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AN ANALYSIS OF TRIP GENERATION AND VEHICULAR TRAFFIC PATTERN IN AKURE METROPOLIS ONDO STATE, NIGERIA

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ABSTRACT
The study examined trip generation and vehicular traffic pattern Akure metropolis which is one of the fast developing urban centres in Nigeria. Purposive sampling technique was employed to select five major roads in the area, while accidental sampling technique was adopted to administer two hundred copies of structured questionnaire to road users as intervals of 2km. Also, traffic situation was obtained from traffic counts and classification of vehicles at key traffic points across the roads. The result showed that civil servants and students constituted the principal road users in the area, and that majority of the road users earned between N10, 000 – N100, 000 monthly. It showed that 8 – 10am and 2 – 5 pm were the peak hours of traffic congestion in the city due to series of problems encountered by passengers such as bad roads, street parking, road narrowness, poor traffic system and impatience by motorist. The multinomial logistic model revealed that 32% percent of the variability in trips was explained by the set of independent variables. The statistical significance of the model further revealed that trips made by commuters were significantly related to their socio economic characteristics ($p<0.05$), while occupation accounted for most of the trips made by road users in the area. In addition, the chi square result indicated that the types of vehicles that plied the major roads varied significantly ($p<0.05$). Based on the findings above, the study suggested that the roles of government in providing effective and efficient transport system should be intensified. Also, more areas should be opened as a bye-pass and interlink route for free flow of vehicles, this would improve the social well-being of the people and bring about sustainable transport management.
Keywords: Urban Road Transport, Traffic Operations, Peak Hours, By-pass, Sustainable Transport Management

INTRODUCTION
Urbanization is on the increase globally, due to the movement of people from rural to urban areas. The increased demand for urban road transportation has led to the high cost of transportation, traffic congestion and inadequate vehicular modes of transportation substantially loss of time while in traffic jam and environmental pollution among many others (Oyesiku, 2002; Nwaka, 2005; Asiyanbola and Raji, 2007).Ogunsanya (2002) opined that what people consider as urban transport problems are urban traffic congestion, parking problems, traffic delays to mention but a few. It is important to note that these are mere symptoms of a malfunctioning urban traffic system. Some basic problems are route inadequacy, human misuse of transport infrastructure, poor traffic management, absence of traffic and transportation planning and the upsurge in urban travel demand. (Filani, 1994) also maintained that the underlying factors contributing to urban traffic problems includes; financial constraints, inappropriate political decision and

the absence of planning data. Unless these basic reasons and underlying factors in the urban traffic problem are adequately addressed, the symptoms of malfunctioning transportation system may not be abated (Olukoju, 2003). The vibrant economic activity in most urban centres such as Akure tends to explain the high level of vehicular movement on urban roads, as people move and interact to meet their unending desires. The existence and the establishment of various financial and economic institutions, such as, banks, insurance companies and business centers, is a major factor in this regard; consequently, heavy traffic flows and traffic congestion become a viable daily occurrence (Ogunbodede, 2007). Distance and location are basic to the understanding of spatial distribution and interrelationships of phenomena; it is in this regard, that the rate of traffic problem in urban centre such as, Akure cannot be over-emphasized. Urbanized areas in the metropolis continue to attract more pollution due to increase in the number of vehicular movement. However, Akure like most cities in Nigeria has a number of functions as centre of commerce, education, social, recreation and administrative centres, which necessitate the need for movement and interaction via road transport routes. The increase in population over the years however, has led to the increase demand and pressure on road transport, thereby accelerating transport related problems.

