ANALYSIS OF TRAFFIC FLOW ALONG SANGO-IDIROKO ROAD, OTA, OGUN STATE.

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ABSTRACT
The free flow of traffic on the road is a potential tool for economic development of a city, and must be encouraged. This study examines the causes of traffic congestion along Sango-Owode, Idiroko Road, Ota, Ogun State with a view to providing information that will enhance traffic management. The travel time within the study area was examined by a moving vehicle set at a specific speed while the time taken to cover a zone was recorded, hence, Sango and Oju-Ore zones experienced the most of the delay with about 17 minutes on average wasted for a journey of about two minutes. In assessing the traffic volume, traffic volume counts were conducted for one week (Monday to Sunday) along the study route between Sango and Winners between the hours of 7.00 AM and 7.00PM while the outcome was subjected to PCU analysis of Lewis Keeble. The study revealed that congestion is a common occurrence along the corridor with its peak in the morning periods of 8. 00AM to 10.00AM and in the evening between 5.00PM upwards. The calculated value of PCU's per hour in each zone indicates that the Sango traffic zone 2,218PCU's per hr (highest value), Oju-Ore traffic zone is 1,777PCU's per hr (lowest value), Obasanjo, and Winners' zones (1,556 PCU's per hr and 1,637 PCU's per hr respectively). The result from the PCU revealed that the road under investigation is functioning far above its capacity, and as vehicles queue up on the road; this results to release of carbon emission which contradicts SDG goals 3 and 11. Therefore, there is need to divert or decongest the traffic pressure on this corridor to avoid carbon emission as a result of concentration of vehicles on the way.

Keywords: Traffic congestion, Traffic volume, Travel time, Sango-Oju-Ore

1.0 Introduction

Humankind, nations, regions, and the world would be severely limited in development without transportation, which is a key factor for physical and economic growth (Oyesiku, 2002). Transportation performs the role of linking supply and demand. It is a means of conveying people, goods and information through places. It contributes to the overall development of a country since it serves as an essential means of collecting, moving, transferring, and distributing people and goods from place to place. The rapid urbanization around the world means that more people will be making more trips in urban areas and since the transportation is a life wire of an urban society, it could make or mar the environment depending on interactive measure and degree of responsiveness to transport planning and management in urban planning. Transportation systems and land use are interdependent. Indeed findings of earlier studies indicate compelling and consistent connections amongst them. According to Bailey *et al*, (2008), transportation route is part of distinct development pattern or road network and mostly described by regular street patterns as an indispensable factor of human existence, development and civilization.

In consideration of road network and level of services, the road networks are observed in terms of their components of accessibility, connectivity, and traffic density; level of service, compactness, and density of particular roads. Level of service is a measure by which the quality of service on transportation devices or infrastructure is determined, and it is a holistic approach considering several factors regarded as measures of traffic density and congestion rather than overall speed of the journey (Walter and Scott, 2004). Access to major roads provides relative advantages consequent upon which commercial users locate to enjoy the advantages. Modern businesses, industries, trades and general activities depend on transport and transport infrastructure, with movement of goods and services from place to place becoming vital and inseparable aspects of global and urban economic survival.

The traffic congestion, as the focus of this study, is usually experienced on the road way and especially at intersection. Intersection is an area shared by two or more roads. This area is designated for the vehicles to turn to different directions to reach their desired destinations. Its main function is to guide vehicles to their respective directions. Traffic intersections are complex locations on any highway. This is because vehicles moving in different directions want to occupy same space at the same time. In addition, the pedestrians also seek same space for crossing. Drivers have to make split second decision at an intersection by considering his route, intersection geometry, speed and direction of other vehicles etc. A small error in judgment can cause severe accidents. It also causes delay and depends on type, geometry, and type of control (Aderamo, 2011).

The city of Ota is one of the development pressure areas of Ogun State (Ogun State, 2009), that witnesses high influx of vehicular traffic from both the national and international road corridor that significantly forms the framework of the road network of the city. Aside playing the role of primary roads linking cities, states and neighbouring countries, it also serves as access road and collector road in most cases, thus the attendant traffic challenges on the road. The study assess the transport facility vis-a-vis the current trend of traffic along the road, examines the causes of traffic congestion and suggests measures to ameliorate recurring traffic problems on the route and to ensure sustainable Ota city development.

2.0 The Study Area

Ogun State is one of the fast developing states in Nigeria; lying in the South Western part of the country between latitudes 2061 and306 east of the Greenwich Meridian. The State is bounded on the West by the Republic of Benin and on the East by Ondo State. To the North is Oyo State while Lagos State and the Atlantic Ocean are to the South (Figure 1.1). The geographical location of the State makes it accessible to the economically developed regions in Nigeria. Abeokuta, the State capital is about 103 kilometres and 70 kilometres from Lagos and Ibadan respectively by road. The other notable urban centres in the State such as Ota (a fast growing industrial centre) is about 17 kilometres from Lagos while Sagamu and IjebuOde are about 65 kilometres and 75 kilometres respectively from Lagos and 102 kilometres and 70 kilometres respectively from Ibadan by road. The geographical placement of Ogun State has made it a 'gateway' to Nigeria from other coastal West African countries like Benin and Togo Republic, Ghana, Sierra Leone and Liberia among others. Ogun State's linkage with the neighbouring international community and much more developed States in Nigeria enhances its trade links and offers tremendous opportunities for its growth and development. By virtue of its location, the State has been able to attract and retain both foreign nationals and people from other Nigerian ethnic groups who find the different centres (particularly urban areas) of the State conducive to living and investment opportunities.

The study area Ota, which is currently the headquarters of Ado-Odo/Ota Local Government has been prominent in the administrative, cultural and economic development of its region for a long time. Ota is located on latitude 6° 42′ North and longitude 6° 13′ East covering a land area of 1,263 square kilometres (Figure 2). It has a terrain of 1,010.4 square kilometres plain land and about 252.6 square kilometres bad terrain comprising16% riverine and 4% hilly regions. *Ota is situated near the boundary with Lagos State and has steadily grown to be the largest industrial town in Ogun State, largely as a result of its proximity to Lagos. Ota maintains the third largest industrial town in Nigeria after Ikeja and Apapa - Lagos. In area of distances, Ota is about 53km to Abeokuta, the capital of Ogun State and 17km to Ikeja the capital of Lagos State. Ota is a strategically located nodal town along Lagos - Abeokuta Expressway.* It shares boundaries with Alimosho Local Government Area in Lagos State

in the South, and South - East; Ipokia Local Government Area to the West, Yewa South Local

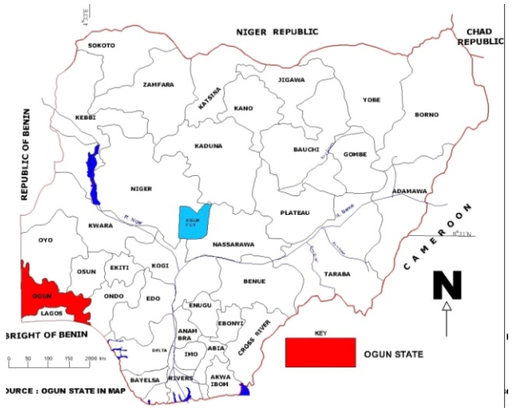

Figure.1: Ogun State Map within the Nigerian Context

Figure 2: Ado-Odo/Ota Local Government Area within Ogun State Context

Ota comprises hierarchy of roads ranging from express road which runs from the Toll Gate, passes through Sango and to Abeokuta, likewise, the Sango-OwodeIdiroko Road that runs from Sango, passes through Ota City centre to Owode-Idiroko axis. The road is an international road as it terminates at Benin Republic border (Figure 3). The structure of development in Ota can best be explained with the framework of the two primary roads that intercepted within the city. The roads connect the city to Lagos (the commercial hub of the country) and to Cotonou (international trade route). Owode - Idiroko Road is a trunk 'A' Road, constructed to link Sango-Ota to the border town of Idiroko and the Benin Republic (Cotonou). It is a two-way road that serves as intercity transit corridor as well as international corridor. The basic features of the road include: dual carriageway of 18 *meters width; No drainage and good shoulders;(not clear)* the road is divided with concrete barrier between Sango and Winners' Chapel location; the road provides access to all abutting plots with no restriction to parking.

