Traffic Congestion at Road Intersections in Ilorin, Nigeria

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Abstract: The paper examined traffic congestion problems and their causes at selected road intersections in Ilorin, Nigeria. The characteristics of the intersections that predispose them to congestion problems and the spatial pattern of traffic congestion at the road intersections were also identified. In addition, traffic volume and delays were estimated and causes of delays identified. Data were collected through direct field survey on intersection characteristics, traffic volume and composition, traffic delay and causes and land use activities. Data were also collected from past research reports, journals, textbooks, maps and the Internet. The analysis of data collected revealed that spatio-temporal variations exist in traffic flows and delays at the studied intersections. Also, traffic wardens and parking problems were found to be the greatest causes of delays at the road intersections in the city. The study therefore recommends that the road intersections be signalized and vehicle parking be strictly prohibited at road intersections to reduce traffic congestion and delays at road intersections in the city.

Keywords: traffic congestion, road intersection, traffic volume, traffic delay, land use

1 Introduction

Cities and their transport systems are fully complementary. As defined by Rodrigue *et al* (2006), cities are locations with a high level of accumulation and concentration of economic activities, which form complex spatial structures that are supported by transport systems. The transportation systems according to Berry and Hurton (1970) are the veins and arteries of urban areas linking together social and functional zones. Urban productivity is highly dependent on the efficiency of its transport systems to move people and goods between multiple origins and destinations. Thus, the most important transport problems are often related to urban areas when transport systems, for a variety of reasons, cannot satisfy the numerous requirements of urban mobility (Rodrigue *et al*, 2006).

One of the most significant urban transport problems is traffic congestion. It is experienced when the supply of the urban transport networks can no longer meet the demand for them. Today nearly all cities in both developed and developing countries suffer from traffic congestion. It manifests itself predominantly in recurrent queues, delays and time wastage which commuters experience along major networks especially during rush hours. Due to incessant increase in population, increase in household incomes and its resultant increase in the level of car usage coupled with poor land-use planning, poor transport design and planning, traffic congestion has become an intractable problem in urban centres in Nigeria.

Traffic congestion is a major curse on urban movements. It is a plague that has become an integral part of normal life in almost all urban areas in the world. More seriously, traffic congestion causes unpredictability in journey times, thereby making urban commuters to plan for these problems by leaving home early just to avoid being late.

The problem of traffic congestion in urban areas is worse at road intersections. Indeed, there is no other point on cities roads that can be greatly congested as road intersections. As defined by O'Flaberty (1997), intersections (where two or more roads meet), are points of vehicle conflict. Similarly, Mchsare *et al* (1998) noted that at no other location within the street and highway systems are so many potential and actual conflicts than at road intersections. This is because at intersections, vehicular flows from several different approaches making either left-turn, through and right-turn movements seek to occupy the same physical space at the same time. In addition to these vehicular flows, pedestrians also seek to use this space to cross the street and thereby worsening the already bad traffic situation.

Urban traffic problems are further exacerbated by the concentration of most of the working places in the same areas (usually in the city centres), so that traffic is essentially unidirectional during the morning and evening peak periods (see Okpala, 1980; Onakomaiya and Ekanem, 1981). It is this latter problem which results in spatial variation of congestion in urban areas that this study examines. The principal objective of this study is to examine the spatial aspects of traffic congestion at road intersection in Ilorin, as well as identify the possible causes and proffer solutions.

The issue of traffic congestion in Ilorin like many other state capitals in Nigeria draws significant attention each day. Intra-urban movements to work, recreational centres, markets, shops and schools are becoming more and more difficult and are characterized by discomfort, delays, waste of time, energy and resources. The problem is more pronounced during the peak periods of morning and evening when vehicles stand still in long queues resulting in stress and reduction in the productive hours of commuters. Although the situation in Ilorin has not grown out of control, signs of potential bottlenecks are already emerging along some routes.

2. Traffic Flow Theories and Congestion Problems

Traffic congestion emanates from the problems encountered with traffic flow. Traffic flow is the movement of individual drivers and vehicles between two points and the interactions they make with one another. Unfortunately, studying traffic flow is difficult because driver behaviour is something that cannot be predicted with one-hundred percent certainty. 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 mathematically. The three main characteristics among which relationships can be established mathematically in traffic flow are: flow, density and velocity. These relationships help in planning, design and operation of roadway facilities.

The speed is the space mean speed; the density or concentration is the number of vehicles per unit length of the highway and the flow is the number of vehicles passing a given point on the highway per unit time.

The relationship between these parameters of the flow may be derived as follows: consider a short cross section of highway length L in which N vehicles pass a point in this section during a time interval T, all vehicles travelling in the same direction. (Salter, 1974).

