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Parking patterns and problems in developing countries: A case from Ilorin, Nigeria

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ABSTRACT

The paper examined the parking patterns, problems and their causes in Ilorin with a view to reduce the problems. The data used were collected through direct field survey of selected road intersections covering traffic volume and composition, traffic delay and causes and land use activities. On-street parking surveys were also carried out along selected roads in the city while off-street parking surveys were carried out at selected locations. The analysis of data collected revealed that variations exist in traffic flows and delays at the studied intersections. Parking problems alone were found to contribute 23.9% of delays at the road intersection in Ilorin. Regression method was used to model parking demand along the selected streets and the off-street parking facilities which could aid in estimating the parking need in the metropolis. The study finally recommended that in order to reduce traffic congestion and delays at road intersections in the city, on-street parking should be discouraged and adequate off-street parking facilities should be provided.

Keywords: Intersections, delays, on-street parking, off-street parking, parking demand.

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INTRODUCTION

Nigeria is urbanizing at a very rapid rate. The total urban population in Nigeria in 1963 was about 11 million. This rose to 32.2 million in 1991 and by 2000 the urban population was estimated at 45 million (NPC, 2006). On the average, Nigerian cities have been growing at the rate of 8% per year, far in excess of the country's population growth rate of 3.2%. Today, the country has 11 cities with population above one million and there are 23 cities with population of over 200,000. This rapid urbanization of the country has resulted in urban transport problems.

The urban transport problems today manifest in the form of poorly maintained urban road network and road complementary facilities, inefficient public transport system and poor land-use-transport planning. But according to Rodrigue et al. (2006), cities and their transport systems are fully complementary. 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 Horton (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 requirements of urban mobility (Rodrigue et al., 2006).

Transport is one of the instruments of unification of Nigeria and an important tool for social and economic development. The development of petroleum resources from the 1950's had significant impact on the nation's social and economic growth, putting increasing demands on the transport system. Goods and passenger movements in Nigeria are performed mainly by road, with the railway and inland waterways playing significant, but less important roles. International freight movement is principally by sea while air transportation is the main passenger carrier.

In Nigeria, as elsewhere, where cars are one of the

dominant modes of transportation, urban circulation is one of the most obvious problems, and parking seems to be an overlooked element of transportation development. Venues of activities such as offices, markets, shops, sports, churches and similar places often generate enormous parking demands, and the difficulty of parking vehicles at desired destinations particularly when located within the central areas of the city constitutes a major problem.

Illegal parking is also a major problem in Nigerian urban environment. Roadside parking is a common phenomenon which reduces the traffic corridors meant for the efficient movement of automobiles. The resultant effect of such illegal parking is traffic congestion which also leads to delay in travelling time and increases the cost of travelling.

In Ilorin metropolis, parking is one of the most noticeable problems as there are few designated parking spaces which have already proved insufficient. Unauthorized and indiscriminate parking along streets within the urban core is a serious impediment to smooth urban movement and is indicative of lack of adequate attention to this aspect of transportation. The objective of this study is to assess the parking patterns and problems in Ilorin with a view to providing suggestions for tackling this urban transportation problem.

REVIEW OF RELATED LITERATURE

Litman (2011) conceptualized parking problem in terms of a paradigm shift which describes a fundamental change in how a problem is perceived and solutions evaluated. Parking problem and solutions can be viewed in terms of a shift from the old paradigm to the new one. The old paradigm assumes that parking should be abundant and free at most destinations. It strives to maximize supply and minimize price (Willson and Shoup, 1999). The paradigm also assumes that parking lots should almost never be filled and that parking facility costs should be incorporated into the costs of buildings or subsidized by governments and that every destination should satisfy its own parking needs. The old parking paradigm asserts that parking requirements should be applied rigidly without exception or variation and that parking management should be seen as a last resort to be applied only if increasing supply is infeasible.

The new parking paradigm on the other hand strives to provide optimal parking supply and price. It considers too much supply as harmful, as too little, and prices that are too low are as harmful as those that are too high. The new paradigm strives to use parking facilities efficiently. It considers full lots to be acceptable, provided that additional parking is available nearby and any spillover problems are addressed. It emphasizes sharing of parking facilities between different destinations and favours charging parking facility costs directly to users and providing financial rewards to people who reduce their parking demand. While the old paradigm tends to resist change and places a heavy burden of proof on innovation, the new paradigm recognizes that transport and land use conditions evolve so parking planning practices need frequent adjustment (Cuddy, 2007).