Sango-Winners' corridor of the road is a distance of 10.5km. This section provides access to major land uses such as the industrial estate, Ogun State Housing Estate; Ota Judicial Complex, Ogun State Hospital, Ota; the Bells University of Technology; Covenant University, Obasanjo Farms and a host of other industrial and commercial land uses including major city market (Ajala, 2017). The arterial roads in Ota can be seen from the road network starting from Oju-Ore, linking Iganmode Road and terminating at the Expressway (Lagos Abeokuta Expressway). The Iganmode Road also links some other major roads within the city such as Osi Road, Abebi Road etc and Terminates at Itele Road which runs to Command Road and Ayobo-Ipaja all in Lagos State.

3.0 Theoretical Framework

3.1 Three-phase traffic theory

The Three-phase traffic theory is a theory of traffic flow developed by Boris Kerner between 1996 and 2002. It focuses mainly on the explanation of the physics of traffic breakdown and the resulting congested traffic on highways. Kerner describes three phases of traffic, while the classical theories based on the fundamental diagram of traffic flow have two phases: *free flow* and *congested traffic*. Kerner's theory divides congested traffic into two distinct phases, *synchronized flow* and *wide-moving jam*, bringing the total number of phases to three:

1. Free flow (*F*)
2. Synchronized flow (*S*)
3. Wide-moving jam (*J*)

In the three phase's traffic theory, the three phases in traffic consist of free flow and two congestion phases: synchronized flow and wide-moving jam. The three phases offer qualitative features of traffic congestion phenomena. However, because of the complexity of traffic system, such as (inhomogeneity) what do you mean? Do you mean heterogeneity? In homogeneity is not an English word. Among vehicles and behaviour of drivers, the theory is meant to provide quantitative correspondence with reality even when recent simulations have been able to reproduce qualitative features.

In traffic theory, a large set of parameters exists (e.g. safety gap between vehicles, average vehicle length, time-delay for acceleration). Among these, it is sufficient to provide only three parameters for understanding the empirical features of three phases: Velocity v, density

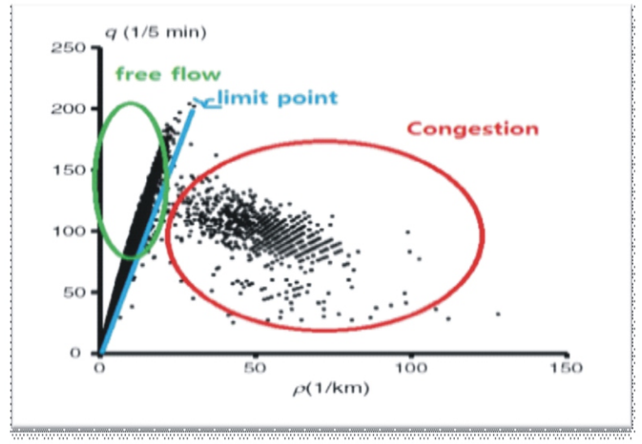

Figure 4: Traffic free flow and congestion
Source: Adapted from Moon Jim Park (2012).

The Three Phase Traffic Theory shows the behaviour of the three parameters **(**flow rate, density, and speed**)** in traffic. Three phase traffic theory offers rich qualitative argument. The three phases are well defines by its special features. Each phase can be well distinguished from each other. Empirical data supports the characteristics of each phase, even though quantitative information is limited.

The traffic flow theory answer the questions such as when do traffic jams emerge, is it predictable by given certain demand levels, when queuing will occur, how long the queues will be? How they will propagate in space and time and how long it will take for the congestion to resolve? Why does an overloaded traffic network underperform? One of the results of the interplay between people and shippers' needs and desires, the locations of activities and the transport resistance factors, is a certain volume of road traffic. Road traffic can be described by using flow variables such as speed and density. The density of traffic is the number of vehicles that are present on a roadway per unit distance. Road traffic flows on certain road

stretches during certain time periods can be either free or congested and/or the flows can be unreliable. In the last two cases, the transport resistance on these roads will be relatively high; consequently, high transport resistance implies negative repercussions on road traffic volumes.

The road traffic-flow variables, and the interactions with aspects such as driving behaviour, weather, and information technology will be affected. Thus, traffic flow operations on a road facility are explained for a given traffic demand profile. Factors such as weather and information technology (for instance, navigation systems) can influence traffic-flow characteristics through driving behaviour although, driver's behaviour is something that cannot be predicted outrightly, but fortunately, drivers tend to behave within a reasonably consistent range and, thus, traffic streams tend to have some reasonable consistency and can be roughly represented graphically or mathematically. However, policies such as road expansions and traffic management measures can have an impact on traffic-flow operations, either directly or indirectly, by influencing driving behaviour (Fig. 5).