The volume of flow Q = N/T

The density D = average no. of vehicles travelling over L/L

The average number of vehicles travelling over L is given by;

$$\frac{\sum_{\iota=1}^{N} t_\iota}{T}$$

where t is the time of travel of the ι^{th} vehicle over the length L; then

$$D = \frac{\sum_{\iota=1}^{N} t_\iota}{T} \Big/ L = \frac{N}{T} \Big/ \frac{L}{\frac{1}{N}\sum_{\iota=1}^{N} t_i}$$

$$\text{i.e. Density} = \frac{\text{Volume}}{\text{Space mean speed}}$$

Numerous observations have been carried out to determine the relationship between any two of these parameters for, with one relationship established the relationship between the three parameters is determined. Usually the experimenters have been interested in the relationship between speed and volume because of a desire to estimate the optimum speed for maximum flow (Salter, 1974; Pensaud and Hurdle, 1991; Hall and Banks, 1992; Disbro and Frame, 1992).

Geographical theories have also been used to explain traffic flow. A basic geographical interest in flow is to provide answer to the question – "why do people and goods move in space?" Ullman (1956) postulated three conditions for spatial interaction (flow), namely complementarity, intervening opportunity and transferability.

The first condition, according to Hagget (1972) is a function of areal differentiation of places. In order for two places to interact, there must be a supply or surplus in one place and a demand or deficit in another which must be specifically complementary. Complementarity will however generate flows between two places only if no intervening opportunity occurs. This means the absence of another location in-between the two places which may provide an alternative source of supply or demand. The third condition in Ullman's principle, transferability refers to the possibility of moving a product. It is a function of distance measured in terms of time and monetary costs (Hagget, 1972).

Before Ullman's principle, geographers were preoccupied with graphical presentation of statistics of traffic flow. Ullman's principle introduced basic conceptual explanation for flow in space and since then, there has been an increasing awareness of the need for concept and method in flow studies (See Smith, 1970). However, all the concepts about flow can be summed up in a matrix-defined origin and destination with origin as rows and destination as columns. According to Smith (1970), there are three characteristics of interest in the matrix, namely, volume, structure and efficiency of flows.

The volume of flows is concerned with diagnostic statements on the magnitude of flows which can be expressed as "more than" or "less than". It involves quantity of people and goods that move along a route. The structure of flow is concerned with the identification of generic locational characteristics of groups of origins or groups of destinations, or groups of origins and destinations – dyad (see Lowe and Moryadas, 1975). The third characteristic, efficiency of flows, is concerned with descriptive and normative characteristics of routing a flow. Transport networks only rarely link a set of nodes by the shortest distance and almost any movement over a given route involves a certain amount of distance inefficiency. The efficiency concept, therefore, aims at optimizing flows by minimizing distance, or transport costs, subject to certain constraints.

The geographical theory of traffic flow is most suitable for the study because it addresses the issue of pattern of flow. This theory has been applied by various scholars in urban transportation studies relating to movement of goods and of people. For instance, Goddard (1970) discerned the pattern of flows in central London and concluded that the Central Area contained a number of specialized sub-centres in which closely related activities aggregate and these districts are maintained by a clear pattern of internal circulation.

Also, Ogunsanya (1982) in his study on the Spatial pattern of urban freight transport in Lagos identified four patterns of flow. These are the metro-originating, metro-terminating, intra-metropolitan and through traffic. All these affect the general pattern of traffic flow in the city. Adenle (1977), writing on factors militating against the flow of traffic in metropolitan Lagos identified amongst others that the chief factors affecting the flow of traffic in metropolitan Lagos is the interface with or imbalance in the composition of the variables flow, density and space mean-speed.

Okoko (2008) studied the pattern of urban goods movement in various landuse typologies in Akure, Nigeria. The study identified through gravity modeling and linear programming, the urban landuse typologies that are major generators of urban goods transport and the landuses that are major attractors of urban goods movement in the city. Other studies include Aderamo (2000) who identified the spatial pattern of intra-urban trips in Ilorin using Factor Analysis and Nystuen and Dacey's (1961) concept of flow structuring in urban centres. He found that the zonal pattern of intra-urban trips in cities is hierarchical in order because of the functional association between these zones (see also Ogunbodede, 1999; Galtima, 1999).

3. Materials and Methods

The data required for this study include information on intersection characteristics and road network; traffic volumes and characteristics. These were collected through primary and secondary sources. The primary sources which represent first hand information were collected through direct field observation and field data collection while the secondary data were collected from journals, textbooks, the internets and past research reports. The road network map of Ilorin with grid reference at one degree interval was used for identification of the studied intersections. As it is not possible to study all the intersections in the city, a sampling technique was employed and a ten per cent sample of the intersections in each four combined grid squares at 2 degrees intervals was selected at random (see also Aderamo, 1998). Some major intersections which were hitherto ignored by sampling were also included. Through this process, the following intersections were selected: (1) Saw-mill/Air Port; (2) Surulere/Agbo-oba; (3) Oloje/Mt. Carmel College; (4) Taiwo/Ita-Amodu; (5) Murtala/Amilegbe; (6) Tanke/Tipper Garage; (7) Gaa-Akanbi/Offa Garage (see figure 1).

