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Mapping and Assessment of Traffic Delay Problems, Characteristics at Major Road Intersection, Effects and Possible Solution in Urban Settlement

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Abstract-Sustainable urban development can be traced to many factors and day to day activities in which transportation system play a vital role. Geographical Information System plays an important role in sustainable urban development. This study assesses traffic delay, characteristics at major road intersection, effects and possible solution in Ido Local Government Area, Oyo State, Nigeria. The study was carried between January and February, 2020. Spatial locations of traffic hotspot were determined through field surveying method by using the differential GPS and questionnaires to assess the delay, causes. Six hundred (600) questionnaires were administered, while five hundred and twenty (520) questionnaires that were returned. Intersection occurs at five divisions within the study area namely; Omi-Adio, Ologuneru/Eleyele, Ido, Apete and Apata. IKONOS satellite imagery of 0.82m-1.0m resolution was used to fix the position of hotspots. Spatial location data were processed using GNSS Solution and IBM SPSS version 20 for questionnaire. Further analysis was done using ArcGIS 10.5. From the results, the causes of traffic in the study area are; roadside parking, double parking, and vehicle breakdown as they have the highest responses with 77 (14.74%), 74 (14.17%), and 69 (13.59%) amongst others. The result also shows that traffic problems is the major causes in road intersections as the number of respondent is high with 346 (66.53%). The study reveals that 261 (31.48%) considered creation of parking spaces as the possible solution with high number of respondent. The result of this study will help both the State and Local Government to know the adequate measure to put in place in the affected areas and avoidance of future occurrence on other roads to be constructed.
Keywords: Sustainable Development, Geographical Information System, Spatial Location

1. INTRODUCTION

Traffic congestion has been one of major issues that most metropolises are facing. In order to mitigate this congestion, many measures have been taken (Rao & Rao, 2012). It is believed that the identification of congestion characteristics is the first step for such efforts as an essential guidance for selecting appropriate measures (Rao & Rao, 2012). Traffic congestion wastes time and energy, causes pollution and stress, decreases productivity and imposes costs on society (Rao & Rao, 2012). Onasanya Olusina and Olaleye (2013) also opined that that Intelligent Transportation Systems (ITS) is an alternative technology which holds promise for relieving congestion. Urban traffic management therefore is an important aspect of transportation planning that attracts the attention of transport experts and governments in both developed and developing countries in the world (Ajala, 2011). Preliminary investigations revealed that there is a gradual increase in the volume of automobile that plies the road networks within the study area. It is one of the major causative factors of the traffic gridlock frequently experienced by road users (Ajayi et al., 2015). Lindsey and Verhoef (2009) on congestion modeling, postulated that there is no single best way to model traffic flow and congestion but that the level of detail at the driver's behavior should be modeled, depending on the object of the analysis. Ogunbodede (2007) examined traffic problems in Akure, Nigeria, using a GIS application for the development of a Traffic Information System (TIS). Aworemi et al. (2009) identified and investigated some major variables as factors causing congestion in Lagos state. These variables are: poor road condition, road accidents, inadequate road infrastructure, and absence of integrated transport system, inadequate traffic planning and driver's behavior. The results obtained from the research showed that poor road condition, road traffic accidents, inadequate road infrastructure, absence of integrated transport system, inadequate traffic planning and driver's behavior made a significant contribution of approximately 70.7% to the traffic congestion situation of Lagos State.

Road Intersection is where two or more roads meet and or are the points of potential vehicle conflict. Road intersection can be classified based on geometric as T – Intersections, Y – Intersections, Scissor intersections, Cross intersections, staggered intersections, Staggered and Skewed intersections and Multi-way intersections. Therefore, the need to map out and assess the traffic problems on major roads in the Ido Local Government

Area, Oyo State, Nigeria will serve as a base map for providing presumable solutions to the threat of traffic delay problem.

2. LITERATURE REVIEW

Early works on measuring the structure of transportation networks date back to the 1960s, when geographers and transportation researchers focused almost exclusively on topologic measures employing graph theoretic network analysis. Some of the factors responsible for traffic congestion in the study area now were among those which Filani and Olateru (1976) argued that traffic problems in Ibadan had also been aggravated by the city's rapid economic and industrial development as most of the existing roads at that time were constructed in the 1940s and early 1950s when the city's economic based and territorial extent were very limited. The department of Transport U.S. (2005) defined Traffic Congestion as an essentially a relative phenomenon that is linked with the different road way system performance that road users expect and how the system actually performs. Congestion results when traffic demand approaches or exceeds the available capacity of the road system. However, the total effect of congestion on Nigeria Highway in which Ido Local Government is part of, cannot be accurately quantify due to uncounted and diversified effects it has on the national capacity but its significant effect can be seen on service delivery, good delivery, pollution, discomfort, excessive fuel consumption, excessive vehicle maintenance all these accounted for economic loss.