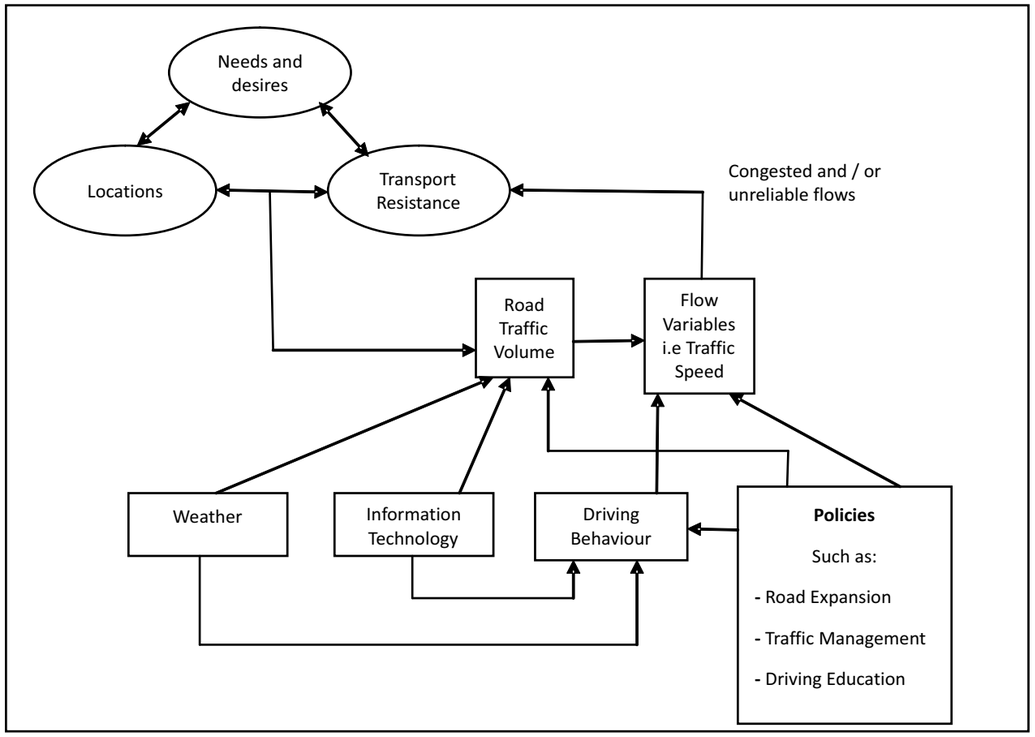

Figure5:Traffic flow model.
Source: Adapted from Serge (1996).

Traffic-flow theory will guide this study in the areas of fundamental characteristics of traffic-flows and the associated analytical methods. Examples of such characteristics are the road capacities, the relation between flow, density and speed, and headway distributions. These relationships help in planning, designing, and operating of roadway facilities.

4.0 Methodology

The population comprises different, motorists and commuters. Meanwhile, some of the commuters, the drivers that may pass through each point during the time of survey and the traders' around made up of the population for the study. The data required for the survey comprise: Travel time analysis; Traffic volumes and characteristics; Environmental characteristics; Traffic control and management analysis; Road infrastructure analysis; Parking characteristics and management. Primary and Secondary data were adopted. The primary sources used were personal observation; oral interview and questionnaire. Personal observation: personal observation was used to determine the road infrastructure and parking characteristics in the study area. Oral Interview and Questionnaire: Oral interview and questionnaire was adopted in this study to gather information as regards the movement pattern of motorists (drivers) and commuters in the study area, so as to facilitate the planning of an efficient transportation system. This survey was conducted using Roadside Traffic Interview. In addition to this, traffic counts were done in the study area for a week(Monday to Sunday) on hourly basis from 7.00AM.to 7. 00PM. Data obtained from secondary sources were map collected from Ministry of Urban and Physical Planning, Ota Zonal Planning Authority, and personal production through the use of planning tools such as AutoCAD and ArcGIS

4.1 Sampling Technique and Sampling Procedure

Systematic random sampling is considered for this survey. This is considered appropriate through the division of the area into different four zones comprises Sango as Zone 'A', Oju-Ore as Zone 'B', Obasanjo Junction as Zone 'C' and Winners' Junction as Zone 'D'. Interview by vehicle type was considered as the level of difficulty each motorist/commuter is experiencing on the road might not be the same. The survey was conducted at the different hours of the day which were: morning, afternoon and evening within peak period and off peak, week days and weekends.

The time of one hour was used to administer the questionnaire at each zone at a period of the day. The total number of questionnaires administered depended on the number of respondents that were captured within this time. This was done in order to capture the commuters/motorists at different hours of the days. The population of Ota in 2018 is 401,649 and all these population one way or the other makes use of the road. Therefore, it is too large to cover hence, Yaro Yamane formula was adopted in determining the size to be sampled. The formula is expressed as $S=N/1+N(e)^2$, where: S= sample size, N= population of the study area, e = Degree of freedom = 0.05, 1= constant. Therefore: Sample size = $401,649/1+401,649(0.05)^2$ S = 401,649/1005

The sample size, therefore, was 399.65. The different types of vehicles were considered for the survey which was the public bus, taxi, private cars and the industrial buses that move the staff to some of the industries in Ota environs. The survey was carried out at different points of the traffic zones. 120 vehicles were stopped and 399 questionnaires in all were shared among the drivers and commuters. During the survey, only 301 questionnaires were retrieved for analysis from the drivers and commuters.

4.2 Method of Administering Data Collection Instruments

Traffic Volume Count

For traffic volume count, sixteen cordon points were established across the study area. These comprised two points at Sango, each point at Iganmode and Joju Junctions, two at Baby O Bus Stop, two at Ota township directional axis, one at Ilogbo Junction, two at Iganmode Grammar School, one at Obasanjo Junction, one at Iyana Iyesi Junction, two at Bells' Main Gate and one at Cannan land. These points were strategically selected for easy analysis of traffic variation across the internal traffic zones in the area, to give information about traffic situation at these points and to give room for the analysis of the significance

of linkage roads in contribution of traffic to the route as well as evacuation of traffic from the studied route. The traffic volume count at the points was done through the help of research assistants. The research assistants were previously trained on how to go about traffic counting and how to make effective use of tally method. The traffic was counted simultaneously between the hour of 7.00AM and 7.00PM from Monday to Sunday.

Travel Time along the Corridor

The traffic flow condition along Sango – Owode/Idiroko corridor was carried out to ascertain the point(s) at which the traffic gridlock is being experienced. This was done through the division of the corridor into equal distance from Sango to Cannan land (Table 1). The division thereby gives the following interval:

Table 1: Distance Coverage Interval

POINTS	INTERVAL (AREA COVERS)
Point A	**Sango Under Bridge – Oju-Ore**
Point B	Oju-Ore – Obasanjo Junction
Point C	Obasanjo's Junction – Iyana Iyesi Junction
Point D	Iyana Iyesi Junction – Cannanland

Source: Author's Field Survey, 2019.

The distance is approximately 1.8 kilometres interval. The survey was carried out at morning peak and evening peak hours on a daily basis for one week (Monday to Sunday). The vehicle (motor car) is used for the survey and the speed is calculated at average of 60 km/h. The result is hereby presented in table 2 and 3.

Table 2: Travel time along Sango – Owode/Idiroko corridor at morning peak period

Points	Corridor	Time of Coverage (in Minutes)													
		DAY 1 Monday		DAY 2 Tue.		DAY 3 Wed.		DAY 4 Thu.		DAY 5 Friday		DAY 6 Saturday		DAY 7 Sunday	
		To	Fro	To	Fro	To	Fro	To	Fro	To	Fro	To	Fro	To	Fro
Point A	Sango Under Bridge – Oju-Ore	6	7	10	8	18	13	7	18	9	15	7	12	28	17
Point B	Oju-Ore – Obasanjo Junction	5	5	3	3	13	12	6	20	4	35	3	15	23	40
Point C	Obasanjo Junction – Iyana IyesiJunction	3	4	4	4	10	13	6	14	5	15	6	6	16	14
Point D	Iyana Iyesi Junction – Cannanland	3	2	3	6	5	8	6	15	5	6	4	8	22	15

Source: Author's Field Survey, 2019.

Table 3: Average daily time travel time at morning peak

Points	Routes	Weekly Average (in Minutes) From Sango to Winners	Weekly Average (in Minutes) From Winners to Sango
Point A	Sango Under Bridge – Oju-ore	12	13
Point B	Oju-Ore – Obasanjo Junction	8	19
Point C	Obasanjo Junction – Iyana Iyesi Junction	7	10
Point D	Iyana Iyesi Junction – Cannanland	7	9

Source: Author's Field Survey, 2019.