A reconnaissance survey of the study area was first carried out at the selected intersections to identify the characteristics that predispose them to heavy traffic. This was followed by traffic census conducted manually using simple hand-tally method to estimate the volume and composition of traffic at the intersections. A continuous count of all vehicles by class/category that passed through the intersections was done by field assistants. The field assistants were instructed to concentrate on a single lane each, and count the vehicles as they depart the intersections. This is because turning movements cannot be fully resolved until vehicles depart the intersections. The number of field assistants at any intersection was determined by the number of legs or approaches to the intersection.

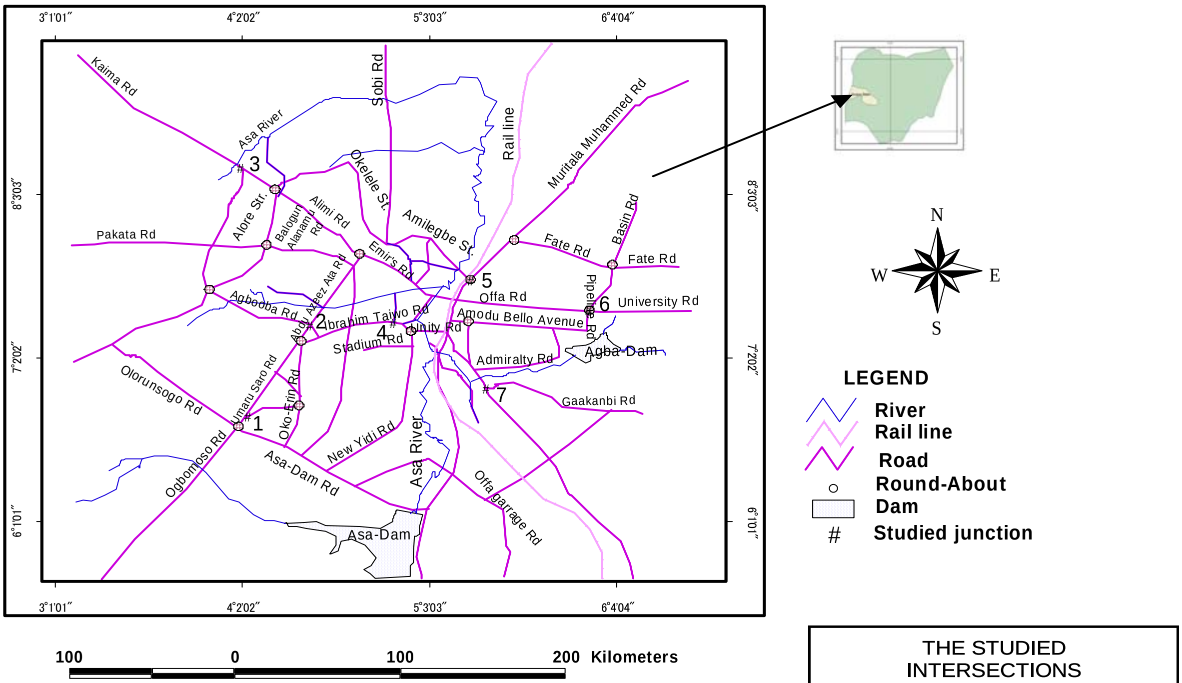


Figure 1 : Road Network Map of Ilorin showing the Studied Road Intersections
Source: Kwara State Ministry of Lands and Housing, 2007.

THE STUDIED INTERSECTIONS
1. Saw-Mill/Airport Road junction
2. Surulere/Agbooba Rd. junction
3. Oloje/Mt. Carmel

The study was limited to off-peak periods because the peak hour traffic study is particularly useful in that it provides most important information concerning maximum traffic loads imposed upon the road network (and their intersections) and as such relates to the capacity analysis and the design of future facilities (Salter, 1974; Ogunsanya, 1984). Therefore, the peak hour periods of morning and evening peaks of 7.00a.m to 9.00a.m and 3.00p.m to 6.00p.m respectively were used. The data were collected for three consecutive days (i.e. Monday, Tuesday, Wednesday) of which the average was then used.

4. Results and Discussion

4.1 Characteristics of the Studied Intersections

The studied intersections are comprised of 4-legged and 3-legged road junctions selected from different locations on major roads in Ilorin. The intersections serve as links to major routes which connect different types of land use activities in the study area. All the studied intersections are unsignalized but traffic flows are controlled by traffic wardens. Also common to all the intersections is the presence of road-side hawkers and traders, and the location of retailing shops along the intersecting roads. These result in road-side obstructions and parking problems from customers who patronize the sold products and thereby impeding the free movements of vehicles. Associated with these problems are the problems of narrowness and poor or no channelization of the intersecting roads to separate the traffic streams. Table 1.0 shows the characteristics of the studied intersections.

Table 1. Intersection Characteristics and Associated Land-use

S/N	Intersection Name	Intersection Types	Land-use Characteristics
1.	Sawmill/Airport	3-legged	Institutional, Sawmill industry, commercial motor parks, retailing shops.
2.	Surulere/Agbooba	4-legged	Markets, Commercial centres, Institutional, Residential estate, retailing shops.
3.	Oloje/Mount Carmel College	3-legged	Market, commercial centres, motor park, Institutional, Residential estate, retailing shops.
4.	Taiwo/Ita Amodu	4-legged	Commercial centres, retailing shops, Institutional.
5.	Murtala/Amilegbe	4-legged	Motor park, Institutional, Offices, Market, Commercial centres, retailing shops, Government Residential Area.
6.	Tanke/Tipper Garage	4-legged	Retailing shops, Institutional, Commercial motor parks, Government Residential Area.
7.	Gaa-Akanbi/Offa Garage	3-legged	Institutional, Retailing shops, Private and public commercial motor parks, Industrial.