Management solutions tend to reduce most parking problems, providing a greater range of benefits and so are supported by more comprehensive planning. It is also important to define parking problems carefully in order to provide solutions. If people complain about a parking problem, for example, it is important to determine exactly what type of problem, and where, when and to whom it occurs. Increasing supply simply helps reduce parking congestion and spill over problems but increases most other problems (Edwards, 2002).

In order to provide optimal parking supply, it is the practice in conventional planning to determine how much parking to be provided at a particular site by planners based on recommended minimum parking standards published by various professional organizations. This provides an index or parking ratio used to calculate the number of spaces to supply at a particular location. These are unconstrained and unadjusted values, which generally reflect the maximum supply that could be needed. These standards are often excessive and can usually be adjusted significantly downward (Litman, 2009).

Conventional parking standards are based on parking demand surveys but the analysis does not usually take into account geographic, demographic and economic factors that can affect parking demand such as whether a site is urban or suburban, and whether parking is free or priced. These standards err toward over supply in many ways. They are derived from parking demand studies that were mostly performed in car-dependent locations. Applying these standards results in far more parking supply than is usually needed at most destinations, particularly where land use is mixed, there are good travel options, parking is managed for efficiency or priced (Bradley,1997).

Better ways are now available to determine how much parking to supply at a particular site. These are the efficiency-based standards which take into account, geographic, demographic and economic factors that affect parking demand (Cuddy, 2007; VTPI, 2008). They also reflect the relative costs and benefits of different options, so less parking is supplied where parking supply is relatively costly to provide and where management programmes are easy to implement.

Litman (2007) has also recommended an integrated parking plan which should be adjusted to reflect the needs of a particular situation. The steps include defining the geographic scope of analysis such as the site, street, district/neighbourhood and regional scale; carefully defining the parking problems; parking planning should be coordinated with a community's overall strategic vision