In addition, the increasing participation of the private sector in trade and commerce in the area has all brought about increased mobility and consequently high demand for road transportation with increasing standard of living. On this note, the daily and increasing number of vehicles in Akure metropolis tends to constitute a major problem in its urban road transport system. The growing pace of traffic problem has not only made a vast demand for land use, but also has created ecological and environmental problems in the area. As a result of these inadequacies, road transport system in the area has become ineffective and inadequate to accommodate the pressure on increasing transport demands. Hitherto, the growing problems of traffic congestion in Nigeria have attracted more attentions more than any other urban problems and solution to this menace is well documented in the literature. Some of these suggestions include expansion of road network (Okpala, 1981; Ogunsanya, 1985), improved traffic management and staggering of working hours (Rahman, 2004, Oni, 2004), improvement in public mass transportation (Bashiru and Waziri, 2008; Oduola, 1981; Filani, 2000). Others suggested solutions include intermodal coordination (Hoyle and smith, 1998; Badejo, 2006) and the use of non-motorized transport and traffic education (Ogunbodede, 2000). Going through the literatures, it has been observed that transport is a subject of universal interest and issues on traffic congestion cannot be ruled out. While most of the above measures are aimed at reducing traffic in Lagos metropolis, emerging cities such as Akure metropolis are not integrated towards such a traffic management measures. Apart from the work of Ogunbodede(2007)that examine assessment of traffic congestion in Akure metropolis using a GIS approach, no other studies has examine urban road transport problems in Akure metropolis using a multinomial regression model in predicting the effect of socio-economic variables on transport demands. It is on this background that the study examines urban transport problem in Akure Metropolis, which is experiencing immense pressure on its road transport infrastructure, and the resultant effect of rural-urban migration on dynamic socio-economic activity within the metropolis. The study is aimed to determine the main choice of urban road transport system, examine possible factors

responsible for traffic congestion and identify periods of high and low traffic issues in the area. The study however, hypothesizes that:

1. The choice (car/taxi, bus motorcycles/bikes as well as Lorries) of urban road transport system varies significantly with traffic routes.
2. The type of trips (school, market and work) made by commuters is significantly related to their socio economic characteristics (sex, income, education and occupation).

MATERIALS AND METHODS

The study area is Akure, the administrative capital of Ondo State. Akure is located on latitude 7^0 15′ north and longitude 5^0 05′ east**.** The area is characterized by a tropical wet and dry climate. The raining season starts from early April to late October, while the dry season starts from November to March. The rainfall in the study area is between 1200mm to 1700mm, the humidity is about 85% and the area experiences wet season for roughly 8½ to 9 months. The upgrading of the area into a business hub led has to increase in population with a corresponding increase in vehicular ownership. Furthermore, Akure is one of the MDG cities (millennium Development goals city and World Bank assisted programme). The area serves as a significant corridor to the capital city of Nigeria. The development of the area into a world class city had induced people from different part of the suburb to migrate to area; this has resulted in traffic and vehicular movement with inherent traffic congestion.

Research Design, Type of Data and Sampling Procedure

The descriptive research design was employed which enabled traffic attributes to be collected by administering a structured questionnaire as well as monitoring traffic flows along major roads. Data for the study was sourced principally from field surveys (primary data). The first set of primary data, on the socioeconomic characteristics of road users, pattern of road transport, effects of roads on trips and problem of road transport in Akure were sourced through the administration of a structured questionnaire and oral interview to road users/commuters. The second set of data on vehicular traffic situation across major routes (incoming and outgoing), peak period of trips and type of vehicle was sourced from traffic counts and classification of vehicles at key traffic points across the roads. The purposive and accidental sampling techniques were employed. The purposive sampling technique was used to select five major roads in the area due to their immense contributions to the transport corridor in the area, the accidental sampling technique was used to administer as well as interview road users at 30m interval along the roads. The five roads included the Oba Adesida road, Oyemekun road, Parliament road, Ilesha road and State Hospital road. Interviews and questionnaire administration were conducted using accidental sampling technique at interval of 2km along each road. At each interval, 10 commuters (both passengers and pedestrians) were administered copies of questionnaire, out of this, 2 were interviewed. The number of questionnaire administered was proportional to the length of the road (table 1).