The peak period is the hour where there are many vehicular movements on the road and usually, the road is always filled up with traffic. However, for the context of this study, the peak period is determined to be between 8. 00AM to 10.00AM. The movement along this route at that time took different time. From point A to point B, that is, from Sango Under Bridge to Oju-Ore, took an average of12 minutes to and 13 minutes from Oju-Ore to Sango Under Bridge. From point B to point C (Oju-Ore to Obasanjo Junction) it took an average of8 minutes to and 19 minutes from Obasanjo to Oju-Ore. At Point C, Obasanjo to Iyana Iyesi took an average of 7 minute and 10 minutes from Iyana Iyesi to Obasanjo while at point D which is Iyana Iyesi to Cannanland took it took an average of 7 minutes and from Cannaland to Iyana Iyesi, it took 9 minutes on average in the morning (Table 4).

More time is usually being spent from Obasanjo Junction to Oju-Ore according to the survey in the morning while Oju-Ore to Sango (Under Bridge) also takes much time as well. This implies that most of the delays being experienced in the morning usually occurred between Oju-Ore and Sango (Under Bridge). Although, in some weekdays, the road can be free and vehicles can move as fast as completing the journey within 3 minutes but when congestion is experienced, it can take as much as approximately 30 minutes to complete the same journey.

Table 4: Travel time along Sango – Owode/Idiroko corridor at evening peak period

Points	Corridor	Time of Coverage (in Minutes)													
		DAY 1 Monday		DAY 2 Tue.		DAY 3 Wed.		DAY 4 Thu.		DAY 5 Friday		DAY 6 Sat.		DAY 7 Sunday	
		To	Fro	To	Fro	To	Fro	To	Fro	To	Fro	To	Fro	To	Fro
Point A	Sango Under Bridge – Oju-ore	6	7	20	18	22	17	5	11	10	12	5	12	6	24
Point B	Oju-ore – Obasanjo junction	4	10	5	15	32	24	7	21	7	6	5	9	8	33
Point C	Obasanjo Junction – Iyana Iyesi Junction	5	8	4	12	32	20	4	14	6	11	4	10	4	24
Point D	Iyana Iyesi Junction – Cannanland	3	2	9	13	5	5	6	15	5	8	4	5	6	18

Source: Author's Field survey, 2019.

The evening peak is considered to be between 4. 00pPM and 6. 00PM. The movement along this route at that time took different time. From point A to point B, that is, from Sango UnderBridge to Oju-Ore, took an average of 11 minutes to and 14 minutes from Oju-Ore to Sango under bridge. From point B to point C (Oju-Ore to Obasanjo Junction) it took an average of 10 minutes to and 17 minutes from Obasanjo to Oju-Ore. At Point C, Obasanjo to Iyana Iyesi took an average of 8 minute and 14 minutes from Iyana Iyesi to Obasanjo while at point D which is Iyana Iyesi to Cannanlandtook an average of 5 minutes and from Cannaland to Iyana Iyesi, it took 9 minutes on average at the evening (Table 5).

More time is usually being spent from Obasanjo Junction to Oju-Ore according to the survey in the evening just as it is in the morning while Oju-Ore to Sango under Bridge also takes much time as well. This implies that most of the delay being experienced in the evening also occurred between Oju-Ore and Sango under Bridge. Although, in some weekdays, the road can be free and vehicles can move as fast as completing the journey within 6 minutes but when congestion is experienced, it can take as much as approximately 35 minutes to complete the same journey. The delay is mostly experienced at the weekends precisely on Sundays when the road is filled above capacity because of the activities on the road. Meanwhile, the survey conducted is in relation to the traffic situation at the time of the survey while the congestion on the road can last for hours in some other times.

Table 5: Average daily travel timeat evening peak

Points	Routes	Weekly Average (in Minutes)	Weekly Average (in Minutes)
		From Sango to Winners	From Winners to Sango
Point A	Sango Under Bridge – Oju Ore	11	14
Point B	Oju-Ore – Obasanjo Junction	10	17
Point C	Obasanjo Junction – Iyana Iyesi Junction	8	14
Point D	Iyana Iyesi Junction – Cannanland	5	9

Source: Author's Field Survey, 2019.

5.0 Findings and Discussion

5.1 Traffic Volume and Vehicle Characteristics in the Study Area

The traffic volume count along the corridor was conducted in seven separate days (Monday through Sunday) within a week. The study area was divided into four (4) Internal Traffic Zones which were: Sango Junction as "Zone A"; Oju-Ore Junction "Zone B"; Obasanjo Farm Junction "Zone C" and Winners' Junction as Zone "D". This was done in order to determine the daily average traffic volume and vehicle characteristics of the study area

5.1.1 Internal Traffic Zone "A" – Sango Junction

The variations of daily traffic volume in Zone A of the Sango/Idiroko corridor were shown in Table 6. The total daily traffic volume in the Internal Traffic Zone A (Sango Junction) of the study area was 135999. The traffic peak period in this zone is between 2. 00PM and 3.00 PM with average daily traffic volume of 1907. The morning peak is between 8. 00AMand 9. 00AM with volume of 10761 with average of 1537 while the evening peak is between 6. 00PM and7. 00PM with traffic volume of 11412 and 1630 on average. The peak period in this traffic zone is difficult to determine as the traffic is high all through the days with no significant distinction between the volumes at a specific time. However, the average daily traffic in this zone is 19428.

Table 6: Average Daily Traffic in Zone "A" - Sango Junction during Weekdays.

TIME	Mon.	Tues.	Wed.	Thur.	Friday	Sat.	Sunday	Total	Average
7:00am - 8:00am	1220	942	949	784	1123	1355	1140	**7513**	**1073**
8:00am - 9:00am	1945	1813	1099	1088	1751	1482	1583	**10761**	**1537**
9:00am - 10:00am	1837	1673	1252	1204	1660	1527	1591	**10744**	**1535**
10:00am - 11:00am	1444	1480	1794	1770	1393	1575	1395	**10851**	**1620**
11:00am - 12:00noon	1723	1863	1232	1200	1770	1801	1749	**11338**	**1620**
12:00noon - 1:00pm	1846	1997	1234	1225	1930	1660	1740	**11632**	**1662**
1:00pm - 2:00pm	2045	2141	812	700	2100	1764	2108	**11670**	**1667**
2:00pm - 3:00pm	2527	2361	920	901	2069	2240	2334	**13352**	**1907**
3:00pm - 4:00pm	2233	2193	1145	1128	2037	2284	2151	**13171**	**1882**
4:00pm - 5:00pm	2055	2253	1005	1000	2002	2324	1769	**12408**	**1773**
5:00pm - 6:00pm	2212	2214	927	896	1863	1538	1497	**11147**	**1592**
6:00pm - 7:00pm	2381	2276	1020	993	2002	1548	1192	**11412**	**1630**
TOTAL	**23468**	**23206**	**13389**	**12889**	**21700**	**21098**	**20249**	**135999**	**19428**

Source: Author's Field Survey, 2019

Table 7, indicates the vehicle characteristics of this traffic zone. Motorcycle / Tricycle has the highest average daily number of vehicles (6892) flow to and from the zone. Car recorded 5656 traffic on average while Goods Vehicles/Van generated the least at 1915 on average. This zone also recorded the highest number of truck/trailer (2033 on average) out of all the traffic zones under study. This shows the importance of this area as it is rapidly growing in population, economic activities and highly industrialized. This superiority of the motorcycle/tricycle in this zone as a mode of movement implies that there is presence of delay in movement and the resultant effect is that the commuters plying this zone prefer motorcycle/tricycle in order to save time and to avoid traffic delay.