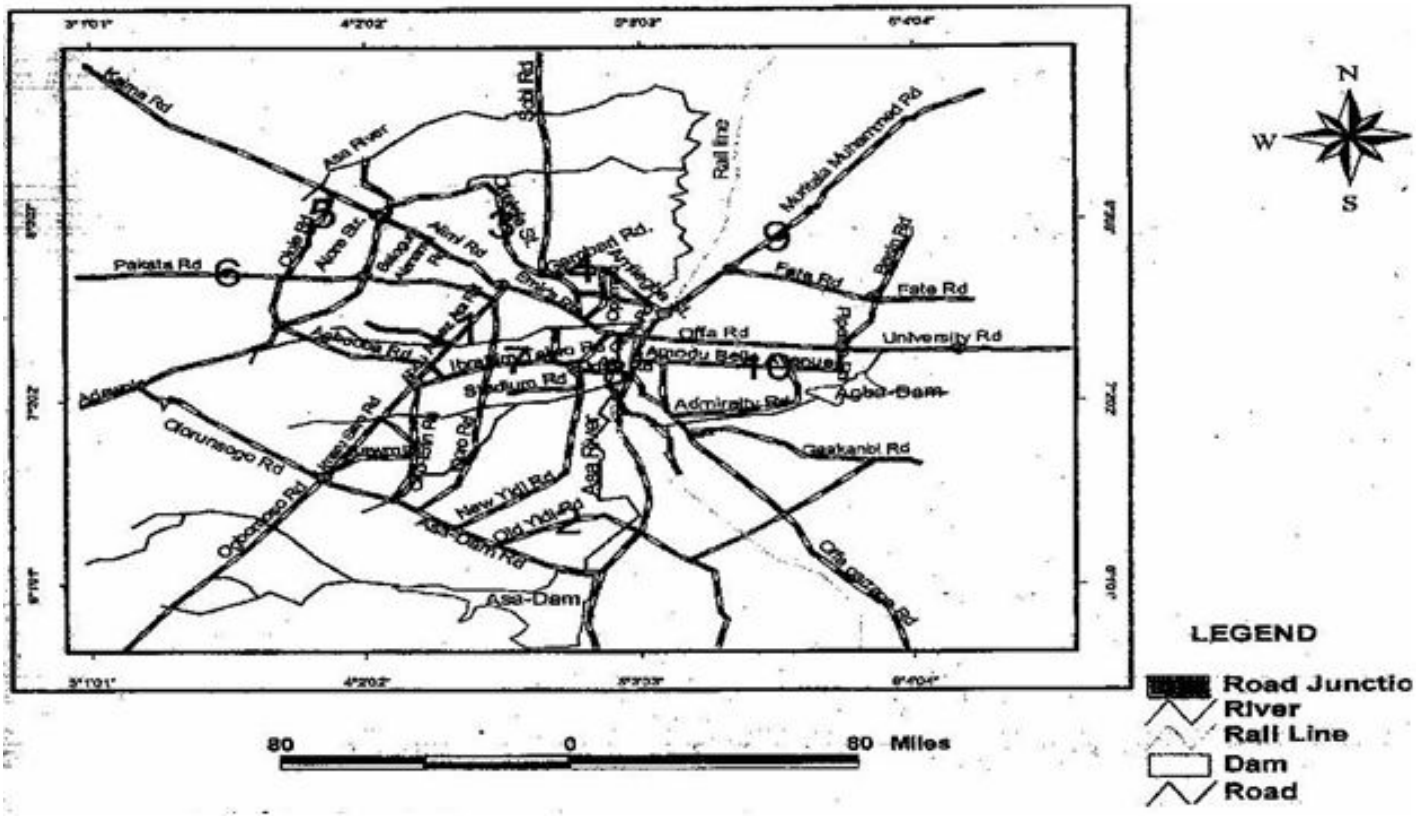

Figure 1. Map of Ilorin showing the sampled roads. Source: Kwara State Ministry of Lands and Housing, 2010.

and development of a comprehensive evaluation framework. A survey of parking supply and demand in the study area is then conducted after which a list of potential solutions using ideas from both the survey and stakeholders' ideas, each option is then evaluated with respect to evaluation criteria. The final step is to develop an implementation plan which may include various phases and contingency-based options.

MATERIALS AND METHODS

The data used for this study include the socio-economic characteristics of respondent vehicle parkers, existing parking facilities along sampled streets, locations where parking facilities are required, types of parking system available in the study area, and existing parking regulations and control. Data were also collected on attitude of commuters especially the commercial vehicles operators towards parking in the study area.

Ten major streets were chosen, through random sampling, to collect data on on-street parking. These are Taiwo, Muritala Mohammed, Abdulazeez Attah, Ipata, Okelele, Oloje, Unity, Pakata, Old Yidi Roads and Ahmadu Bello Way. Figure 1 shows the sampled roads used for the study. Data were also collected from premises of 10 corporate institutions where organised parking are prevalent. The designated public institutions selected for off-street parking are Ilorin West Local Government Area Secretariat, First Bank Plc Parking lot, University of Ilorin, UBA Plc, NYSC Secretariat, Martrite Supermarket, Governor's Office, Sharia Court of Appeal, Kwara Hotels, and Ministry of Finance parking lots.

Two sets of structured questionnaires were used for the collection of data, one set of questionnaire for off-street parking and one for on-street parking. Information on the number of vehicles parked in a chosen parking lot at a particular period of time was collected. The survey was conducted between 8:00 a.m – 6:00 p.m on Monday to Friday of the week. Data on regulatory measures were obtained from the three Local Government Areas that make up the study area, the State Ministry of Transport, the traffic warden division of the Nigerian Police and the command sector of the Federal Road Safety Commission (FRSC).

The data collected were analyzed using both descriptive and inferential statistics. The results were shown using tables, graphs and charts. The multiple regression method was also used to examine the relationship between vehicles parked and time period used in parking. The Statistical Package for the Social Sciences (SPSS 16.0) was employed in the regression analysis.

RESULTS AND DISCUSSION

Characteristics of the studied intersections

The studied intersections are Pakata/Adeta, Surulere/Agbo-Oba, Oloje/Mount Carmel College, Taiwo/Ita Amodu, Gambari/Balogun Fulani and Omoda/Ajikobi. These are shown in Table 1. The intersections are of different types and serve different types of land uses. They comprise of 5-legged, 4-legged and 3-legged junctions.

