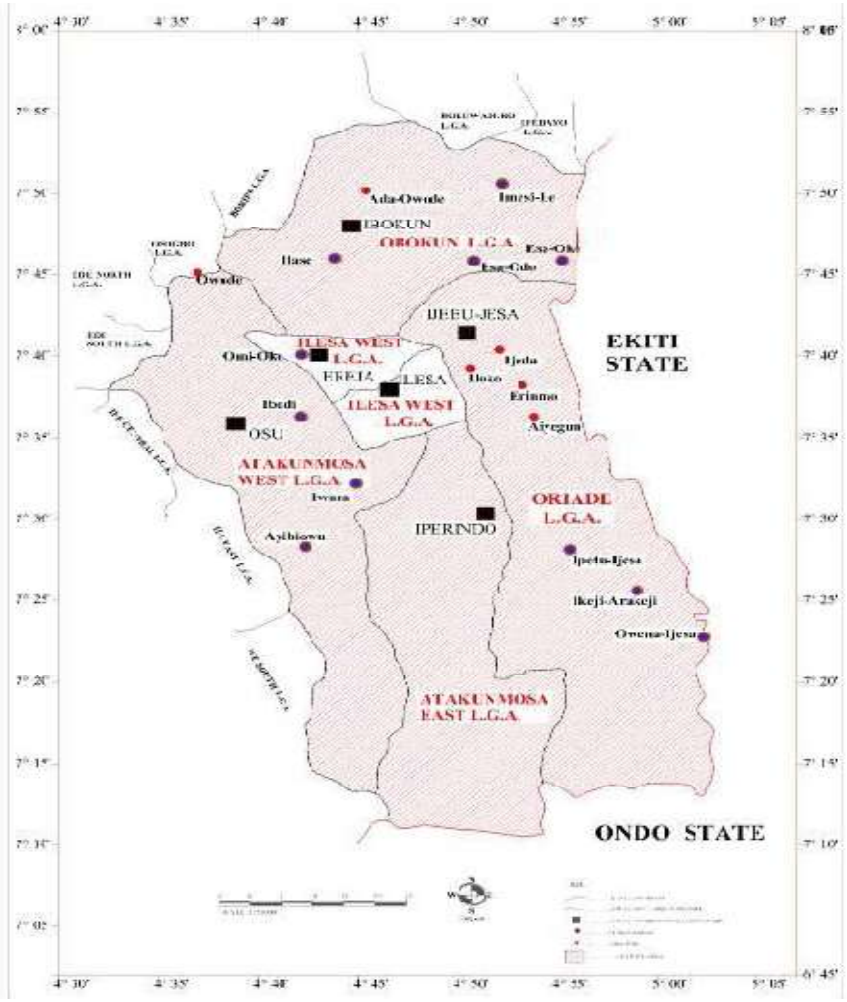

Fig. 2. Map showing Ilesa in geographical setting

The people of the state are involved in farming activities, producing such food crops as yam, maize, cassava, beans and cocoyam. The cash crops grown include tobacco and palm produce. Transportation in the state is mostly by road and with trading as a major occupation; transportation plays an important role in the town. This explains for heavy traffic in Ilesa and the need for working bus stops

Data acquisition and preparation

The study focused on three different categories for the research population, these are the commuters that patronize the bus stops in Ilesa; the public transport operators and government officials (Director of Works, Ilesa LGA and Secretary Ilesa LGA). The research populations were sampled at the 42 identified bus stops. A breakdown is presented in the Table 1.

Table 1. Traffic Corridors in Ilesa

Traffic corridor	Corridor Label	Number of identified bus stops
Olomilagbala	A	7
Irojo	B	4
Ilesa junction	C	8
Omi-aladiye	D	9
Capa	E	3
Bello junction	F	6
Ido Ijesa	G	5
TOTAL		42

Source: Author's Field Survey

The research employed the use of hierarchical sampling method because the traffic corridors identified had high prevalence of commuters. Sampling 50% of the total number of commuters counted on the points used as bus stop on the traffic corridors identified in the study area, the first fifty public transport operators were sampled and then 2 government officials were also sampled.