2.1 Effects of Traffic Congestion on Human and Environment

Fatal accidents, injuries and death, according to World Health organization (WHO) Over 3,400 people die on the world's roads every day and tens of millions of people are injured while others are disabled every year. Children, motorcyclist, pedestrians, cyclists and older people are among the most vulnerable of road users (Sevitt, S. 1968). World Health Organization (WHO) always works hand in hand with governmental and non-governmental Organizations (NGOs) all over the world to raise the profile of the preventability of road traffic injuries and promote good practice related to addressing key behavior risk factors: speed, drink-driving, and the use of motorcycle helmets, seat-belts and child restraints. The traffic speeds are slower where densities are higher and the reverse is true. In the United States, average roadway speeds in urban areas are around 32 miles per hour; the European speeds are less than 20 miles per hour, while Canadian speeds are less than 25 miles per hour (Chakravarthy, et al, 2008). The inability to forecast travel time and delay movements (Hensher,1997), research has proved that travel behaviors of customer choice models to drive the valve of time spent in travel for both work and other activities. However, research studies by (Jackson and Jucker ,1982) (polka ,1987), (Black and Towriss, 1993) again have demonstrated the importance of considering time variability in the deviation of traveler cost function, the studies show that the right circumstances during congested peak period travel, reduces the variability hence uncertainty associated with trip times can offer a significant traveler benefits. This empirical evidence examined that a major cause of day to day variability in trip times is the occurrence of traffic incidents, including major accidents that block traffic lanes for prolonged periods and many minor incidents, such as vehicle breakdowns and other factors (Lindley ,1987), (Giuliano ,1989). This model described the mean and variance in the time lost due to such traffic incidents along freeways.

3. METHODOLOGY

3.1 Study Area

Ido local government is an urbanized area of the Ibadan city. Ibadan being the largest city in Africa, is located approximately on longitude 3^0 5' east of the Greenwich meridian and latitude 7^0 23' North of the equator with the distance of about 119 kilometer (74 miles) Northeast of Lagos and 120kilometers (75 miles) East of the Nigerian international border with the republic of Benin. The study area is Ido local government area, Oyo State, Southwest Nigeria. The local government consists of five divisional area with communities under them. The total population of Ido local government according to the 2006 population census was 103,261 (National Population Commission, 2006). It lies between longitude 3°47′34.99″E and latitude 7°30' 44.49″ N.

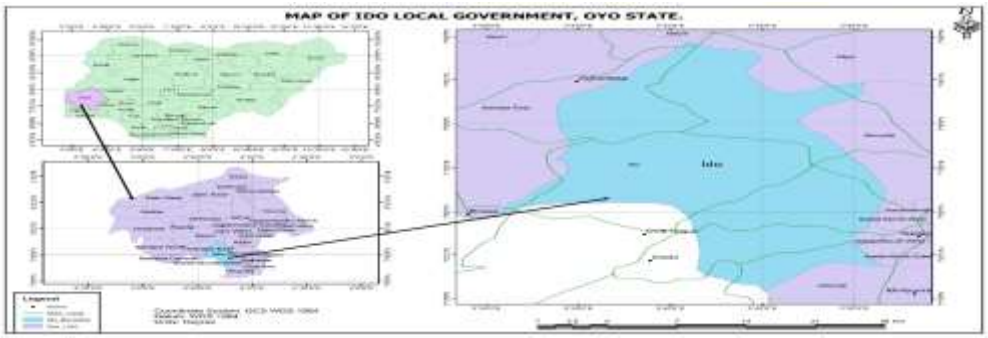

Figure 1: Study Area Map

3.2 Method of Data Acquisition

- ✓ For the purpose of this study, both the primary and secondary data source was adopted. The primary data source was based on the use of Hi-target differential Global Positioning System to acquire the (x, y, and z) coordinates of traffic points and intersection points for mapping purposes, Questionnaires was also administered to six hundred (600) respondents' within the five divisions that make up the study area; and traffic volume counts was carried out at various intersections leading to the congested area along the major roads. The secondary data source was adopted from Journals publications, Books, Conference paper presentation and also a purchased IKONOS imagery of 0.8m-1.0m resolution of the study area.

3.2.1 Procedure for Acquiring hotspots data for Traffic points and Intersections

Hi-target differential GPS was used to acquire the x, y coordinate of traffic points and intersections in the study area. The mode of operation used in acquiring the data was static mode whereby the differential GPS on the control station acquire a single data and continue to refine it to the maximum accuracy while the other GPS (Rover) in all traffic points and intersections was given a time interval of five (5) minutes to acquire data (x, y, z) for all the traffic points and intersections in the study area.

3.2.2 Procedure for Acquiring Attribute data for Traffic points and Intersections

The main attribute data that was used for the study is questionnaire and interview. In each area captured in this study, questionnaires were randomly distributed to have a representative coverage. The respondents were selected considering the fact that they must be a road user that passes through such road corridor virtually every day. The questionnaire was distributed using stratified random sampling to the respondents. For the distribution of the questionnaires, the traffic locations are subdivided into five (5) divisions using the coon location under which the communities are.