Table 7: Average Daily Vehicle Characteristics in Zone "A"

Days	Motorcycle / Tricycle	Car	Bus	Truck / Trailer	Van
Day 1	8129	6790	3309	2630	2610
Day 2	7960	6775	3132	2711	2628
Day 3	5020	3702	2585	992	1090
Day 4	4796	3580	2534	945	1034
Day 5	7410	6495	3169	2402	2224
Day 6	7542	6745	3006	2256	1549
Day 7	7389	5508	2787	2297	2268
Total	48246	39595	20522	14233	13403
AVERAGE	**6892**	**5656**	**2932**	**2033**	**1915**

Source: Author's field Survey, 2019.

5.1.2 Internal Traffic Zone "B" – Oju-Ore Junction

In the Internal Traffic Zone B (Oju-Ore Junction), the peak period is between 9.00AM and 10.00AM which an average of 1724 traffic volume is generated daily in the zone. However, Table 8 shows that the lowest traffic volume (1253) is generated between 4.00PM and 5.00PM, while 5.00PM and 6.00PM recorded 1356 on average as the second lowest traffic volume despite the feasible higher concentration of traffic on the road at those periods. This shows that there is always traffic congestion on this zone specifically in the evening between the hours of 4.00 PM and 6.00PM and often run to 8.00PM or more sometimes as observed. Oju-Ore is also one of the major nodes along the road under study. The presence of Ota Township Road intersecting the major road of Sango – Owode-Idiroko Road creates a major bottleneck as the traffic along this route (Ota Township Road) is equally rich in volume.

Table 8: Average Daily Traffic in Zone "B" - Oju-Ore's Junction

TIME	Mon.	Tues.	Wed.	Thurs.	Friday	Sat.	Sun.	Total	Average
7:00am - 8:00am	1096	1238	1207	1090	1177	986	1523	**8317**	**1188**
8:00am - 9:00am	1171	1226	1205	1227	1249	1496	2028	**9602**	**1372**
9:00am - 10:00am	1046	1912	1921	1713	1686	2058	1730	**12066**	**1724**
10:00am - 11:00am	952	1688	1731	1821	1840	1656	1623	**11311**	**1616**
11:00am - 12:00noon	925	1607	1706	1693	1674	1569	1105	**10279**	**1468**
12:00noon - 1:00pm	754	1574	1585	1598	1600	1087	1370	**9568**	**1367**
1:00pm - 2:00pm	727	1691	1729	1773	1780	1176	1873	**10749**	**1536**
2:00pm - 3:00pm	912	1452	1342	1361	1421	1426	1490	**9404**	**1343**
3:00pm - 4:00pm	1068	1628	1624	1656	1662	1461	1241	**10340**	**1477**
4:00pm - 5:00pm	1370	1657	971	970	1017	1252	1537	**8774**	**1253**
5:00pm - 6:00pm	1504	1229	1111	1132	1113	1567	1837	**9493**	**1356**
6:00pm - 7:00pm	1226	1064	1355	1344	1367	2017	1523	**9896**	**1414**
TOTAL	**12751**	**17966**	**17487**	**17378**	**17586**	**17751**	**18880**	**119799**	**17114**

Source: Author's Field Survey, 2019.

Table 9 shows that average of 5199 cars ply the zone on a daily basis, while 6886 motorcycles/tricycles are recorded on a daily basis in this zone. An average of 966 trucks/trailers and 2911 buses plied to and from this zone daily. This implies that motorcycles/tricycles and cars ply this zone more than any other vehicles on daily basis.

Table 9: Average Daily Vehicle Characteristics in Zone "B"

Days	Motorcycle / Tricycle	Car	Bus	Truck / Trailer	Van
Day 1	5874	4226	1182	709	760
Day 2	7534	5360	3343	861	868
Day 3	7472	5044	3250	855	866
Day 4	7177	5102	3329	832	938
Day 5	7295	5142	3330	869	950
Day 6	6294	5350	3068	1304	1735
Day 7	6556	6170	2872	1332	1736
Total	48202	36394	20374	6762	7853
AVERAGE	**6886**	**5199**	**2911**	**966**	**1122**

Source: Author's Field Survey, 2019.

5.1.3 Internal Traffic Zone "C" – Obasanjo Farm Junction

Tables (10 and 11) show the variation of average daily traffic volume and vehicle characteristics along this traffic zone. An average of 5981 motorcycles/tricycles, 4138 cars and 2413 buses constitute the daily traffic volume in this zone. The peak periods of this zone is between the hours of 9. 00AM and 10.00AM morning peak constitutes an average volume of 1536 and 4. 00pm and 5. 00PM as evening peak constitutes an average volume of 1245. The evening peak volume is relatively low compared with morning peak. This is as a result of traffic delay usually experienced in this zone as it always serious in the evening than in the morning, despite more vehicles on the road in the evening than in the morning.

Table 10: Average Daily Traffic in Zone "C" - Obasanjo Junction

TIME	Mon.	Tues.	Wed.	Thurs.	Friday	Sat.	Sun.	Total	Average
7:00am - 8:00am	1550	1098	625	1025	1157	1330	1203	**7988**	**1141**
8:00am - 9:00am	2383	1139	847	1247	1640	1722	1458	**10436**	**1491**
9:00am - 10:00am	2256	1615	813	1213	1325	1817	1716	**10755**	**1536**
10:00am - 11:00am	1143	1630	346	746	958	1540	1434	**7797**	**1114**
11:00am - 12:00noon	1363	1585	569	969	1093	1261	1518	**8358**	**1194**
12:00noon - 1:00pm	1365	1466	403	803	1045	1249	1470	**7801**	**1114**
1:00pm - 2:00pm	1386	1580	638	1038	1234	1329	1756	**8961**	**1280**
2:00pm - 3:00pm	1572	1340	560	960	1401	1558	1830	**9221**	**1317**
3:00pm - 4:00pm	1086	1410	492	892	1155	1596	1308	**7939**	**1134**
4:00pm - 5:00pm	1399	1605	565	965	1287	1774	1117	**8712**	**1245**
5:00pm - 6:00pm	1515	1239	529	829	863	1467	1115	**7557**	**1080**
6:00pm - 7:00pm	1225	1179	473	873	745	1578	1031	**7104**	**1015**
TOTAL	18243	16886	6860	11560	13903	18221	16956	**102629**	**14661**

Source: Author's Field Survey, 2019.

Table 11: Average Daily Vehicle Characteristics in Zone "C"

Days	Motorcycle / Tricycle	Car	Bus	Truck / Trailer	Van
Day 1	7448	5638	3096	1034	1027
Day 2	7245	5000	3078	822	741
Day 3	2862	1659	1230	585	524
Day 4	5262	2859	2330	585	524
Day 5	5578	3787	2255	1121	1162
Day 6	6618	5127	2549	1700	2227
Day 7	6856	4893	2352	1332	1523
Total	41869	28963	16890	7179	7728
AVERAGE	**5981**	**4138**	**2413**	**1026**	**1104**

Source: Author's Field Survey, October 2019.