Source: The Authors

Table 1 shows that 3 of the intersections constituting 42.9% are 3-legged. These are Sawmill/Airport; Oloje/Mt. Carmel and Gaa Akanbi/Offa Garage. The 4-legged intersections which constitute 57.1% are Surulere/Agbooba, Taiwo/Ita Amodu, Murtala/Amilegbe and Tanke/Tipper Garage.

In terms of land use characteristics of the studied junctions, majority of them are located where institutional, commercial, markets, retailing shops, motor parks predominate. The intersecting arms also connect residential estates, public and private institutions and other major activity-centres in the city.

4.2 Pattern of Traffic Flow

Table 2. and Figure 2 show the average traffic volumes in vehicles per hour at the studied junctions for both morning and afternoon peaks.

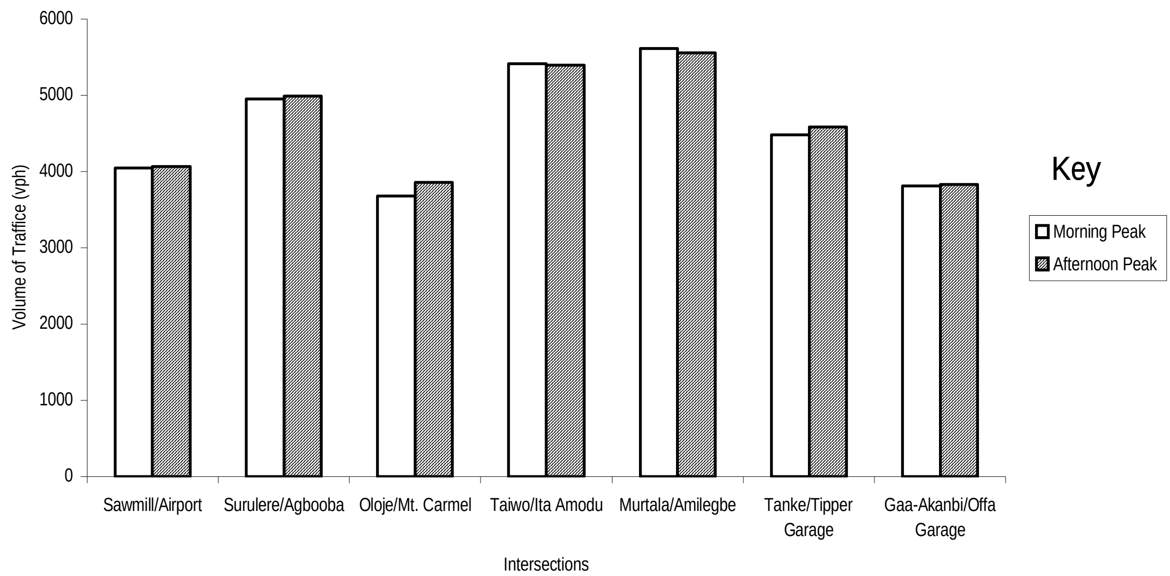
Table 2. Average Volume of Traffic at Selected Junctions in Ilorin

S/N	Intersection	Morning peak		Afternoon peak	
		VPH	% of Total	VPH	% of Total
1.	Sawmill/Airport	4044	12.64	4070	12.59
2.	Surulere/Agbooba	4959	15.49	4996	15.46
3.	Oloje/Mt. Carmel	3680	11.50	3861	11.95
4.	Taiwo/Ita Amodu	5419	16.93	5401	16.71
5.	Murtala/Amilegbe	5619	17.56	5567	17.23
6.	Tanke/Tipper Garage	4479	13.99	4591	14.21
7.	Gaa-Akanbi/Offa Garage	3807	11.89	3829	11.85
Total		32,007	100.00	32,315	100.00

Source: The Authors, 2008

Table 2. shows that for both morning and afternoon peaks, Murtala Mohammed/Amilegbe junction recorded the highest volume of traffic among the studied roads. These are 5619 vph (17.56%) and 5567 vph (17.23%) of total volume for morning and afternoon peaks respectively. This is followed by Taiwo/Ita Amodu junction with 5419 vph (16.93%) and 5401 vph (16.71%) for morning and afternoon peaks respectively. Surulere/Agbo-Oba junction ranks third recording 4959 vph (15.49%) and 4996 vph (15.46%) morning and afternoon peaks respectively while Tanke /Tipper Garage junction ranks fourth recording 4,479 vph (13.99%) morning peak and 4591 vph (14.21%) afternoon peak.