Table 1: Intersections where traffic occurs under the five divisions in the study area

S/No.	Omi-Adio	Ologuneru/Eleyele	Ido	Apete	Apata
1	Abidogun	Eleyele 1	-	Onigbodogi	BCJ
2	Bakatari	Eleyele 2	-	OjuOja 1	NNPC
3	-	Ologuneru	-	OjuOja 2	Fatimoh
4	-	-	-	Jeje	Wema
5	-	-	-	Ori Are	Apata Market
6	-	-	-	Fanawole	-
7	-	-	-	Awotan	-

Source: Compiled by Authors

Table 2: Intersections where traffic occurs under the five divisions in the study area

S/N	Intersection Name	Intersection Type	Land Use Characteristics
1	Abidogun	3 Legged	commercial motor parks, Retailing shops, Markets
2	Bakatari	3 Legged	commercial motor parks, Markets, Offices
3	Eleyele 1	3 Legged	Improper motor parks, Retail shops, Market, Offices, Water cooperation,
4	Eleyele 2	3 Legged	Improper motor parks, Retail shops, Market, Offices, Water cooperation.
5	Ologuneru	3 Legged	Motorcycle park, Bus stop, Mini shops, Residential.
6	Onigbodogi	3 Legged	Residential, mini shops, motorcycle park
7	OjuOja 1	4 Legged	Shopping complex, market, commercial motor park, Club, Institution.
8	OjuOja 2	4 Legged	Shopping complex, market, commercial motor park, Club.
9	Jeje	4 Legged	Residential, mini shops
10	Ori Are	3 Legged	Shops, Motorcycle parks
11	Fanawole	3 Legged	Church, Residential, mini shops
12	Awotan	3 Legged	Retail shops, Hospital, Filling station
13	BCJ	4 Legged	Offices, Filling station, mini shops, IBEDC
14	NNPC	3 Legged	NNPC, Mini car park, Bus stop
15	Fatimoh	3 Legged	Institution, Offices, Bus stop
16	Wema	3 Legged	Banks, Road safety office
17	Apata Market	3 Legged	Market, mini marts, Filling station, Improper public motor park

Figure 2: IKONOS Imagery of the study area

3.3 Manual Traffic Count

There are various technique and methods used in traffic survey (traffic counting) some of which involves the use of traffic timer but for the purpose of this study, manual counting was adopted. Preliminary investigation has incited and thus carried out traffic counting at selected location. The counting (number of vehicles) was based assessed per hour, all private car, commercial cab and buses, motorcycle, tricycle and heavy duty vehicles were counted. Data sought out at the end of the counting were analyzed using appropriate tools. Manual counting is usually carried out between hours for a day because it is impossible to manually carry out the counting for a longer period. For the purpose of this study, counting was carried out at each intersection point between hours of 7am to 9:00am, and 5:00pm to 7:00pm for morning and evening observation respectively from Monday to Saturday. Sample of the data acquired from the traffic count is shown below.

Table 3: Manual Counting of Vehicles at Apete to Ijokodo for 2hours

DAY	Duration	Car 1(Commercial)	Car 2 (Private)	Bus	Tricycle	Motorcycle	Truck/ Lorry	Total
Monday	Morning	727	578	64	15	1338	10	**2732**
	Evening	512	339	68	33	1112	19	**2083**
Tuesday	Morning	537	428	54	19	953	8	**1999**
	Evening	456	388	33	11	881	10	**1781**
Wednesday	Morning	543	461	72	25	906	24	**2031**
	Evening	488	410	61	37	827	14	**1837**
Thursday	Morning	359	396	63	18	926	6	**1768**
	Evening	519	335	51	12	909	13	**1839**
Friday	Morning	592	449	66	27	861	10	**2005**
	Evening	508	427	43	16	783	13	**1790**
Saturday	Morning	214	195	26	13	762	17	**1227**
	Evening	295	183	31	18	813	11	**1351**

Figure 3: sample of traffic delay in Eleyele Junction and Ologuneru Road

3.4 Data Processing of spatial location of hotspots

The spatial data were downloaded into the computer through the cable and DGPS software (Hi-Target Geometric Office (HGO) and GNSS Solution) was used for data processing. IBM SPSS Statistical analysis 20 was used for processing the questionnaires and ArcGIS 10.5 was used for mapping, analyzing spatial data, running queries and other spatial analysis. These data were processed and manipulated to give useful information.

Table 4: Processed Data (x, y) of the traffic points in locations from five divisions

Divisions	Traffic points	Easting (mE)	Northing (mN)	Divisions	Traffic points	Easting (mE)	Northing (mN)
Omi Adio	Bakatari	582614.556	817148.827	Apete	OjuOja 1	596629.495	823222.140
	Abidogun	582836.410	817281.913		OjuOja 2	596606.476	823281.671
Ologuneru /Eleyele	Ologuneru	591412.297	822075.440		Ori Are	596469.554	823391.738
	Eleyele 1	594806.301	820226.661		Fanawole	596393.340	823692.393
	Eleyele 2	594851.280	820158.751		Onigbodogi	596417.012	824019.022
Ido	Ido	584757.472	826362.327		Jeje	595313.583	823920.826
Apata	Fatimoh	594392.854	815572.198				
	BCJ	592282.647	816142.509				
	Wema	591529.509	816175.064				
	Apata Market	591169.940	816249.676				
	NNPC	590533.775	816864.719				

3.4.1 Questionnaire Processing

The Questionnaire was analyzed using IBM SPSS statistical analysis 20. A database was first designed in the variable view and data view and the responses of various respondents are keyed in to the software using the five divisions under the Local Government.