5.1.4 Internal Traffic Zone "D" – Winners Junction

In this traffic zone, the morning peak hour is between 8am–9am with a total average of 1313, while the highest vehicle recorded is 5823 motorcycles/tricycles within the 12hours of the traffic count. The evening peak period is 6. 00PM to 7. 00PM with 1450 average daily traffic volume (Table 12 and Table 13). The traffic volume at this zone is higher on Sunday than any other day within the week. This indicates the importance of a major land use (church) located in this zone that contributes to traffic generation. However, the volume is at highest on Sunday during the period of church service between the hours of 8. 00AM and 3. 00PM. The cars plying this route almost compete with motorcycle on Sundays in terms of volume.

Table 12: Average Daily Traffic in Zone "D" - Winners' Junction

TIME	Mon.	Tues.	Wed.	Thurs.	Friday	Sat.	Sun.	Total	Average
7:00am - 8:00am	862	839	1044	1011	984	1001	1047	**6788**	**9670**
8:00am - 9:00am	1279	1174	1277	1190	1362	1428	1478	**9188**	**1313**
9:00am - 10:00am	1408	1176	1139	1164	1587	943	1338	**8755**	**1251**
10:00am - 11:00am	1193	1161	1135	1022	1373	1074	1434	**8392**	**1199**
11:00am - 12:00noon	1336	1185	1159	1159	1281	1021	1510	**8651**	**1236**
12:00noon - 1:00pm	1401	1315	1332	1244	1485	1168	1762	**9707**	**1387**
1:00pm - 2:00pm	955	1118	1118	1214	1097	928	1876	**8306**	**1187**
2:00pm - 3:00pm	1162	1146	1046	1191	1124	1366	1720	**8755**	**1251**
3:00pm - 4:00pm	1213	1157	1467	1186	1156	1025	1471	**8675**	**1239**
4:00pm - 5:00pm	1335	1231	1431	1234	1376	1048	1320	**8975**	**1282**
5:00pm - 6:00pm	1282	1365	1455	1430	1349	935	919	**8735**	**1248**
6:00pm - 7:00pm	1365	1450	1530	1426	1325	1907	1150	**10153**	**1450**
TOTAL	**14791**	**14317**	**15133**	**14471**	**15499**	**13842**	**17025**	**105078**	**15011**

Source: Author's Field survey, 2019.

Table 13: Average Daily Vehicle Characteristics in Zone "D"

Days	Motorcycle / Tricycle	Car	Bus	Truck / Trailer	Van
Day 1	5531	4059	2554	1219	1428
Day 2	5884	3701	2493	1055	1184
Day 3	6455	3985	2525	1024	1144
Day 4	5815	3652	2558	1013	1433
Day 5	5532	4834	2288	1374	1471
Day 6	4545	4018	2379	1519	1381
Day 7	7000	5730	1971	1059	1265
Total	40762	29979	16768	8263	9306
AVERAGE	**5823**	**4283**	**2395**	**1180**	**1329**

Source: Author's Field Survey, 2019.

5.2 Summary of the Traffic Volume in the Study Area

Table (14 and 15) and Figure 6show the summary of the variations of daily traffic volume in the study area (Sango/Idiroko Corridor). The morning peak hour is between 9. 00AM and 10. 00AM with an average of 6046 vehicles plying the Corridor, while the evening peak hour is between 2. 00PM and 3. 00PM having an average of 5818 traffic flow. The traffic volumes between the zones indicate that Zone "A" has highest daily traffic volume (19428) constitute 29% while Zone "C" has the least (14661) and constitute 22.1%. The range of daily traffic volume between these traffic zones is 4767. This indicates that there are different link roads that probably create the diversion of traffic or add to the number of traffic within the internal traffic zone. This gives room for the large variation between the Zones.

Table 14: Average Daily Traffic in the Study Area

TIME	ZONE A	ZONE B	ZONE C	ZONE D	TOTAL
7:00am - 8:00am	1073	1188	1141	9670	**13072**
8:00am - 9:00am	1537	1372	1491	1313	**5713**
9:00am - 10:00am	1535	1724	1536	1251	**6046**
10:00am - 11:00am	1620	1616	1114	1199	**5549**
11:00am - 12:00noon	1620	1468	1194	1236	**5518**
12:00noon - 1:00pm	1662	1367	1114	1387	**5530**
1:00pm - 2:00pm	1667	1536	1280	1187	**5670**
2:00pm - 3:00pm	1907	1343	1317	1251	**5818**
3:00pm - 4:00pm	1882	1477	1134	1239	**5732**
4:00pm - 5:00pm	1773	1253	1245	1282	**5553**
5:00pm - 6:00pm	1592	1356	1080	1248	**5276**
6:00pm - 7:00pm	1630	1414	1015	1450	**5509**
TOTAL	**19428**	**17114**	**14661**	**15011**	**66214**

Source: Author's Field survey, 2019.

Table 15: Average Weekly Traffic in the study area

ZONES	AVERAGE	Percentage (%)
Zone A (Sango Junction)	19428	29.34
Zone B (Oju-Ore Roundabout)	17144	25.88
Zone C (Obasanjo Junction)	14661	22.12
Zone D (Winners' Junction)	15011	22.66
Total	**66214**	**100**

Source: Author's Field survey, 2019.

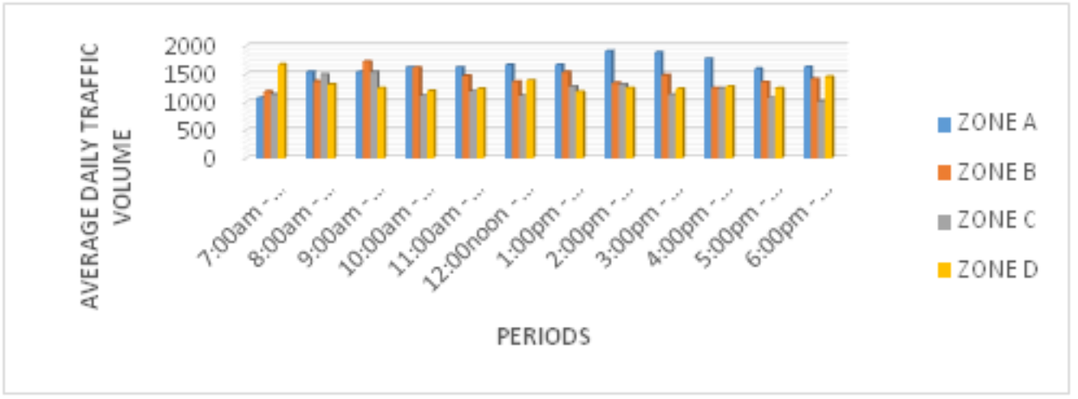

Figure 6: Variations of hourly Traffic Volume Generated in the study area.

Source: Author's Fieldwork,2019.