Table 1. Characteristics of the studied intersections.

S/No.	Intersection name	Intersection types	Land-use characteristics
1	Pakata/Adeta	5-legged	Institutional, residential estate, commercial, motor parks, retail shops
2	Surulere/Agbo-Oba	4-legged	Market, commercial centre, institutional, residential estate, retail shops
3	Oloje/Mount Carmel College	3-legged	Market, commercial, motor park, institutional, residential estate, retail shops
4	Taiwo/Ita Amodu	4-legged	Commercial centres, retail shops, institutional
5	Gambari/Balogun Fulani	3-legged	Motor park, institutional, offices, market, commercial centres, retail shops, government residential area
6	Omoda/Ajikobi	4-legged	Retailing shops, institutional, commercial, motor parks

Source**:** Authors' Field Survey

Table 2. Traffic composition at the studied junctions.

S/N	Intersections	Traffic composition						
		A	B	C	D	E	F	G
1	Pakata/Adeta	1122	694	1101	519	125	89	4
2	Surulere/Agbooba	1442	1233	1263	389	242	101	4
3	Oloje/Mount Carmel College	1146	1001	1139	216	135	71	3
4	Taiwo/Ita Amodu	1429	1199	1344	423	240	103	4
5	Gambari/Balogun Fulani	1127	1140	1083	353	288	73	4
6	Omoda/Ajikobi	1001	1003	1022	434	108	87	5
	Total	7267	6270	6952	2334	1138	524	24
	Percentage	29.7	25.6	28.4	9.5	4.6	2.1	0.09

Source: Field Survey, 2010. A = Motorcycle, B = Private Cars, C = Taxis, D = Buses, E = Delivery Vans, F = Trucks/Trailers/Lorries/Tankers/Tippers, G = Others.

The traffic flows at all the studied intersections are controlled by traffic wardens. Also common to all the intersections, are 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, thereby impeding the free movement of vehicles. Associated with these problems are the problems of narrowness and poor nature of the intersecting roads to separate the traffic streams.

Table 1 shows that 3 of the intersections constituting 50.0% are 4-legged. These are Pakata/Adeta, Surulere/Agbo-Oba, Taiwo/Ita-Amodu and Omoda/Ajikobi. The 3-legged intersections which constitute 33.4% are Oloje/Mount Carmel and Gambari/Balogun Fulani. Pakata/Adeta junction constituting only 16.6% is 5-legged. In terms of land use characteristics of the studied intersections, majority of them are located where institutional, commercial, markets, retailing shops and motor parks predominate. The intersecting arms also connect residential estates, public and private institutions and other major activity centres in the city.

Pattern of traffic composition

The average peak-hour traffic composition at the sampled intersections is as shown on Table 2. The table shows that of all the vehicle types recorded at the sampled junctions, motorcycles had the highest occurrence (29.7%) which is followed by taxis (28.4%). Private cars ranked third (25.6%) while buses came fourth with 9.5%. Other types of vehicles recorded at the sampled junctions are delivery vans (4.6%), trucks/tractors/lorries/tankers/tippers (2.1%) and other vehicles (0.09%).

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

Table 3. Delay causes at studied intersections.

S/N	Intersections	Delay causes (min)						
		A	B	C	D	E	F	G
1	Pakata/Adeta	37	4	13	1	5	4	4
2	Surulere/Agbooba	42	7	22	2	4	9	9
3	Oloje/Mount Carmel College	26	2	15	2	1	2	8
4	Taiwo/Ita Amodu	41	6	25	5	6	8	9
5	Gambari/Balogun Fulani	33	4	19	1	5	4	4
6	Omoda/Ajikobi	32	7	19	2	4	9	9
	Total	211	30	113	13	26	36	43
	Average	35.2	5	18.8	2.2	4.3	6	7.2
	Percentage	44.7	6.4	23.9	2.8	5.5	7.6	9.1

Source: Field Survey, 2010. A = Traffic Controller/Wardens, B = Accident, C = Parking Problems, D = Pedestrian Crossing, E = Road-side Hawking and Retailing, F = Vehicle Breakdown, G = Vehicle Turning and Maneuvering Problems, H = Others.

a regular mode to use in meeting the needs of the inhabitants in terms of public transportation while there are now more private cars on the city's roads due to improved income and better purchasing power of workers. 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.