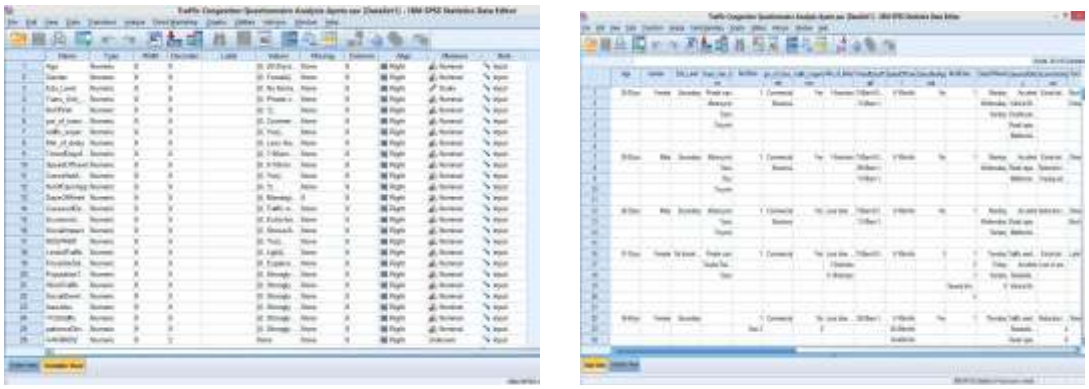

Figure 4: Sample of database created on questionnaires responses by respondents

4. RESULT

Table 5 shows the analysis of the questionnaire distributed and returned. Table 6 showed the summary of the analysis of the responses by the respondents from the questionnaire. Table 7 presents the analysis of the manual counting. Figure 6 described the road networks and traffic locations along Major roads and their respective intersections. Figure 7 presents the database creation for spatial location of the hotspots and figure 8 presented the queries for the study.

4.1 Analysis of Data Acquired via Questionnaires

For the study, six hundred questionnaires (600) were administered, while five hundred and twenty (520) questionnaires that were returned were done via the statistical analysis software. The results of the analysis shows that out of sixty (60) that was distributed to Omi Adio, only forty three (43) was returned; in Ologuneru/Eleyele, one hundred and twenty (120) were distributed while one hundred and eight (108) were returned; in Ido, being sparsely populated among the local government, a total of sixty(60) were distributed and fifty two (52) were returned; in Apete, being the area with highest population under the study area, two hundred and twenty (220) questionnaires were administered, while two hundred and eleven (211) were returned; in Apata, a total of one hundred and thirty (130) were administered and one hundred and six (106) were returned .

Table 5: Number of administered and returned questionnaires

S/N	Location Name	Distributed Questionnaires	Returned Questionnaires
1	Omi-Adio	60	43
2	Eleyele/Ologuneru	120	108
3	Ido	60	52
4	Apete	230	211
5	Apata	130	106
	Total	**600**	**520**