5.3 The Link Roads

There are different link roads in the study area, which are responsible for either the evacuation of traffic along the corridor under study or addition of traffic. However, even (7) has been identified to be major among these link roads and it comprises Iganmode Road, Joju Road, Ota Township Road, Ilogbo Road, Obasanjo Road, Iyana-iyesi Road and Winners Chapel Road.

The roads were, therefore, assigned an identity for referencing in this report as:

P1 - Iganmode Road, P2 - Joju Road, P3 -Ota Township Road, P4 -Ilogbo Road

P5 - Obasanjo Road, P6 - Iyana Iyesi Road, P7 - Winners' Chapel

The traffic volume at link roads indicates that: The link Road P3 (Ota Township Road) has the highest weekly traffic diversion (34009) and constitute 26.5%, because of the importance of this road as it is the road to the Lagos boundary (Toll Gate as popularly Known). Majority of the residents of Ota and its environs work or have one or two things to do in Lagos on a daily basis. It also served as the route to bypass the ever-congested Sango (Under Bridge. Link Road P7 (Winners Chapel) recorded 29165 traffic diversion which constitute 22.7%. The traffic diversion here is always very high on Sundays during the church service while during the week, is not that high. Link Road P5 (Obasanjo Road) recorded the lowest weekly traffic diversion (4.8%) along the study area. The range of weekly traffic diversion along this Corridor is 12969. This indicates that traffic is highly diverted in some points than others (Table 16 and 17).

Table 16: Average Weekly Traffic at the Link Roads

TIME	P1	P2	P3	P4	P5	P6	P7	TOTAL
7:00am - 8:00am	820	1012	2315	1316	502	983	1281	**8229**
8:00am - 9:00am	914	1318	3541	1275	518	1276	2406	**11248**
9:00am - 10:00am	864	1663	3672	1430	478	1048	2277	**11432**
10:00am - 11:00am	941	1554	3261	1427	523	935	2216	**10857**
11:00am - 12:00noon	854	1450	2912	1543	516	866	2019	**10160**
12:00noon - 1:00pm	822	1422	2845	1293	507	602	2001	**9492**
1:00pm - 2:00pm	834	1485	2977	1452	562	619	2468	**10397**
2:00pm - 3:00pm	866	1647	2773	1367	524	646	2604	**10427**
3:00pm - 4:00pm	895	1867	2422	1216	501	701	3022	**10624**
4:00pm - 5:00pm	986	1894	2640	1410	487	1033	3376	**11826**
5:00pm - 6:00pm	1102	1965	2536	1401	544	1575	3381	**12504**
6:00pm - 7:00pm	1065	1873	2115	1291	519	2016	2114	**10993**
TOTAL	**10963**	**19150**	**34009**	**16421**	**6181**	**12300**	**29165**	**128189**

Source: Author's Field survey, 2019.

Table 17: Weekly Traffic Diversion in the study area.

TRAFFIC DIVERSION POINTS	NUMBER	Percentage (%)
Point 1 (IganmodeRoad)	10963	8.53
Point 2 (JojuRoad)	19150	14.94
Point 3 (Ota Township Road)	34009	26.54
Point 4 (IlogboRoad)	16421	12.81
Point 5 (Obasanjo Road)	6181	4.82
Point 6 (Iyana Iyesi'sRoad)	12300	9.60
Point 7 (Winners Chapel)	29165	22.76
Total	**128189**	**100**

Source: Author's Field survey, 2019.

5.4 Summary of the Vehicle Characteristics in the Study Area

Table 19 and Figure 7 show the summary of the various vehicle characteristics in all the traffic zones in the study area. Motorcycles/tricycles constitute the highest average daily traffic volume (25582) and represents 39% on the corridor. This is reflected across all the internal traffic zones under the study. The trucks and trailer recorded the lowest daily traffic volume (5205) which is 8% in the study area (Sango/Idiroko Corridor). This shows that commuters on this corridor prefer motorcycles / tricycles to cars or buses as a result of certain factors such as avoidance of traffic congestion, poor road condition, among others.

Table 18: Average Daily Vehicle Characteristics in the Study Area

VEHICLE TYPES	ZONE A	ZONE B	ZONE C	ZONE D	TOTAL
Motorcycle / Tricycle	6892	6886	5981	5823	**25582**
Car	5656	5199	4138	4283	**19276**
Bus	2932	2911	2413	2395	**10651**
Truck / Trailer	2033	966	1026	1180	**5205**
Good Vehicle / Van	1915	1122	1104	1329	**5470**
TOTAL	**19428**	**17084**	**14662**	**15010**	**66184**

Source: Author's Field survey, 2019.

Table19: Average Daily Vehicle Characteristics in the Study Area

Vehicle Types	Number	%
Motorcycle / Tricycle	25582	38.65
Car	19276	29.13
Bus	10651	16.09
Truck / Trailer	5205	7.86
Good Vehicle / Van	5470	8.27
TOTAL	**66184**	**100**

Source: Author's Field survey, 2019.

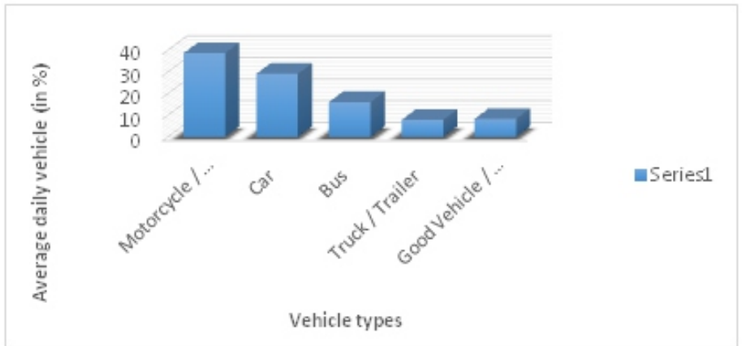

Figure 7: Vehicle characteristics in the study area

5.5 Evaluation of Carriage Capacity of Sango/Idiroko Corridor

In evaluating the carriage capacity of the Sango/Idiroko Road, the Passenger Car Unit (PCU) per hour for Urban Standard Road according to Lewis Keebles (1969) was used (Table 19). The evaluation was done in each zone, in order to determine the carriage capacity of each zone in the study area, in reference to the traffic volume generated daily per hour.

Table 19: Equivalent Value in Passenger Car Unit (PCU's)

Vehicle Characteristics	PCU's
Motorcycle / Tricycle	0.75
Car	1.0
Bus	2.0
Truck / Trailer	3.0
Good Vehicle / Van	2.0
Capacity in PCU's per hour for BOTH directions of flow	***1,200***

Source: Lewis Keebles, 1969.

The calculated values of PCU's per hour in each zone indicates that the Sango traffic zone (Zone "A") has the highest calculated value of 2,218 PCU's per hour), while the calculated value of Oju-Ore traffic zone (Zone "B") is 1,777 PCU's per hour (the lowest calculated value among the zones). Obasanjo and Winners' traffic zones attain 1,556 PCU's per hour and 1,637 PCU's per hour respectively (Appendix I). However, the result from the PCU means that the road under investigation is functioning far above its capacity and the same result was achieved at all the internal traffic zones of the study route. This indicates that there is need to divert or decongest the traffic pressure on this corridor. The summary is hereby presented in Table 20.