Table 1: Distribution of Questionnaire along the major routes

Selected roads	Lengths of road (km)	Questionnaire
Oba – Adesida Road	15	70
Oyemekun Road	8	40
Parliament Road	5	20
Ilesha – Road	10	50
State Hospital Road	5	20
Total	**43**	**200**

Source: Fieldwork, 2011

METHOD OF DATA ANALYSIS

Data obtained was analysed using descriptive and inferential statistics. Descriptive statistical tools such as tables and simple percentages were used to represent the data to aid understanding of the variables, while multivariate statistical technique (multinomial logistic model) was employed. The multinomial logistic model (MLM) was used to predict the occurrence of trips using socioeconomic variables (sex, education, income and occupation). The multinomial (polytomous) logistic regression is the extension of the binary logistic regression. It is used when the categorical dependent outcome (in this case, trip pattern) has more than two levels (Chan, 2005; Bayaga, 2010). For example, instead of predicting only trip to school or trip to work, we have three groups, namely: trip to school, trip to work and trip to market. In fact it is employed when the dependent variable has more than two nominal or unordered categories, in which dummy coding of independent variables is quite common (Bayaga, 2010). The model was however used for this study since most of multivariate analysis techniques require the basic assumptions of normality and continuous data, involving independent and/or dependent variables, for this reason, multinomial logistic regression was used where the above assumptions tend to be violated (Bayaga, 2010; Kayri and Cokluk, 2010). The application of multinomial logistic regression arises when an analyst analyses relationships between a non-metric dependent variable and metric or dichotomous independent variables (Chan, 2005). In this study, both the dependent and independent variables are non-metric or categorical. However, in order to effectively carryout this test, items in the questionnaire coded for descriptive analysis were transformed or recoded into dummy variables (the independent variables). In this case, income with four options, was recoded into two dummy variables of low income as 0, and high income as 1; also occupation with five options/responses were recoded into three dummy variables of unskilled as 0, students as 1 and skilled as 2 and so on. Analysis was carried out with the aid of SPSS (17.0) software for windows.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Respondents

The socioeconomic characteristics of respondents shows that males accounted for 131 (65.5%), while 69 (34.5%) were females. This implies that that majority of the respondents were males. The age pattern revealed that 77 (38.5%) of the road users were between the ages of 18 - 25 years, those between the ages of 26 -35 years were 64 (32%), 41 (20.5%) were between the ages of 36 – 50 years, while 18(9.0%) comprised road users above 50 years. This indicates that the traffic environment of the area mostly comprised the active population who toil for various needs. The educational qualification of respondents revealed that 81 (40.5%) had tertiary education, 63 (31.5%) had post-

primary education, 26 (13%) had primary education, while 30(15.0%) of them had no formal education. It further means that over 85% of the road users are literate, who perhaps are conscious of the traffic situation in the area. This indeed added value to the rate at which road users responded to traffic rules and regulations. Furthermore, the occupational structure of the commuters (road users) revealed that 90 (45%) of the road users were civil servants, 50 (25%) were students, 30 (15.6%) were technicians/professionals, 21 (7.0%) were traders, while 9(4.5%) comprised individuals engaged in petty jobs like wheel barrow pushers and road carriers. This again indicates that civil servants and students constituted the area's traffic corridor. The monthly income of the respondents showed that majority, 89 (69.5%) of the road users were low income groups whose income ranged from N10, 000 to N100, 000, while those with income above N100, 000 constituted 21 (10.5%).

PATTERN OF ROAD TRANSPORT

The distribution of vehicle users is important to this study. It is on this premise that the transport system in Akure metropolis is being examined based on types of vehicles used and routes mostly plied (used). Information on the responses of commuters (road users) plying the major routes within Akure metropolis revealed that 68 (34%) plied Oba Adesida roads, 30 (15.0%) used Parliament road, 17(8.5%) plied Oyemekun roads, while 45(22.5%) and 40(20%) represented commuters that plied Ilesa and the State Hospital roads respectively (fig 1). In addition, the types of vehicles used by the road users as shown in fig 2, revealed that cars/taxi (55%) was the main vehicle used, this was closely followed by motorcycles/bikes (27%), while 13% and 5% accounted for buses and other types of vehicles such as lorries, jeeps and pickups respectively. The predominance of car/ taxi in the area's transport environment is unconnected to the deplorable state of roads, which makes it the easiest and highly adaptable vehicle for such purpose. As a result of the deplorable roads, majority of the cars/taxi plying the roads are rickety and others in bad condition.