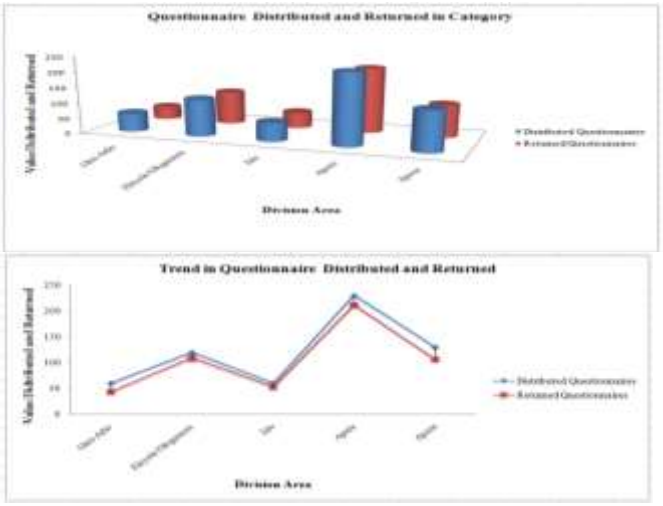

Figure 5: Variation and Trend in questionnaire distributed and returned

Table 6: Summary of processed returned questionnaires by respondents

Age			**Educational level**		
	Frequency	Percent		Frequency	Percent
20-25yrs	135	25.96%	No formal Education	56	10.77%
26-30yrs	90	17.31%	Primary	50	9.62%
31-35yrs	110	21.15%	Secondary	152	29.23%
36-40yrs	94	18.08%	Tertiary	262	50.38%
Above 40yrs	91	17.50%	Total	520	100.00%
Total	520	100.00%	**Which of the transport vehicles do you use?**		
Gender/Sex					
Female	217	41.73%	Private cars	139	26.73%
Male	303	58.27%	Delivery van	60	11.54%
Total	520	100.00%	Motorcycle	93	17.88%
How many transport vehicles do you have?			Trucks/Trailers	40	7.69%
1	358	68.85%	Taxis	102	19.62%
2	112	21.54%	Bus	64	12.31%
3	48	9.23%	Tricycle	22	4.23%
Over 3	2	0.38%	Total	520	100.00%
Total	520	100.00%			
For what purpose do you use your transport vehicle for?			**How much delay do you experience when there is congestion?**		
Commercial	240	46.15%	Less than a minute	121	23.27%
Private	170	32.69%	1-5minutes	126	24.23%
Business	104	20.00%	6-10minutes	95	18.27%
Official	6	1.15%	More than 10min	178	34.23%
Total	520	100.00%	Total	520	100.00%
What time of the day do you experience traffic congestion along this corridor?			**At what speed do you travel when there is congestion?**		
7:00am-8:59am	148	28.46%	0-10km/hr	323	62.12%
09:00am-10:59am	62	11.92%	10-20km/hr	116	22.31%
11:00am-12:59pm	67	12.88%	20-30km/hr	54	10.38%
01:00pm-02:59pm	53	10.19%	30-40km/hr	20	3.85%
03:00pm-04:59pm	15	2.88%	Over 40km/hr	7	1.35%
05:00pm-06:59pm	55	10.58%	Total	520	100.00%
07:00pm-08:59pm	70	13.46%	**Do you experience delay due to traffic congestion along this corridor?**		
09:00pm-10:59pm	32	6.15%	Yes	459	88.27%
Everytime	18	3.46%	No	61	11.73%
Total	520	100.00%	Total	520	100.00%
Have you cancelled appointments due to delay?			**Which days of the week do you experience traffic**		

			congestion along this corridor?		
Yes	359	69.04%	Monday	209	40.19%
No	161	30.96%	Tuesday	64	12.31%
Total	520	100.00%	Wednesday	56	10.77%
(If yes) How many times have you cancelled appointment?			Thursday	9	1.73%
1	182	35.00%	Friday	80	15.38%
2	89	17.12%	Saturday	52	10.00%
3	72	13.85%	Sunday	50	9.62%
Many times	112	21.54%	Total	520	100.00%
Several times	65	12.50%	**In your own opinion, what do you think are the causes of delay and traffic along the corridor?**		
Total	520	100.00%	Traffic wardens	42	6.69%
In your own opinion, what are the economic impact of the delay and traffic?			Accident	56	12.69%
Extra fuel consumption	269	51.73%	Roadside Hawking	48	10.03%
Reduction in working hours	132	25.38%	Vehicle Breakdown	69	13.59%
Paying extra fee	51	9.81%	Roadside parking	77	14.74%
Less in productivity	68	13.08%	Double parking	74	14.17%
Total	520	100.00%	Road capacity single/double	49	9.97%
In your own opinion, what are the social impact of delay and traffic?			Lack of walkway	30	3.72%
Stress/Anger	218	41.92%	Malfunction of Traffic light	47	9.41%
Late/Missed Appointment	83	15.96%	Rough tarred surface of the road	70	5.26%
Unpredictable travel time	73	15.22%	Total	520	100.00%
Bucking another time of travel	79	13.47%	**How would you classify the level of traffic in this corridor?**		
Extra time consumption	67	12.88%	Light	142	27.31%
Total	520	100.00%	Fair	105	20.19%
Do you think road intersections could be the major problem behind traffic delay?			Heavy	209	40.19%
Yes	346	66.53%	Very Heavy	64	12.31%
No	179	33.47%	Total	520	100.00%
Total	520	100.00%	**As population increases and people become more affluent, traffic delay problems becomes worse**		
What do you think the possible solutions could be?					
Expansion of Road	122	23.46%	Strongly Agree	209	40.19%
Creation of Parking spaces	164	31.48%	Agree	217	41.73%
Repair of Roads	118	22.69%	Neutral	38	7.31%
Erection of traffic light	116	22.31%	Disagree	39	7.50%
Total	520	100.00%	Strongly Disagree	17	3.27%
Traffic occurs during close and start of work			Total	520	100.00%
Strongly Agree	198	38.08%	**Traffic has cause more harm to the social development of the state than good**		
Agree	239	45.96%	Strongly Agree	100	19.23%
Neutral	57	10.96%	Agree	255	49.04%
Disagree	13	2.50%	Neutral	106	20.38%
Strongly Disagree	13	2.50%	Disagree	48	9.23%
Total	520	100.00%	Strongly Disagree	11	2.12%
Rate at which people lose jobs increases with increase in traffic			Total	520	100.00%
Strongly Agree	105	20.19%	**Do you believe you can play a better role in the improvement of traffic?**		