Delay causes at studied intersections

Table 3 shows the analysis of the causes of delays at the studied intersections. The analysis showed that delays at road intersections are mostly caused by traffic wardens and parking problems. Delays due to traffic wardens constitute 44.7% and took an average of 35 min while delays due to parking constitute 23.9% and took an average of 19 min. The problem of traffic wardens can be attributed to the absence of modern traffic management techniques at the studied intersections. 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.

Turning and maneuvering problems constitute 9.1% and took an average of 7 min. This can be attributed to the narrowness and the non-channelization of most of the intersecting roads. Vehicles breakdown and accidents constitute 7.6 and 6.4% and took an average of 6 and 5 min, respectively, of total delay time. Also, road-side hawking and retailing account for an average of 4 min delay time, constituting 5.5% of total delay time, while pedestrian crossing accounts for only 2 min delay time and constituting 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 min constituting 2.8% of total delay time.

Modeling parking demand

On-street parking model

Parking demand is the number of parking space need in a given area at some time interval. A relationship exists between parking demand and such variables as the total number of residents in the catchment area of a parking facility, the vehicle ownership of the residents in the catchment area, the average household income and the average travel distance from each resident to parking facility (Ng and Ma'soem, 2005).

Ng and Ma'soem proposed a multiple regression equation of the form:

$$y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 \quad (1)$$

where:

y = Parking demand

x_1 = Total population in catchment area (within 5 km radius from parking facility)

x_2 = Average vehicle ownership per household in catchment area

x_3 = Average household income in catchment area

x_4 = Average travel distance from each resident to the parking facility

α_1 - α_4 = Regression coefficients

α_0 = The intercept.

The parking demand model developed for this study is:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + e \quad (2)$$

Table 4. Selected roads and on-street parking in Ilorin.

S/No.	Road	Ward location	Ward population (Thousands)	Number of vehicles parked on both sides of the road	Number of vehicles packed per hour	Vehicle ownership by ward for sampled respondents
1	AbdulAziz Attah	Magaji Ngeri	71.5	380	138	4
2	Old Yidi	Magaji Ngeri	71.5	117	75	12
3	Emir's	Balogun Fulani	58.8	232	72	12
4	Gambari	Balogun Gambari	69.7	392	135	9
5	Oloje	Magaji Oloje	28.3	317	84	7
6	Pakata	Adewole	41.6	42	45	8
7	Ibrahim Taiwo	Badari	44.5	435	75	12
8	Unity	Oke-Ogun	43.1	150	75	11
9	Murtala Mohammed	Balogun Fulani	58.8	203	132	41
10	Sulu Gambari	Magaji Are	19.8	135	54	41

Source: Authors' Survey

where:
y = Parking demand
x_1 = Ward population within which a selected street is located (within 5 km radius from the selected street)
x_2 = Average number of vehicles parked per hour
x_3 = Average vehicle ownership per household within the ward (catchment area)
$\beta_1 – \beta_3$ = Regression coefficient
β_0 = The intercept
e = error term

The sampled roads for the study are: 1) AbdulAzeez Attah, 2) Old Yidi, 3) Emir's, 4) Gambari, 5) Oloje, 6) Pakata, 7) Taiwo, 8) Unity, 9) Murtala Mohammed, 10) Sulu Gambari.

Each of these roads is within 5 km radius of the ward within which it is located. The wards are shown on Table 4. The parking demand was estimated using the number of vehicles parked on both sides of the road during the survey period. Data were collected on the average vehicle ownership per household through a home-interview survey (Hanson, 1980). As it was not possible to interview all the households in the city, a sampling technique was employed. A sample of 1 in 20 dwellings was selected using systematic sampling procedure. The sampling was done on dwellings along main streets and information on vehicle ownership were obtained from household heads. A total of 624 people from all the 20 wards were interviewed. The number of vehicles parked per hour was also counted. Table 4 shows the data used for modeling parking demand while Figure 2 shows the pattern of the plot of number of vehicles parked on both side of the roads during the survey period.

Using the Statistical Package for Social Sciences (SPSS), the data collected were analysed with linear regression and the results obtained are as shown in Tables 5 and 6.