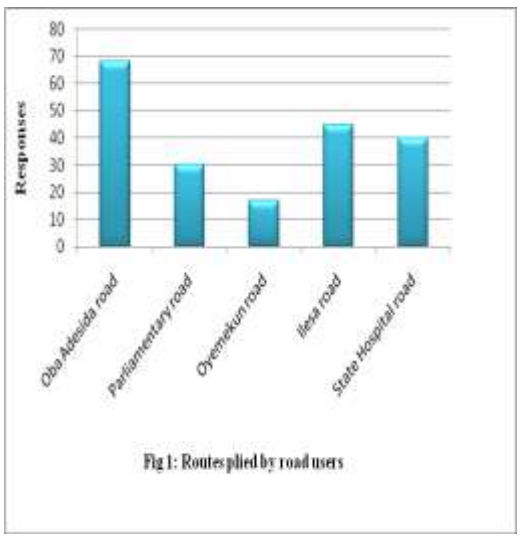

Fig 1: Routes plied by road users

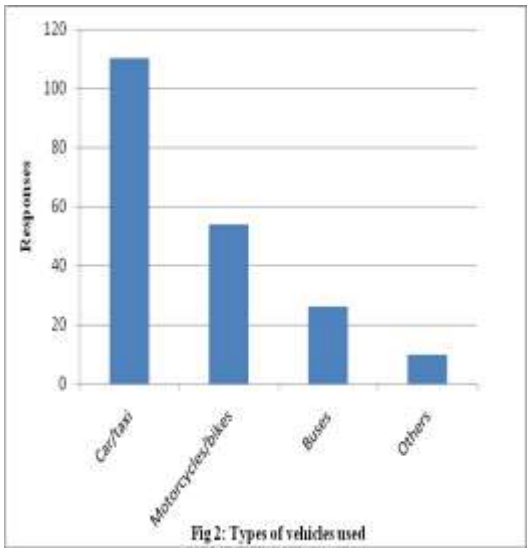

Fig 2: Types of vehicles used

Trip Pattern Across the Major Roads

Table 1 gives vital information trip pattern across the major roads. It revealed that majority (37%) of the commuters used the various routes to their places of work; this was closely followed by trips to school (36.5%), while 53 (26.5%) used the routes to the markets. Indeed, place of work and school accounted for the overall trips taken by the commuters in the area. The result further revealed that Oba Adesida road with 58(29%) accounted for the highest proportion of trips taken by the commuters, while the lowest trips were made on Ilesa road. This is evident as Oba Adesida road links and the traverses major land uses in the area such as banks, insurance and financial institutions, shopping mall, eateries, and offices among others.

Table 1: Major routes and trips

Major routes	Trips			Total
	Market	Work	Schools	
Oba Adesida road	18 (34%)	22 (29.7%)	20 (27.4%)	54 (29%)
Oyemekun road	13 (24.5%)	10 (13.5%)	10 (13.7%)	33 (16.5%)
Parliament road	13 (24.5%)	17(23%)	11(15.1%)	41(20.5%)
Ilesa road	8 (15.1%)	10 (13.5%)	12 (16.4%)	30 (15%)
State hospital road	3 (5.7%)	15 (20.3%)	20 (27.4%)	35 (17.5%)
Total	**53(26.5%)**	**74(37%)**	**73(36.5%)**	**200(100%)**

Source: Fieldwork, 2011

Vehicular Traffic Situation Across Major Routes

The result in table 2 indicated that Oba Adesida road (44%) was the busiest route, followed by Oyemekun road (25%) and State hospital road (18.5%), while Ilesa road route was observed to be less busy in terms of vehicular movements or activities. In addition, the result indicated that car /taxi was the most frequently used vehicle across these routes, followed by buses, while motorcycles and Lorries among others were the least used vehicles along these routes. This result was put to a further statistical analysis by chi-square in order to test if the vehicles used varied across the major roads. The result revealed that significant variation existed among the types vehicles that plied the major roads ($X^2 = 18.413$, $p<0.05$).