Fig. 2.0 Average Peak-hour Volume at the Studied Intersections



Source: The Authors, 2008

Sawmill/Airport junction ranks fifth recording 4,044 vph (12.64%) morning peak and 4,070 vph (12.59%) afternoon peak. Gaa-Akanbi/Offa Garage junction ranks sixth with 3,809 vph (11.89%) morning peak and 3829 vph (11.85%) afternoon peak while Oloje/Mt. Carmel junction ranks seventh with 3,680 vph (11.50%) morning peak and 3,861 vph (11.95%) afternoon peak respectively.

The average volume of flow at Murtala Mohammed/Amilegbe junction exemplifies the importance of the roads converging at this junction and the land use activities they serve. Murtala Mohammed Road services

Post Office and the commercial activities along it. The northern arm of the road services Maraba Motor Park, Kwara State Polytechnic main campus, Ilorin Government Secondary School and Federal Secretariat while Amilegbe road services Ipata Market, University of Ilorin Teaching Hospital Maternity Centre and many retailing shops. These activities account for the high volume of traffic at the junction.

Taiwo/Ita Amodu junction is another road experiencing high volume of traffic. Taiwo road is one of the busiest commercial belts in Ilorin with supermarkets, eateries, retailing shops along it. Ita Amodu road also services many commercial activities along it and links with Oja Oba market in the heart of the city. Adamu road directly opposite Ita Amodu road also contributes to the traffic volume at this junction resulting from commercial and institutional land use along it.

The volume of flow at Surulere/Agbo Oba junction also explains the importance of the roads converging at the junction. These are Abdulaziz Attah road which carries a lot of traffic from Oja-Oba, Baboko Market and the University of Ilorin Teaching Hospital, Agbo Oba road services the heavily populated residential area of Agbo-Oba and Adewole Housing Estate while Surulere road links the junction with Taiwo road with retailing shops along it.

Tanke/Tipper Garage junction is an emerging commercial centre with University of Ilorin permanent site road, Pipeline road and Tipper garage road radiating from it. The University of Ilorin road services University of Ilorin permanent site and an array of secondary and primary schools, residential and commercial uses along it. Pipeline road services a new Government Reservation Area and links with Ajasse-Ipo road to the South which also harbours residential and commercial land uses. Tipper garage road services predominantly residential areas to the north of the junction.

Sawmill/Airport junction services commercial, institutional and residential land uses. Sawmill garage road links with an important motor garage in the city. This garage caters for vehicles carrying passengers to Lagos, Ibadan, Abeokuta, and Ogbomoso. The road also accommodates commercial activities along it. Airport road is an extension of AbdulAziz Attah road and services the Ilorin international Airport with a lot of commercial activities along it.

Gaa-Akanbi/Offa garage junction is a convergence of predominantly residential and commercial land uses. Gaa-Akanbi road services Gaa-Akanbi residential quarters with some commercial activities along it while Offa road links with Offa garage to the South-east and some residential, commercial and institutional land uses along it.

Oloje/Mt. Carmel junction is to the western end of the city and services residential and institutional land uses. These include Oloje residential quarters, Ogidi village, Mt. Carmel College, Federal Government College and Oko Olowo quarters.

The distribution of traffic volume at the sampled junctions depicts the nature of the predominant land use activities the roads converging at the junction serve and their classification within the general road network pattern of the city. Three out of the four arms of Murtala Mohammed/Amilegbe junction are dual carriage ways while two out of the four arms of Taiwo/Ita Amodu junction are dual carriage way. Surulere/Agbo-Oba junction also has two out of its four arms as dual carriage ways while Tanke/Tipper garage junction has three out of its four arms as dual carriage ways. The Sawmill/Airport junction has two out of its three arms as dual carriage ways while Mt. Carmel/Oloje junction and Gaa-Akanbi/Offa garage junction each has two of its three arms as dual carriage ways. Consequently, they all carry significant volume of traffic within the city's road network pattern.

4.3 Pattern of Traffic Delays

Table 3. and Figure 3. show the average delay times in minutes at the studied intersections for both morning and afternoon peaks.