Agree	207	39.81%	Strongly Agree	131	25.19%
Neutral	98	18.85%	Agree	249	47.88%
Disagree	79	15.19%	Neutral	108	20.77%
Strongly Disagree	31	5.96%	Disagree	17	3.27%
Total	520	100.00%	Strongly Disagree	15	2.88%
Would you help in reducing traffic by exercising some level of patience while driving?			Total	520	100.00%
Strongly Agree	159	30.58%			
Agree	261	50.19%			
Neutral	64	12.31%			
Disagree	28	5.38%			
Strongly Disagree	8	1.54%			
Total	520	100.00%			

4.2 Discussion of Results

Table 6 above shows the response from the questionnaires about the causes of the traffic –The analysis shows that roadside parking, double parking, and vehicle breakdown had the highest causes of traffic with 77 (14.74%), 74 (14.17%), and 69 (13.59%) respondents respectively among other causes. 346 (66.53%) respondents agreed that traffic problems is caused majorly by road intersections while 179 (33.47%) of respondents did not believe that the traffic is caused by intersecting roads rather by other causes. 459 (88.27%) of respondent agreed that they have experienced delay along the routes while only 61 (11.73%) of the respondents agreed that they have not experienced traffic, which implies that the respondent within the study area experience delay except those in Ido with low response and also the questionnaire sampling method projected the needed respondents. Also, the total of 121 (23.27%) respondents' agreed that they experience delay for less than a minute when there is traffic, 126 (24.23%) agreed between 1 – 5 minutes, 95 (18.27%) agreed to 6 – 10 minutes of the delay, while 178 (34.23%) respondents agreed on more than 10 minutes, which showed from the analysis that the level of traffic along the routes varies but heavy and as such contributed positively or negatively to the lifestyle of the people affected.

Traffic delay occurs mostly in the morning when people are leaving for work and also in the evening when they are returning back home. This fact was ascertained from the analysis of the questionnaires showing that 148 (28.46%) of the respondents agreed that traffic occurs in the morning (7:00am – 8:59am) which is the significant hour for resuming work, 62 (11.92) respondents agreed with (9:00am – 10:59am), 67 (12.88) agreed with 11:00am-12:59pm, 53 (10.19) agreed with 01:00pm-02:59pm, 15 (2.88) agreed with (03:00pm-04:59pm), 55 (10.58) agreed with (05:00pm-06:59pm), 70 (13.46) agreed with (07:00pm-08:59pm) while 32 (6.15%) agreed that it is every time. From the analysis of the questionnaire, it showed that traffic in areas like Apata, Ologuneru, Apete, requires serious attention due to the high rate in responses by the respondents that they experience traffic delay along the routes.

The economic impact of traffic of the situation is examined with 269 (51.73%) respondents agreed on extra fuel consumption, 132 (25.38%) respondents agreed on reduction in working hours, 51 (9.81%) agreed on paying extra fees, 68 (13.08%) respondents agreed on less productivity – This implies that the traffic has a negative impact on the economy of the people except in Ido where the traffic is less and only a few responded to that aspect of the questionnaire.

4.3 Analysis and Discussion of Manual Traffic Count

The traffic count conducted was done manually using hand tally method to estimate the volume and composition of traffic at the intersections. A continuous count of all vehicles by categories that passed through the intersections was done. The study was limited to peak periods of 7:00am to 9:00am and 5:00pm to 7:00pm as the peak hour study helps to gather important information concerning maximum traffic loads imposed upon the road network and as such relates to the capacity analysis. The data were collected for six days (Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday) of which the average was then used.

Table 7: Average peak hour traffic volume at selected intersections

Intersection	**Approach**	**Average Peak hour Traffic Volume**		**Intersection**	**Approach**	**Average Peak hour Traffic Volume**	
		VPH	**% of Total**	ApeteOju Oja 1	RCCG	412	2.25%
Apata	Kuola	1921	10.48%		Awotan	1824	9.96%
	BCJ	2192	11.96%		Ijokodo	1603	8.75%

	NNPC	1436	7.84%		Papa	400	2.18%
	Total	**5,549**	30.29%		**Total**	**4,239**	23.14%
Omi Adio	Oloyo	399	2.18%	Onigbodogi	Yidi	635	3.47%
	Ojurin	1090	5.95%		Apete	773	4.22%
	Command	852	4.65%		Ajibode	419	2.29%
	Total	**2,341**	12.78%		**Total**	**1827**	9.97%
BCJ	Apata	1032	5.63%	**Grand Total for all intersections**	**18,322**	**100.00%**	**Grand Total for all intersections**
	IBEDC	365	1.99%				
	NIHORT	885	4.83%				
	OdoOna	2084	11.37%				
	Total	**4,366**	23.83%				

The average traffic volumes in vehicle per hour at the studied intersections during the peak periods are shown in Table 7. The analysis reveals that Apata junction recorded the highest volume of traffic and delay among the studied intersections which are 5,549 vph (30.29%) of total traffic volume. The high volume of traffic volume at this junction reiterates the importance the roads converging at this junction and its land use activities. The land use activities of the roads are mainly for commercial purpose. The road service Kuola, BCJ and NNPC which are major business/commercial zones in the local government. BCJ junction is another road experiencing high volume traffic. It ranks second with 4,366 vph (24.83%) for traffic volume. The road is one of the busiest commercial belts in the local government with supermarkets (Brent), eateries (Foodco), banks (GT Bank), and retailing shops along it. Nihort road also services many construction activities as it is seen as an alternative route to their destinations and links with Ologuneru. IBEDC road which is directly opposite the Nihort road also contributes to the traffic volume at this junction resulting from commercial and institutional land use along it.