Table 2: Vehicular traffic situation across major routes

Type of vehicle	Major roads				
	Oba Adesida road	Oyemekun road	Parliament road	Ilesa road	State hospital road
Car/taxi	72 (81.8%)	26 (52%)	7 (41.2%)	2 (25%)	27 (73%)
Motorbike	6 (6.8%)	4 (8%)	3 (17.6%)	2 (25%)	5 (13.5%)
Bus	4 (4.5%)	13 (26%)	5 (29.4%)	3 (37.5%)	3 (8.1%)
Others	6 (6.8%)	7 (14)	2 (11.8%)	1 (12.5%)	2 (5.4%)
Total	**88**	**50**	**17**	**8**	**37**

Source: Fieldwork, 2011

Problem of Road Transport in Akure

Fig 3 shows that traffic holdup (43.5%) and narrowness of roads (35%) were the major transport problems experienced daily by road users. However, the major effects of these problems included delay in movement, traffic congestion and increased rate of fuel or energy combustion. Other likely and observable impacts were vehicular accidents caused by poor road condition and mobility problem caused by long queues and prolong traffic hold-up. This agrees with the submission of Ogunbodede (2007) that the transport infrastructures and traffic management put in place in Akure have not been able to ameliorate traffic congestion in the city. These associated problems have made the Akure transport environment unappealing to commuters and has made movement in the area difficult mostly during periods of emergencies.

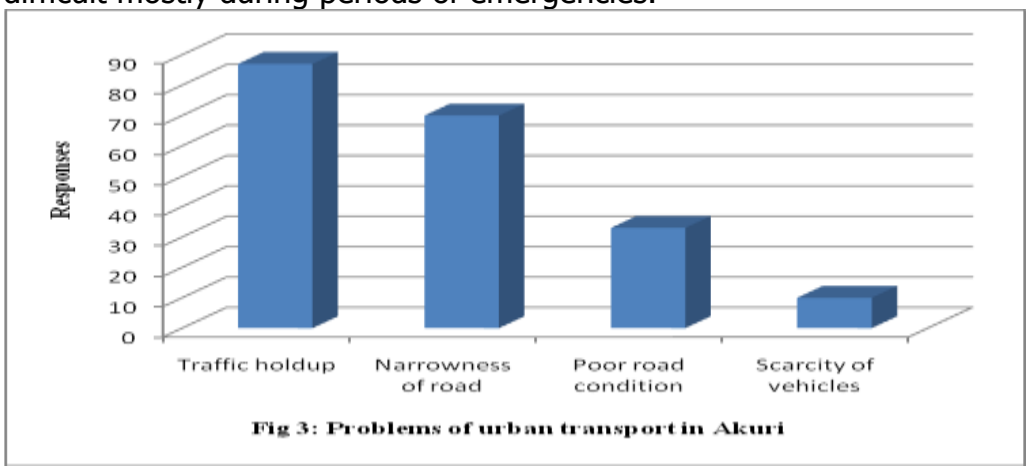

Fig 3: Problems of urban transport in Akuri

Peak Period of Trips

A cursory look at table 3 shows that 8-10am constituted the highest peak of trips across the selected routes with over 48.5% of the trips; at this time of the day, commuters hurry to meet up with the day's activities, students and workers rush to be punctual at schools and workplaces, next to this, was 2-5pm with 40.5% of the traffic. This is evident as it is a period workers, students and some market women usually retire home. Other peak hours included 10 -12 noon (6.5%) when few of the workers had breaks at workplaces as well as commuters embarked on trips to visit friends and others go for shopping, a negligible number (4.5) move between 12-2pm which indicated less of vehicular movement across the major routes. In all, the major routes are usually very busy between the hours of 8-10am in the morning and 2 – 5pm in the evening, while lesser traffic is experienced during break hours of 12-2pm. Thus traffic is said to be very free at this particular time.