Table 3. Average Traffic Delay Time at Selected Junctions in Ilorin

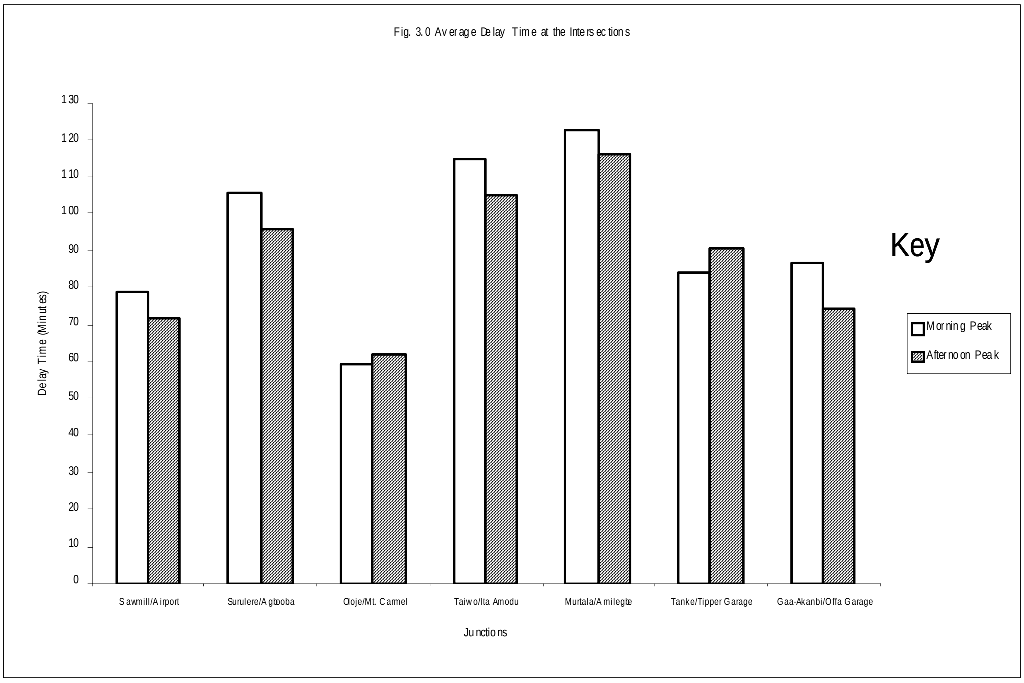
S/N	Intersection	Delay Time (Minutes)			
		Morning peak		Afternoon peak	
		Minutes	% of Total	Minutes	% of Total
1.	Sawmill/Airport	79	12.10`	72	11.69
2.	Surulere/Agbooba	106	16.23	96	15.58
3.	Oloje/Mt. Carmel	59	9.04	62	10.06
4.	Taiwo/Ita Amodu	115	17.61	105	17.06
5.	Murtala/Amilegbe	123	18.84	116	18.83
6.	Tanke/Tipper Garage	84	12.86	91	14.77
7.	Gaa-Akanbi/Offa Garage	87	13.32	74	12.01
Total		653	100.00	616	100.00

Source: The Authors, 2008

Table 3 shows that in terms of distribution of peak-hour delay time during morning peak, Murtala Mohammed junction ranked first (18.84%) followed by Taiwo/Ita Amodu junction (17.61%) while Surulere/Agbo-Oba junction ranked third (16.23%). Gaa-Akanbi/Offa garage junction ranks fourth (13.32%) while Tanke/Tipper garage ranks fifth (12.86%). The sixth and seventh junctions in rank are Sawmill/Airport (12.15%) and Oloje/Mt. Carmel junction (9.04%) respectively.

During afternoon peak, delay time recorded at the junctions rank Murtala Mohammed/Amilegebe junction (18.83%) first followed by Taiwo/Ita Amodu junction (17.06%). Surulere/Agbo-Oba junction ranks third (15.58%) while Tanke/Tipper garage ranks fourth (14.77%). The fifth junction in rank is Gaa-Akanbi/Offa garage (12.01%) with Sawmill/Airport junction coming sixth (11.69%) while Oloje/Mt. Carmel junction attained the seventh position (10.06%).

Overall, the delay times are associated with the traffic volumes at the various junctions which ultimately translate to traffic congestion.



Source: The Authors, 2008

4.4 Pattern of Traffic Composition

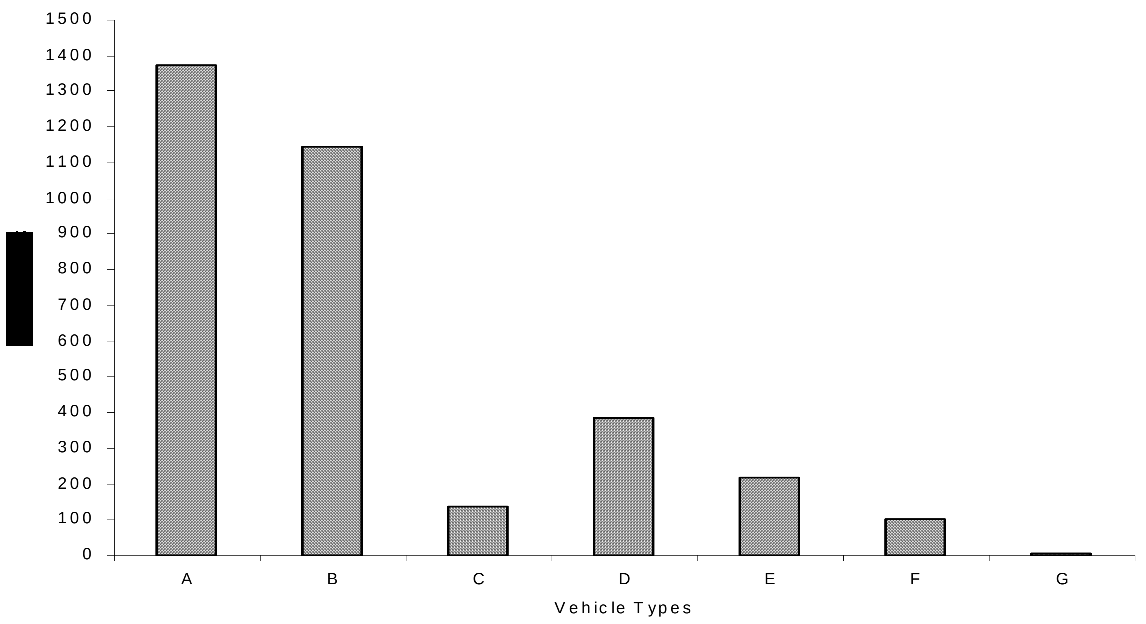
Table 4. and Figure 4 show the average peak-hour traffic composition at the sampled intersections. The table shows that of all the vehicle types recorded at the sampled junctions, motorcycles had the highest numbers of an average of 1372 vehicles (29.87%) which is followed by taxis with an average of 1370 vehicles (29.83%). Private cars ranked third with 1143 vehicles (24.89%) while buses came fourth with 386 vehicles (8.40%). Other types of vehicles recorded at the sampled functions are delivery vans, 219 (4.77%) trucks/tractors/lorries/tankers/tippers 99 (21.6%) and other vehicles 4 (0.1%). The dominance of motorcycles among the types of vehicles recorded shows the emerging trend in the use of motorcycles for public transportation in the city. This mode is now becoming popular and it has helped a lot in reducing the transportation problem in the city. Taxis are a regular mode to use in meeting the needs of the inhabitants in terms of public transportation while there is now more private cars on the city's roads due to improved income and better purchasing power of workers.