Apete junction ranks third recording 4,239vph (23.14%) traffic volume and delay respectively. The volume of flow and delay at the junction also explains the importance of the roads converging at the junction. These are Papa road which is a substitute for those coming from Awotan, the RCCG road is also an alternative to those enrouteYidi/Arola, and the presence of the motor Garage at the junction contributes greatly to the traffic. Also, the road to Ijokodo which also serves the Overpopulated Polytechnic, Ibadan is also a leading cause of traffic. Omi Adio junction ranks fourth with 2,341vph (12.78%) for traffic volume. This junction is a convergence of predominantly commercial land uses. Omi Adio road services the people of Oloyo village which is an agriculturally populated village. This road also serves as the connecting route between Ibadan and Abeokuta. This junction also has a garage directly beside it that transports people from the junction to Apata, thereby constituting for the traffic.

Idi - Oro junction ranks fifth with 1827vph (9.97%) for traffic volume. This junction is a convergence of predominantly residential and commercial land uses. The road services the people of Ajibode with a few commercial activities along it and also services the people of Yidi/Arola with some commercial activities along the route. Overall, the distribution of traffic volume at the sampled intersections depicts the nature of the predominant land use activities which the roads converging at the junction serve and their classification within the general road network pattern of the city. Most of the major routes in the local government are single lanes of between 9m to 15m except for the routes in Eleyele, Ologuneru and Ido which has just been dualised. Also, none of the routes has a working traffic light for easy control of traffic along the corridor.

4.4 Spatial Analysis

The spatial result was represented inform of maps/plans and query was analyzed and interpreted below. All congested major road junction in the study area was mapped out and query in conjunction with the questionnaire using ArcGIS 10.5 for easy traffic flow query and assessment.

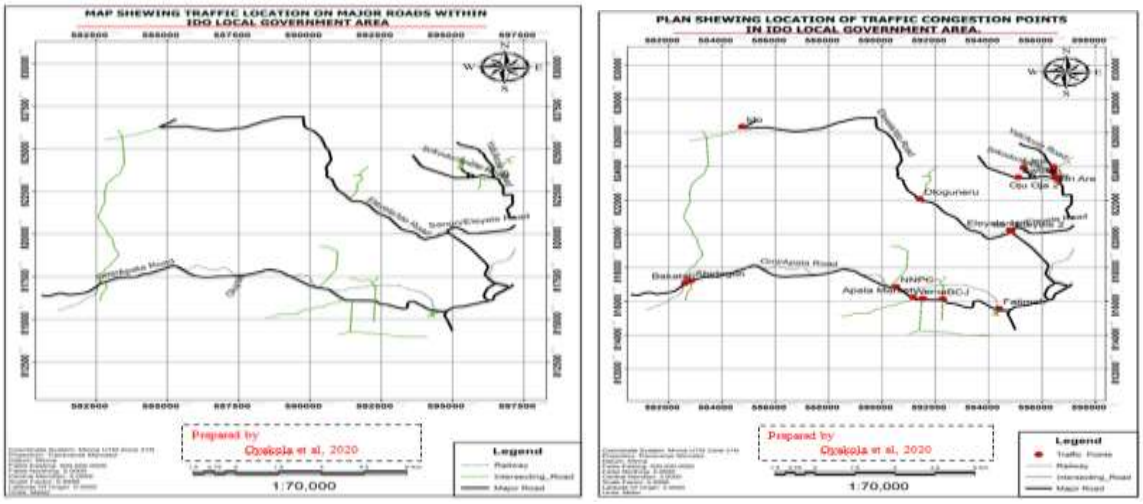

Figure 6: Road networks and traffic locations along Major roads and their respective intersections

4.4.1 Spatial Queries

Queries are used at all stages of GIS analysis for checking the quality of data and the result obtained. The query performed in this study gave answer to the question asked from the database. These were achieved as a result of implicit link of both geometric and attribute data. The database was created to provide answers to questions that are launched into the system.