Data gathered for 3 weeks (btw February – March) was used to determine the total number of people patronizing bus stops in Ilesa. In the 3 weeks used, 3 days were used i.e. 2 working days and 1 weekend while focusing on the morning peak period 7am-9am and evening peak period 4pm-6pm. A total number of 155 respondents were targeted by this research as broken down in Tables 2 and 3.

Table 2. Commuters Patronizing Bus stops in Ilesa

Week	Mon	Thurs	Sat	Total	Ave	Sample size (50%)
1	70	74	56	200	67	34
2	74	72	67	212	71	36
3	71	71	75	217	72	36
Total	215	217	198	629	210	105

Source: Author's Field Survey
Note: for 3days and during peak periods

Table 3. Total Population, Sampling Frames and Sample Size for the Study

Research population	Sample Frame	Sample size
Commuting population	Commuters patronizing bus stops in the study area- 210	105
Public transport operators	1st 50 buses	50
Total		155

Source: Author's Field Survey

Another technique employed was the use of GPS which was used to capture points on ground. Identifying the areas with bus stops, points captured on these routes were identified as location of bus stops. Also satellite imagery of the study area from Google earth for April 2013 obtained focused on the major streets. Roads were buffered and the location of the bus stops determined using acceptable standards of 400m (Bus priority team 2010). The Base map which comprised the Administrative map and the road network map of the study area obtained from Ilesa Local government Secretariat was scanned and run into the CD drive of a computer, the map was geo-referenced and then digitized. Digitization was done manually using On-screen method. This allowed for the spatial referencing of location on ground. The final map produced carries all information on ground as it were on the map i.e. to put the Map and all features contained on it at the right location on the ground.

The use of ArcGIS 9.3 software and GPS was used to specify and capture the coordinates on the ground. The maps obtained from the local government secretariat were then geo-referenced and digitized. The collected GPS points of the bus stops were exported into GIS environment. At this stage the co-ordinates of the bus stops are known with which their positions were used to determine the base map of the study area to the geographical co-ordinates.

These are taken as point data which gave the bus stop locations and the distances between the bus stops. Overlap in the location allowed a common point to be considered for the location of the stop using standard such that there is no overlap. This point selected considers other criteria that would influence the patronage of the stop. New bus stops were created in areas lacking using 400m as the standard. (Bus priority team, 2010) Thus locations were such that none of the areas are under-served or over served. Conclusions drawn from the results of the analysis assisted in proposing the best location of bus stops in Ilesa Township.

RESULTS AND DISCUSSION

The proposed best location of the bus stops as shown by the GIS outputs and the results of questionnaires administered are discussed below.

GIS Analysis

Ground truthting was done using GPS to capture the locations of the existing bus stops in Ilesa with their coordinates. All existing road network were tracked in other for the bus stops to be identified on ground. About 42 bus stops were identified in the study area. Data from the GPS were then exported via ArcGIS 9.3. The base map of Ilesa was geo-referenced that is, converting the base map into real life position on the earth surface. The data captured with the GPS on the system was then added on the geo-referenced map of Ilesa. The resulting effect is the bus stops and the road network locating at the exact points as it were on ground as shown in the maps below. The road network and the bus stops locations were then digitized to produce the required maps.