Table 4. Traffic Composition at the Studied Junctions

		Traffic Composition						
S/N	Intersection	A	B	C	D	E	F	G
1	Sawmill / Airport	1196	994	1187	319	199	102	4
2	Surulere/Agbooba	1492	1253	1463	400	262	108	5
3	Oloje/Mt. Carmel	1176	1007	1159	206	155	81	4
4	Taiwo/Ita Amodu	1629	1299	1644	463	260	113	4
5	Murtala/Amilegbe	1637	1340	1683	553	288	83	4
6	Tanke/Tipper Garage	1336	1202	1336	378	181	106	5
7	Gaa-Akanbi/Offa Garage	1136	906	1118	380	187	97	3
	Total	9602	8001	9590	2699	1532	690	29
	Average	1372	1143	1370	386	219	99	4

Source: The Authors, 2008
A = Motorcycle C = Taxis E = Delivery vans
B = Private cars D = Buses F = Trucks/Trailers/Lorries/Tankers/Tipper
G = Others

Fig. 4 Traffic Composition at the Junctions



Source: The Authors, 2008
A = Motorcycle C = Taxis E = Delivery vans
B = Private cars D = Buses F = Trucks/Trailers/Lorries/Tankers/Tipper
G = Others

Buses provide services for the transportation of goods and people while delivery vans are used mainly for transporting goods in the city. Trucks, trailers, lorries, tankers and tippers are heavy-goods vehicles and they provide intra-city and inter-city services for the transportation of goods, materials for housing construction and petroleum products.

4.5 Time taken by Delay Causes

Table 5. and figure 5 show the pattern of time taken by delay causes in average daily peak-hour traffic delay. The table shows that of all the delay causes, traffic control by wardens ranks first, an average 42 minutes and constituting 46.7% of the total delay time. This is followed by parking problems with an average of 21 minutes and constituting 23.3% of total delay time. The parking problems experienced include on-sheet parking, double parking, parking to load and unload which reduce the road space thereby impeding the free movement of vehicles.

Table 5. Delay Causes at Studied Intersections

S/N	Intersection	Delay Causes (minutes)						
		A	B	C	D	E	F	G
1	Sawmill / Airport	37	4	19	1	5	4	4
2	Surulere/Agbooba	45	7	22	2	4	9	9
3	Oloje/Mt. Carmel	29	2	15	2	1	2	8
4	Taiwo/Ita Amodu	47	6	27	5	6	8	9
5	Murtala/Amilegbe	55	8	28	3	3	9	11
6	Tanke/Tipper Garage	40	3	20	2	5	5	11
7	Gaa-Akanbi/Offa Garage	42	4	16	1	1	6	7

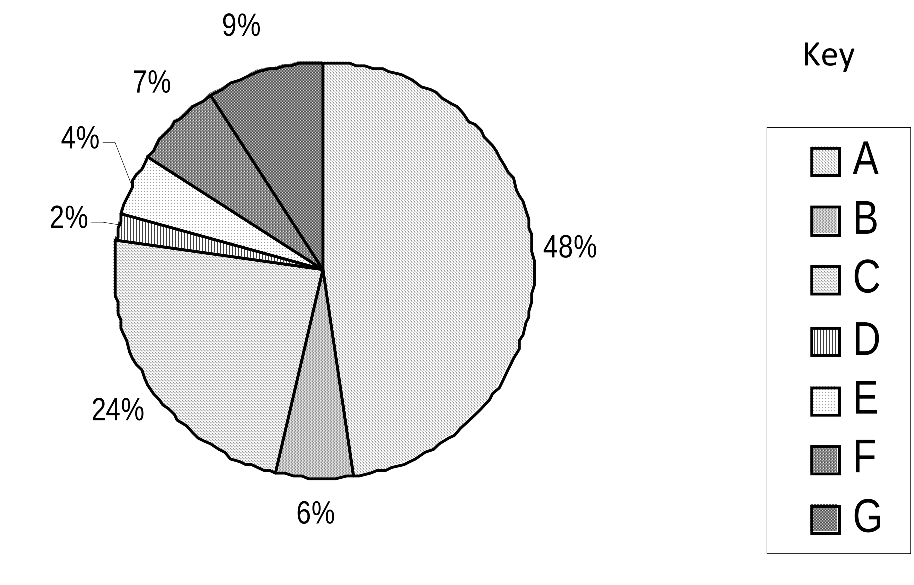
	Total	295	34	147	16	25	43	59
	Average	42	5	21	2	4	6	8
	Percentage	46.7	5.6	23.3	2.2	4.4	6.7	8.9