Figure 7: Database created for traffic points

Queries

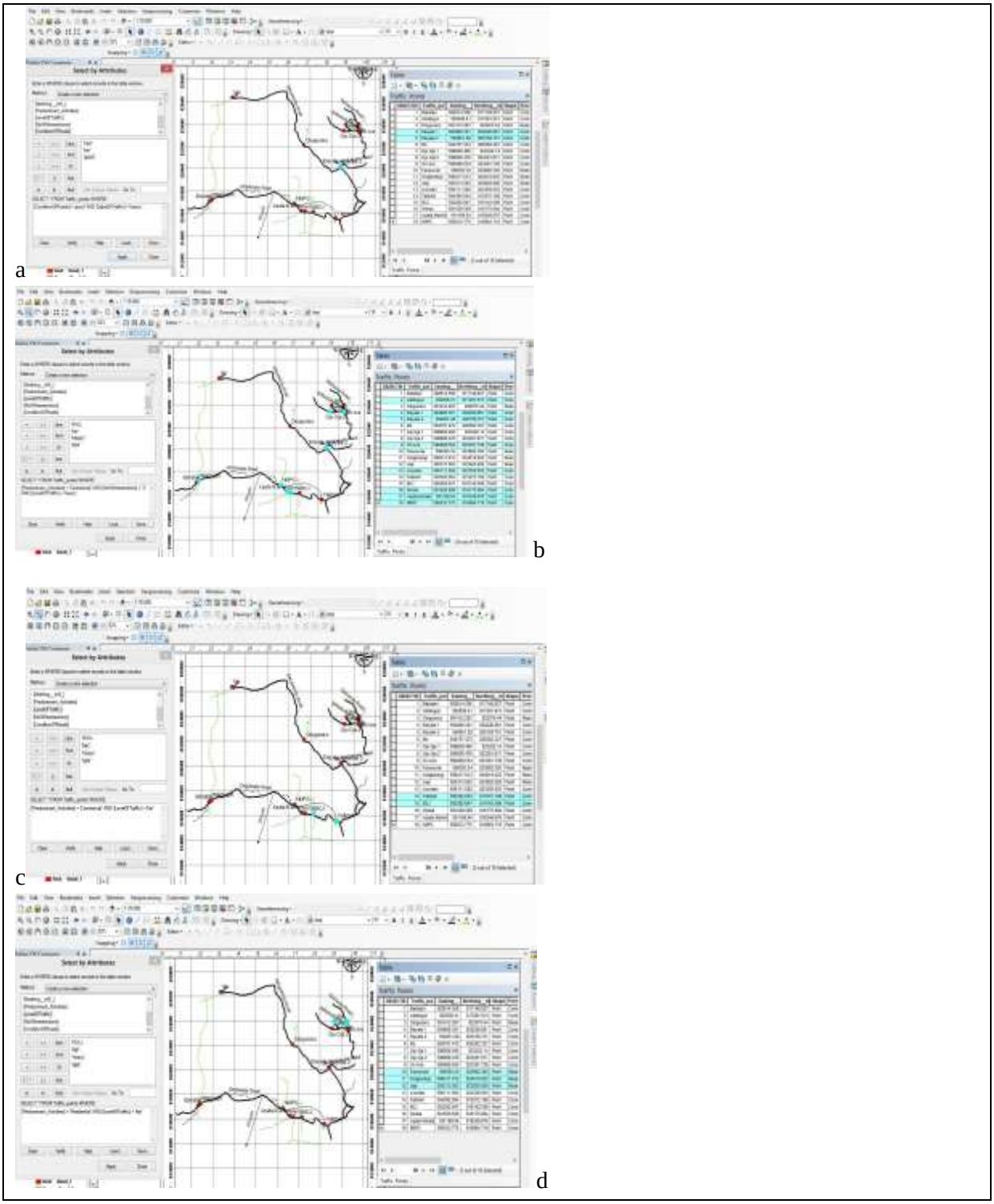

Figure 8: Queries for the study

The query in figure 8a explains that the road being good and heavy which implies that being good does not mean that there won't be traffic. Figure 8 (b &c) shows that the traffic locations experience heavy and fair traffic due to commercial activities being predominant at the locations. Figure 8d shows that the traffic locations experience fair due to the residential activities in the locations.

5. CONCLUSION

The application of GIS has helped in the proper assessment of the causes of traffic congestion within Ido local government area. From this study, it was discovered that all the causes of traffic delay has been highlighted from the result of the findings through the respondents' responses. The causes are vehicle breakdown, Traffic wardens, Roadside markets, Accidents; Roadside parking among others as the traffic problems is attributed to expansion of road, repair of roads, erection of traffic light, and creation of parking spaces. The study has found out that traffic congestion occurs mostly in the morning (peak periods of (7:00am – 9:00am) i.e. when going to work and evening (peak periods of 5:00pm – 7:00pm) i.e. when going back home during weekdays. The study has also been able to iterate the fact that traffic occurs mostly at road intersections.

6. RECOMMENDATIONS

After the study was carried out, it is deemed fit that to counter the problem at hand, the following are the suggestions should be put in place:

- Adjacent Land use planning
- Provision of Parking spaces/Bus stops for commercial vehicle
- Erection of Traffic Light.
- Effective traffic management and control.

Finally, there is need to dualize all the major roads in order to eradicate the use of one-way strategy employed along these roads and in turn to reduce congestion and increase traffic flow, also driving schools should be made compulsory so that driving license holders will have a full knowledge of traffic rules.

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