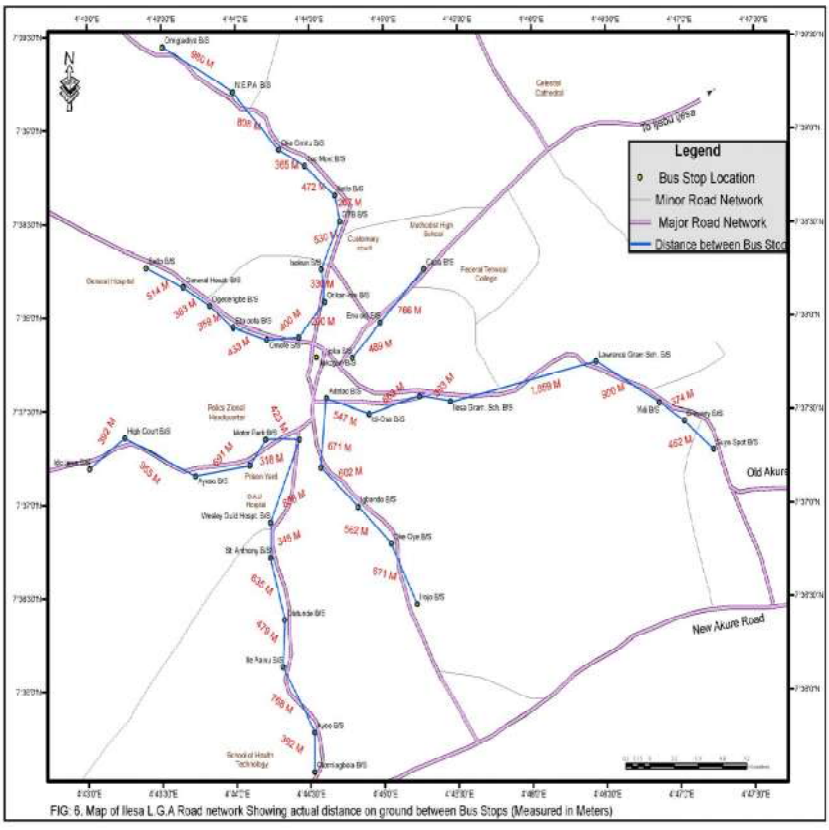

Fig. 3. Map of Ilesa LGA Road Network Showing actual Distance on ground between Bus Stops (Measured in Meters)

An ideal spacing for bus stops is approximately 400m, although a closer spacing in town centre and residential areas may be necessary to meet passenger requirements, and enough space provided for more than one bus to access and serves the stop at the same time (Bus Priority Team, 2010).

Figure 3 is the map used to showcase the distance between the bus stops. This was done by making some queries such as; What is the distance between the bus stops? The distance between the bus stops is then shown. The distance varied from as low as 300m apart to as high as 1,859m apart. This implies that commuters may have to walk longer distances to some bus stops which could lead to bus stops springing up between the located ones. It was also observed that certain areas do not have bus stops to serve those implying commuters and driver use convenient points along the road not minding the implication on traffic flow.

The impact of this on traffic is that buses may have to stop more frequently on the areas where they are closely located which may have negative impact on traffic flow since there are no built bus stops in these locations. Areas with sparsely located bus stops imply that commuters will travel long distances before accessing a bus stop. The resulting effect is bus stops springing up at various locations along the roads. This often leads to traffic snarl as there will be an increase in the frequency of stop along the roads. Another effect of the spring up of these bus stops is that appropriate standard will not be used in the location of the bus stops.

Having identified the areas lacking bus stops, points are proposed that bus stops can be appropriately located along these routes. An ideal spacing for bus stops is approximately 400m, although a closer spacing in town centre and residential areas may be necessary to meet passenger requirements, and enough space provided for more than one bus to access and serves the stop at the same time (Bus Priority Team, 2010). This therefore prompted the use of 400m distance as the standard. Figure 4 below displays the location of the bus stops using 400m as the distance between the proposed bus stops. This makes it possible for all areas of Ilesa to have access to functional bus stops. Figure 5 is a display of the distance between the bus stops using 400m. It was discovered that the distance between some of the bus stops on ground fell below 400m.Where there was overlap in the location of the bus stops using 400m distance, it was removed. Areas where the distance between the bus stops could accommodate the location of a new bus stop, this was appropriately located using 400m distance. The map is so produced that the black dot represents the identified bus stops on ground, the red dot represents the proposed ones. This was adequately done with GIS because GIS allows the information to be viewed at a glance. GIS helps to track and capture information from real world and used to produce required maps

Socio-Economic Characteristic of the Respondents

The socio-economic factors that affect the location of bus stops in the study area include: occupational status, distance of residents to work place, disaggregating occupation of the residents against distance, frequency of patronage of this bus stops, disaggregating occupation of the residents against patronage, mode of transportations, usage of bus stops, impact of traffic flow.