The correlation analysis on Table 5 shows that parking demand (y) has a high correlation of 0.601 with the average number of vehicles parked per hour (x_2) and a low value of 0.258 with the total population in catchment area (x_1). Also the ward population within 5 km radius of the selected streets (x_1) has a correlation of 0.416 with average vehicle ownership by households within the ward (x_3). The other variables display negative relationships. For instance, parking demand (y) has a correlation of -0.318 with average vehicle ownership in catchment area (x_3) while (x_2) has a correlation value of -0.677 with x_1. Also, x_3 has a correlation value of -0.271 with x_2. The correlation values however show that the variables do not suffer from the problem of collinearity at 5.0% level of significance (Leung, 1982).

Table 6 shows the regression summary for parking demand and the independent variables. The three independent variables explain 56.3% of the total variation in parking demand. The remaining 43.7% are variables which cannot be included in the model due to their exogenous features. These include economic and environmental factors.

The regression summary also shows that only x_2 representing average number of vehicles parked per hour is significant at 0.05 level of significance considering its t-value. This shows that exogenous variables such as environmental factors and parking regulation may affect the model. The value of the coefficient of determination R^2 which is 56.3% however shows that the model is a good fit for the data.

The regression model obtained is:

$$y = 174.22 – 3.452x_1 + 3.528x_2 – 4.520x_3 \quad (3)$$

Off-street parking model

A simple regression model was developed for the off-

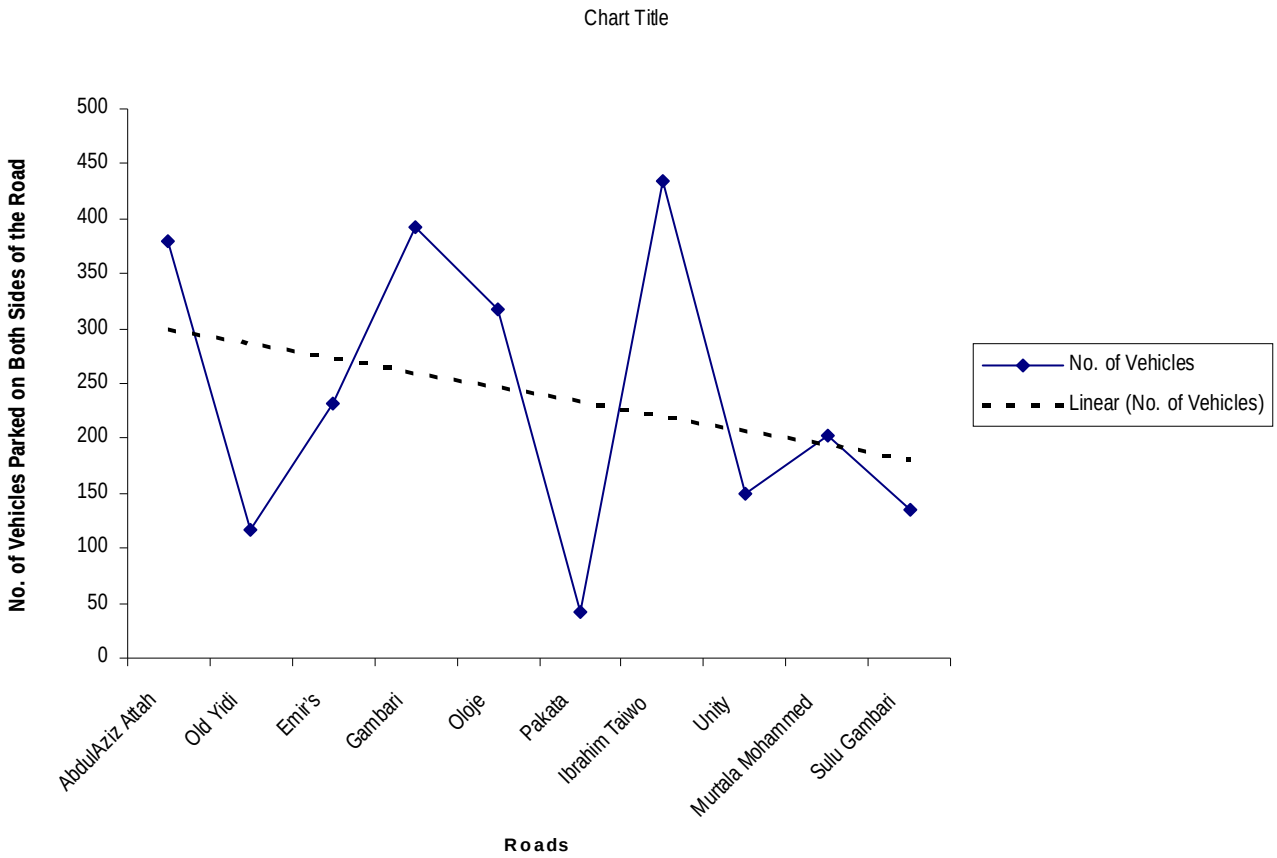

Figure 2. On-street parking along selected roads in Ilorin.

Table 5. Pearson correlation for the dependent and independent variables.

	y	X_1	x_2	x_3
y	1.00			
x_1	0.258	1.00		
x_2	0.601	-0.677	1.00	
x_3	-0.318	0.416	-0.271	1.00

Source: Computer output

Table 6. Regression summary for parking demand and the independent variables.

Dependent variable	Independent variables	Regression coefficients	Standard error	T-values	Level of significance
Parking demand	Constant	174.222	133.706	1.303	0.240
	x_1	-3.452	2.851	-1.211	0.272
	x_2	3.528	1.443	2.444	0.050*
	x_3	-4.520	2.928	-1.544	0.174

Source: Computer Output. R^2 = 0.563, *Significant at = 0.05 level.

street parking model (Ng and Ma'soem, 2005). The model takes the form:

$$y = a + bx + e \quad (4)$$

where

y = Parking demand (total number of occupied parking spaces)

x = Number of unoccupied parking space

Table 7. Off-street parking at selected locations in Ilorin.

S/No.	Location	Number of occupied parking space	Number of unoccupied parking space
1	Ilorin West LGA	77	5
2	First Bank Plc.	40	10
3	Unilorin	194	73
4	UBA Challenge Branch	21	2
5	NYSC Secretariat	36	10
6	Martrite Supermarket	16	8
7	Governor's Office	150	21
8	Sharia Court	23	37
9	Kwara Hotel	36	64
10	Ministry of Finance	40	11