Source: The Authors, 2008

A = Traffic Controller/Wardens
B = Accident
C = parking problems
D = Pedestrian Crossing
E = Road-side hawking & Retailing
F = Vehicle Breakdown
G = Vehicle turning & Manouvering Problems
H = Others

Turning and maneuvering problems take an average of 8 minutes and constitute 8.9%. This can be attributed to the narrowness and the non-channelization of most of the intersecting roads. Vehicle breakdown and accidents take an average of 6 minutes and 5 minutes and accounting for 6.7% and 5.6% respectively of total delay time. Also road-side hawking and retailing account for an average of 4 minutes delay time constituting 4.4% of total delay time while pedestrian crossing accounts for only 2 minutes delay time and 2.2% of total delay time. Other causes of delay identified include conflicts, construction works and rainfall which also account for an average of 2 minutes constituting 2.2% of total delay time.

Fig. 5: Pattern of Delay Causes at the Intersections



Source: The Authors, 2008
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H = Others

5. Implication for Urban Transportation Planning

Traffic congestion problems are manifesting in many of the major urban centres in Nigeria. They are indeed becoming a menace to free flow of traffic in these cities. These problems are caused by ineffective use of road space and growth in the number of vehicles on our roads associated also with urban population growth. The study of congestion problems at sampled intersections in Ilorin revealed that there are significant spatio-temporal variations in traffic flows and delay times at the studied intersections during morning and afternoon peak periods. These variations can be attributed to the differences in land use characteristics at the intersections and the areas served by the roads.

The analysis of the causes of delays in Ilorin showed that delays at road intersections are mainly caused by traffic wardens and parking problems. The problem of traffic wardens can be attributed to the absence of modern traffic management techniques at the road intersections. Since human labour for traffic control is susceptible to failure due to fatigue and exhaustion, the traffic wardens are therefore not efficient or present to control the traffic when they are exhausted or during bad weather (like rainfall and in some cases, scorching sunshine).

The parking problems found can be attributed to narrowness of the intersecting roads which do not give room for side-kerb parking. In addition, there is no provision for off-street parking in the city and as such vehicles have no alternative than to use the roads as parking space. This therefore gives room for indiscriminate on-street parking and parking to load and unload.

The findings from this study have implication for urban transportation planning. The designs of the road intersections in the study area should be reviewed such that the approaches are broad for a distance of about 200 metres to avoid obstruction of side turning vehicles by the straight moving ones. All the approaches to the intersections should also be chanelized to separate traffic streams. Also, road-side hawking and trading and all forms of commercial activities should be strictly restricted up to a distance of 200 metres from the intersections. Town planning control mechanism should be used to control developments around the intersections.

The public transportation system in the city should be improved by introducing high-capacity buses and tricycles to work alongside with taxis and motorcycles for the conveyance of people in the study area. This will reduce the number of vehicles on the road. Besides, there is the need to signalize the intersections by installing traffic lights and signals to serve as substitute for the ineffective human labour of traffic management.

In addition, there is the need for provision of off-street parking spaces in Ilorin and along the intersecting roads. Also on-street parking of whatever types should be strictly restricted up to a distance of 200 metres away from the intersections. This can be done by installing NO PARKING and NO WAITING signs at the intersections to discourage arbitrary parking.

Many of the problems identified at the studied junctions are common to other road intersections in the city. The recommendations made are therefore useful for solving traffic congestion problems at road intersections generally in the city.

6. Conclusion

The study examined traffic congestion problem at road intersections in Ilorin and has offered useful suggestions for improving traffic flow at the junctions.

Though the traffic flow problem in Ilorin has not yet assumed the dimension of those of Lagos, Ibadan, Port-Harcourt and other bigger urban centres in Nigeria, signs of potential bottlenecks are already emerging (Aderamo, 1998). There is therefore the need to evolve more effective traffic management method for the city. As population increases and people become more affluent, traffic congestion problem becomes worse. With the high rate of growth of Ilorin, traffic problem should not be left until it deteriorates to the level of larger urban centres in Nigeria. It is on this note that this study has suggested immediate solutions to traffic congestion and delay problems at road intersections in Ilorin.

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