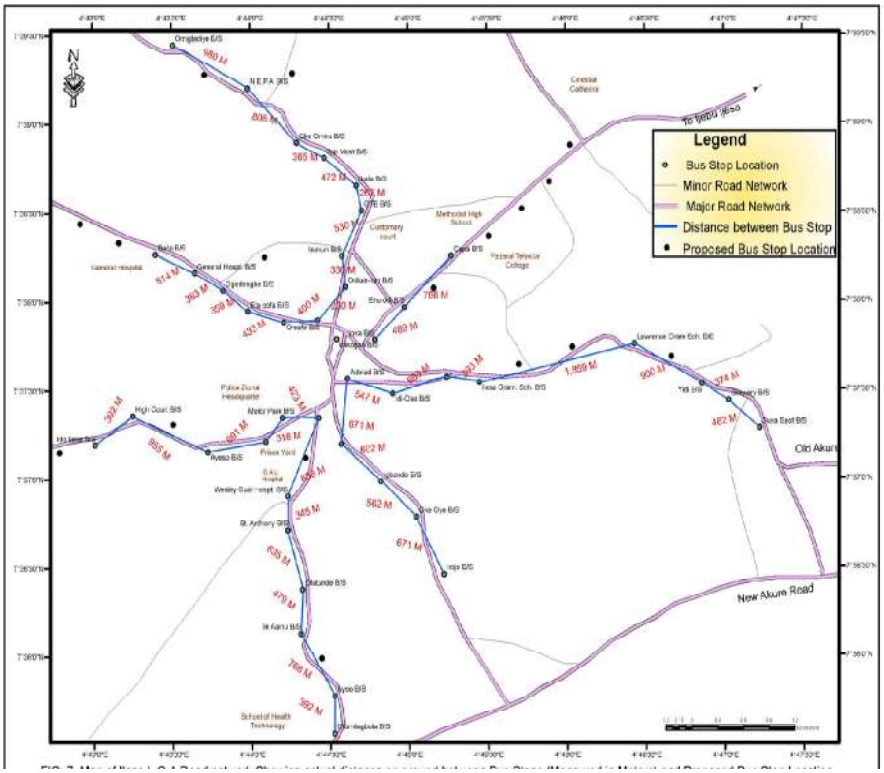

Fig. 4. Map of Ilesa LGA Road Network Showing actual distance on ground between Bus Stops (Measured in Meters) and Proposed Bus Stop Locations