Source: Authors' Survey

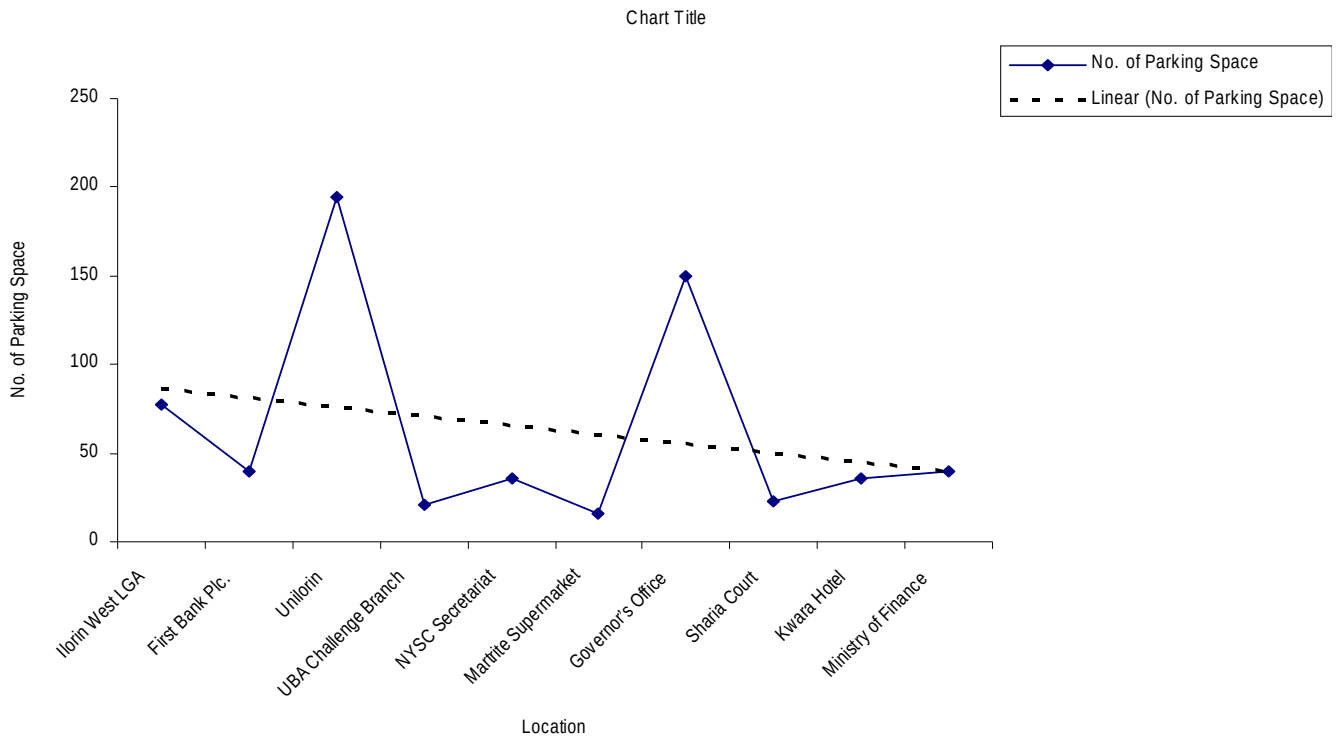

Figure 3. Off-street parking at selected locations in Ilorin.

a = Intercept
b = Regression coefficient
e = Error term

The parking spaces were located at the following locations: 1) Ilorin West Local Government Area Secretariat; 2) First Bank Plc; 3) Unilorin; 4) UBA Challenge Branch; 5) NYSC Secretariat; 6) Martrite Supermarket; 7) Governor's Office; 8) Sharia Court; 9) Kwara Hotel; 10) Ministry of Finance.

Table 7 shows the data used for the analysis of off-street parking demand while the plot of off-street parking is shown on Figure 3.

Regression analysis results in the regression summary between parking demand and the independent variable is shown in Table 8.

The regression summary shows that the independent variable explains only 25.2% of the variation in parking demand. This means that the remaining 74.8% are due to variables which are not included in the model. These could be regulatory and environmental factors.

However, the model shows that the independent variable is statistically insignificant as shown by the F = 2.691 value which is less than the table value of 5.32 at

Table 8. Regression summary between parking demand and the independent variable.

Dependent variable	Independent variable	Regression coefficients	Standard error	T-values	Levels of significance
Parking demand	Constant	34.555	24.817	1.392	0.201
	x	1.193	0.727	1.640	0.140

Source: Computer Output. $R^2 = 0.252$, Df = $^1/_8$, F = 2.691 < 5.32.

0.05 level. This implies that the model is only suitable for explanation and not prediction of off-street parking demand in Ilorin.

The linear regression model obtained is:

$$y = 34.555 + 1.193x \quad (5)$$

Implication for urban transportation planning

This study has implication for urban transportation planning. The designs of the road intersections in Ilorin should be reviewed such that the approaches are broad for a distance of about 180 m to avoid obstruction of side-turning vehicles by the straight moving ones.

Road-side hawking and trading and all forms of commercial activities should be strictly restricted up to a distance of 180 m from the intersections. Town planning control mechanism should be used to control developments around the intersections.

The public transportation in Ilorin should be improved by introducing high-capacity buses and tricycles to work alongside with taxis and motorcycles for the conveyance of people. 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.

On-street parking of whatever type should be restricted up to a distance of 180 m 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 Ilorin. The recommendations made are therefore useful for solving traffic congestion problems at road intersections generally in Ilorin.

CONCLUSION

Parking has been a long standing problem in many urban centres in Nigeria. This has been due to the absence of clearly designated areas for parking in many of our cities. This has led to traffic congestion and delay problems.

This study has examined the pattern and problems of on-street and off-street parking in Ilorin and the factors contributing to them. Parking demand models have been built for estimating on-street parking and off-street demands of selected streets and parking facilities in Ilorin. This will go a long way in assessing the parking needs of the different parts of the city.

Further, it is recommended that a more effective traffic management system should be evolved for Ilorin. With the high rate of growth of Ilorin, traffic and parking problems should not be left until they attain the level of larger urban centres in Nigeria.

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