Table 20: PCU per hour for the Traffic Zones

Internal Traffic Zones	Calculated Value (PCU's per hour)	Excess PCU	Rate
Sango (Zone A)	2,218 PCU's per hour	1,018	Highly Congested
Oju-ore (Zone B)	1,777 PCU's per hour	577	Very Congested
Obasanjo (Zone C)	1,556 PCU's per hour	356	Very Congested
Winners (Zone D)	1,637 PCU's per hour	437	Very Congested

Source: Author's field survey, 2019.

The implication of this is that there will be serious problem on this road at most of the time. Similarly, the environmental problem of carbon emission will be experienced as vehicles queue up on the road while all the vehicles in Nigeria currently run on fossil fuel.

5.6 Environmental Issues and Transportation Sustainability

The environmental issues along the study route is seen from the street trading, on-street parking, road intersection at some junctions and most importantly, the carbon emission as a result of concentration of vehicles on the road way. This poses a danger to the environment and contradicts the target of sustainable development precisely goal 3 and 11 which emphasis is on good health for people in terms of increased road safety and sustainable cities by ensuring access to transport and expanded public transport respectively. Sustainable Development Goals are the blueprints to achieve a better and more sustainable future for all. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace, and justice and if we don't get road transport right, we won't get any of the sustainable development goals right. The 2012 United Nations Conference on Sustainable Development (Rio +20) emphasized that transportation and mobility are central to sustainable development. Sustainable transportation can enhance economic growth and improve accessibility. Sustainable transport achieves better integration of the economy while respecting the environment, improving social equity, health, resilience of cities, urban-rural linkages and productivity of rural areas. Transportation, therefore, contributes directly to five targets on sustainable goals which are: road safety (Target 3.6); energy efficiency (Target 7.3); sustainable infrastructure (Target 9.1), urban access (Target 11.2), and fossil fuel reduction (Target 12.c). Therefore, the elimination of the traffic congestion along Owode-Idiroko Road can be achieved through the considerations of the recommendations in order to ensure the sustainable development of Ota City.

6.0 Conclusion and Recommendations

Efficient transport system is central to development of smart cities. Where movement is impeded, socio-economic prosperity is restricted and lots of resources are wasted in terms of man-hours. The existing roads are to be rehabilitated to provide good passage way for vehicles and with possible expansion in order to accommodate the present volume and additional volume in the nearest future. There is different existing bypass that can help to decongest the road under study if they are put in good conditions. For instance, the Iju–Ilogbo-Bypass will help to remove significant numbers of vehicles going to Abeokuta and Ifo axis from passing through the ever congested Oju-Ore and Sango.

Coca Cola-IlogboRoad is one of the major linkage roads evacuating traffic from the studied route. The rehabilitation of this road will definitely help in evacuating more traffic to decongest the route under focus. People who are going to Sango can also make use of Veepee Road in order to bypass Sango and Oju-Ore congestion while Arobieye-Iju Road will be much useful for those that are going to Lagos to easily bypass all the potential conflict points and burst out at Ayobo. Reconstruction of Joju Road with proper drainage system will definitely reduce pressure on Sango Under Bridge as significant number of traffic coming to Oju-Ore axis from Abeokuta/Ifo area may not need to pass through Sango but make use of Joju Road (Fig 8 &9 the proposed roads for rehabilitation is in red). Creation of an extra lane for walking and cycling, use of public transit, car sharing, and vehicles' segregation will help in achieving sustainable transport in the area.

Figure. 8: Google earth showing the proposed road for rehabilitation

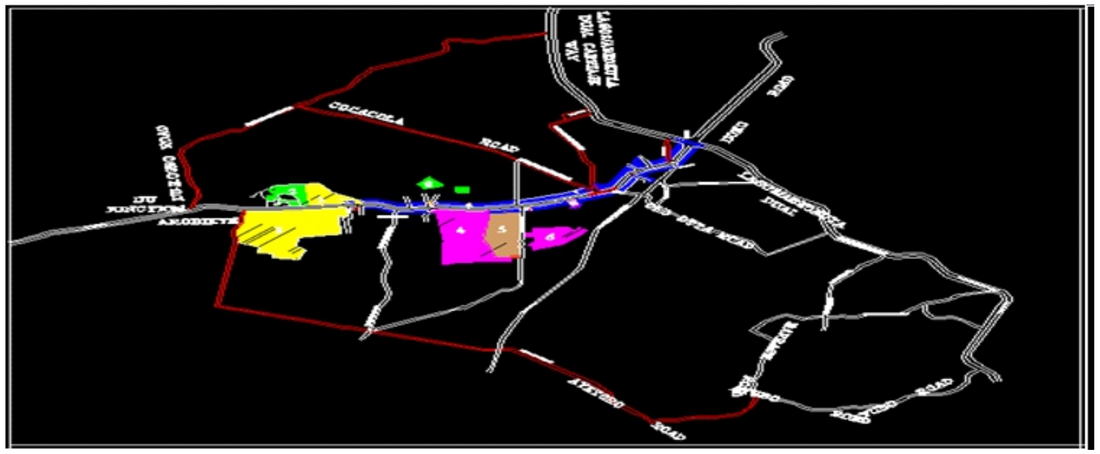

Figure 9: The drawing of road network proposed for rehabilitation
Source: Author's proposed design, 2019.

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APPENDIX I

Calculated Passenger Car Unit for Each Zone

PCU for Zone "A" - SANGO

Vehicle Characteristics	Daily Volume	PCU's	
Motorcycle / Tricycle	6892	0.75 X 6892 = 5169	
Car	5656	1.0 X 5656 = 5656	**26,618**
Bus	2932	2.0 X 2932 = 5864	**12**
Truck / Trailer	2033	3.0 X 2033 = 6099	**= 2,218 pcu's per hour**
Good Vehicle / Van	1915	2.0 X 1915 = 3830	

PCU for Zone "B" – OJU-ORE

Vehicle Characteristics	Daily Volume	PCU's	
Motorcycle / Tricycle	6886	0.75 X 6886 = 5165	
Car	5199	1.0 X 5199= 5199	**21,328**
Bus	2911	2.0 X 2911 = 5822	**12**
Truck / Trailer	966	3.0 X 966 = 2898	**= 1777 PCU per hour**
Good Vehicle / Van	1122	2.0 X 1122 = 2244	

PCU for Zone "C" - OBASANJO

Vehicle Characteristics	Daily Volume	PCU's	
Motorcycle / Tricycle	5981	0.75 X 5891 = 4418	
Car	4138	1.0 X 4138 = 4138	**18,668**
Bus	2413	2.0 X 2413 = 4826	**12**
Truck / Trailer	1026	3.0 X 1026 = 3078	**= 1556 PCU per hour**
Good Vehicle / Van	1104	2.0 X 1104 = 2208	

PCU for Zone "D" – WINNERS' JUNCTION

Vehicle Characteristics	Daily Volume	PCU's	
Motorcycle / Tricycle	5823	0.75 X 5823 = 4367	
Car	4283	1.0 X 4283= 4283	**19,638**
Bus	2395	2.0 X 2395 = 4790	**12**
Truck / Trailer	1180	3.0 X 1180 = 3540	**= 1,637 pcu's per hour**
Good Vehicle / Van	1329	2.0 X 1329 = 2658	

Source: Author's Field Survey, 2019.