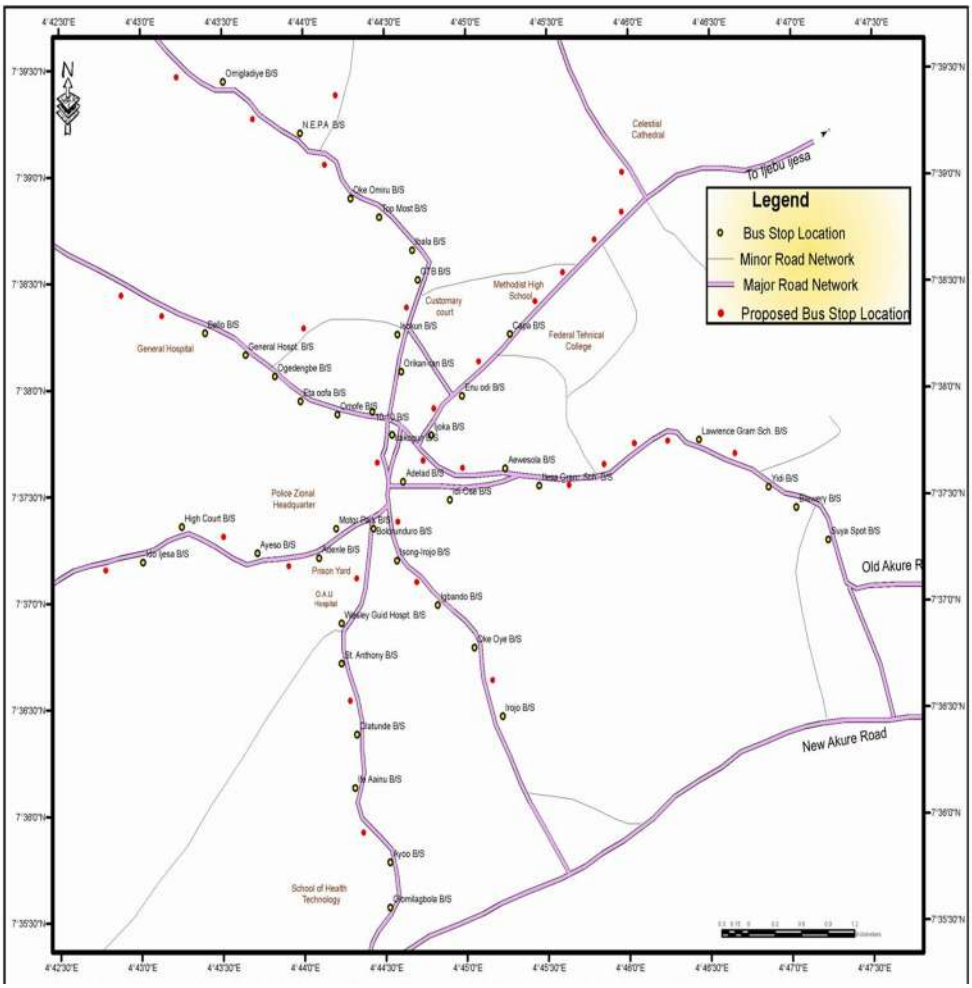

Fig.5. Map of Ilesa LGA Road Network Showing Standard Measurement of 400m or less between Bus Stops and Proposed once

Table 4 shows the occupation of the respondents. The table reveals that 38% of the respondents are involved in trading and other businesses; this is closely followed by the civil servants with 31%. Other occupations are Farming and Professionals. Critical observation into the occupation type shows that traders and civil servants were more in the study area which could be attributed to the nature of their work that necessitate the patronage of bus stops.

Table 4. Occupation of the respondents

Occupation	Frequency	Percent
Professional	9	8.6
Trading/business	38	36.2
Civil service	31	29.5
Farming	27	25.7
Total	105	100.0

Distance of residence to work place will influence the patronage of the bus stops, the farther the distance of residence to work place, the higher the level of patronage of bus stops. Table 5 represents the distance the residence to work place. The table indicates that distance of residence of respondents to work place is very far, with 34.3% of the respondents with the opinion. This can be attributed to the earlier findings that showed that a larger percent of the respondents are traders and civil servants, this implies that the work places of the respondents are at far distances to their places of residence invariably affecting their level of patronage of the bus stops.

Table 5. Distance of Residence to work place

Frequency	Percent	
Below 1km	17	16.2
1km-3km	26	24.8
4km-6km	26	24.8
Above 6km	36	34.3
Total	105	100.0

Table 6 shows the cross tabulation of the occupation and distance to work place of the respondents. It reveals that the major occupation is trading and civil servants and the distance of work place is very far with 38% and 31% respectively.

This indicates that the level of patronage of available bus stops by traders/business individuals and civil servants is higher compared to others. This is not encouraging as this category of workers will need to move out of their living environment.

Table 6. Disaggregating occupation against distance to work place

Respondents	Near	Slightly far	Far	Very far	Total
Professional	2	3	2	2	9
Trading/business	6	10	13	15	38
Civil service	5	10	10	13	31
Farming	4	3	1	4	27
Total	17	26	26	36	105

Table 7 shows the Frequency of Patronage of the bus stops. It reveals that about 50% of the respondents' patronage of bus stops is often. This implies the awareness of the availability of bus stops in the study area

Table 7. Frequency of patronage of Bus stops

Frequency		Percent
Not at all	15	14.3
2/week	16	15.2
1/week	24	22.9
Daily	50	47.6
Total	105	100.0

Disaggregating occupation of the respondents against frequency of the patronage of the bus stops to determine if the type of occupation influences the patronage of bus stops was also shown in table 8. Findings reveal that the traders and civil servants constituted a larger number of respondents patronizing the bus stops as represented in Table 8. This is attributed to earlier findings showing the distance of work place of the traders and civil servants to their residences to be far thereby obliging them to patronize the bus stops more often.

Table 8. Disaggregation of occupation against patronage of bus stops

Respondents	Not at all	Rarely	Few Times	Often	Total
Professional	7	2	0	0	9
rading/business	6	8	8	16	38
Civil service	2	0	4	25	31
Farming	0	6	12	9	27
Total	15	16	24	50	105

The mode of transportation of the respondents is shown in Table 9. The table reveals that 71.4.% of the respondents use public transportation which are majorly taxi cabs. This implies that there is high patronage of bus stops as the public transporters are more inclined to patronize the provided bus stops.

Table 9. Mode of transportation

Mode of Transport	Frequency	Percent
Private Car	2	1.9
Motor Cycle	28	26.7
Taxi Cabs	75	71.4
Total	105	100.0

Table 10 shows the location/condition of the bus stops. The table reveals that the location of the bus stops is fair with 35% of the respondents. This can be attributed to findings that reveal that majority of the bus stops were not actually built but are popular location that have been used over time. The usage of the bus stops is presented in Table 11. It reveals that despite the awareness of bus stops in the study area, public transporters at times do not use the bus stops.

Table 10. Location/Condition of bus stops

Location of bus stops	Frequency	Percent
Poor	11	22
Fair	18	35
Good	21	43
Total	50	100.0

This can be attributed to lack of control/enforcement mechanism to monitor the activities of the operators. 40% of the respondents said they pick and drop off commuters anywhere along the road, 28% said sometimes at bus stop, while even 18% said never at bus stops.

Table 11. Usage of Bus stops

Frequency	Percent	
Never at bus stop	10	18
Anywhere along the road	20	40
Sometimes at bus stops	14	28
Only at bus stops	6	14
Total	50	100.0

Table 12 shows the impacts of bus stops on traffic flow. The table reveals that the respondents are aware of the negative impact of bus stops on traffic flow. 42% of the respondents are of the opinion that the impact on traffic flow is high, 36% of the respondents said moderate while 18% said very high. It can therefore be said that location of the bus stops in Ilesa affects the level of patronage as well impacting the flow of traffic.

Table 12. Impact of bus stops on traffic flow

Frequency	Percent	
No Impact	2	4
Moderate	18	36
High	21	42
Very High	9	18
Total	50	100.0

Conclusions and Recommendation

Achieving the aim of this study to analyze the location pattern of bus stops in Ilesa as well as determine the patronage level of bus stops in the 27 sampled bus stops on the identified traffic corridors some factors such as distance, occupation of commuters, passenger waiting time and walking distance were considered. It was found that these factors did not vary from one bus stop location to another, indicating similarities in the location pattern and patronage of bus stops in Ilesa. A central area was identified where bus commuters enjoy the shortest waiting time for bus and some areas identified as having shortest walking distance to the nearest bus stops, indicating these areas have higher patronage.

The study revealed that distance of residence of respondents to work place is very far, with 34.3%. This can be attributed to the earlier findings that showed that a larger percentage of the respondents are traders and civil servants implying that they live at far distances to their work places. Findings reveal that

the respondents' patronage of bus stops is often. This implies the awareness of the availability of bus stops in the study area. Findings also reveal that 46.7% of the respondents use public transportation. This implies that there is more patronage of bus stops as the public transporters are more inclined to patronize the provided bus stops buttressing the conclusion that there is the inclination of the respondents to patronize bus stops if more are provided considering factors such as distance and cost in the location of the bus stops.

This research work employed GIS capabilities in the analysis of the location pattern and patronage of bus stops in Ilesa with a view to revealing the location patterns, level of patronage as well as proffer strategy for appropriate location standards for bus stops in Ilesa to ensure a sustainable traffic environment. Bus stops locations were identified using 400m distance to rightly locate in areas that earlier suffered. The result of standard uniform spacing was shown and if this is implemented it will give a level of attractiveness and orderliness to bus services in the study area. The study has demonstrated the spatial analysis capability of GIS technology in identifying poorly located bus stops, determination of best location and pointers to an articulated decision making in public transport route management.

The study uses its findings to suggest the following recommendations and guidelines for locating bus stops which will reduce the risk on the roads. A relatively uniform bus stops spacing should be followed except in few points where there are acceptable conditions in consideration but it must not be less than 300metres interval in any case this to allow for optimum use of the bus stops. Accessibility to bus stops should be considered by standard spacing and walking distance. There should be proper naming and statistics of the bus stops to give identity to each for orderliness and references. In areas with bus stops at risk due to slope, there should be sign post to inform and remind the users of the need to be careful. Equally the road surface of such bus stops should be made from materials that will improve friction so as to avoid easy slides (Aluko, 2014).

Periodic assessment of the bus stops should be carried out to assess their functionality in respect to changes i.e. expansion of roads and agglomeration of economic activities in the area.

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