Table 3: Peak hours of trips

Peak hours	Frequency	Percent
8-10am	97	48.5
10-12noon	13	6.5
12-2pm	9	4.5
2-5pm	81	40.5
Total	**200**	**100.0**

Source: Fieldwork, 2010

Traffic Counts of Incoming and Outgoing Vehicular Movement

Here attention is directed towards the nature of traffic flow along major routes in the area. The traffic count based on the inflow and outflow of vehicles was sourced from the systematic counting conducted along the five major routes. Result showed that outgoing traffic flow was greater than the incoming traffic flow. It further revealed that the traffic for incoming and outgoing periods was low early in the morning (6-7am), but increased rapidly between the hours of 7-9 am. Traffic situation at this period was high due to the movement of people to offices, market, shops and schools. However, the traffic flow reduced drastically from 5 – 6pm. Nevertheless, the traffic situations worsen between the hours of 1-3pm when many traders, office workers, artisans, school children retired home. Fig 4 shows that outgoing vehicular movement was higher than the incoming movement. The result further showed that traffic flow was high along Oba Adesida and Oyemekun roads. The reason for the increase traffic flow along these routes is as a result of spatial distribution of economic, educational and land uses in the area. These routes are therefore prone to traffic congestion and bottleneck which result in unnecessary transit waiting time.

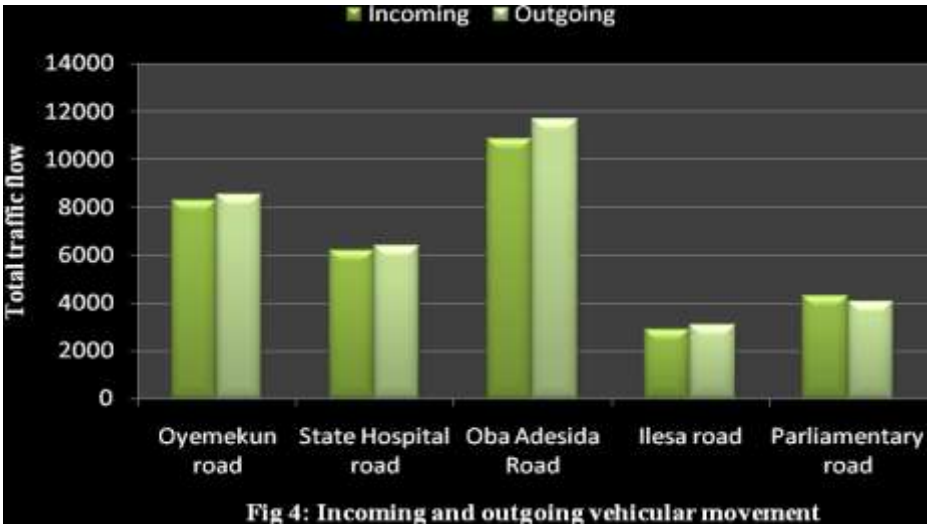

Fig 4: Incoming and outgoing vehicular movement

Modeling Effect of Socio-Economic Characteristics of Road Users on Trip Pattern

Multinomial logistic model was employed to understand the effect of a set of explanatory variables (education, income, occupation and sex) on the variability in the criterion variable (type of trips). The result indicated that the overall test of relationship (between the dependent and independent variables) based on the statistical significance of the final model chi-square in the table 4.1 (model fitting information) reveals that the probability of the model chi-square (66.782) was 0.000, less than the level of significance of 0.01 (i.e. $p<0.01$). On this note, the hypothesis that the trips made by commuters is significantly related to their socio economic characteristics (sex, income, education and occupation) was supported and upheld

Table 4.1: Model fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	223.766			
Final	156.984	66.782	12	.000

The strength of multinomial logistic regression relationship (pseudo R square measures) is shown in table 4.2. In this case, using the Nagelkerke R square value, that provides an indication of the amount of variation in the dependent variable. The result reveals that 32% percent (0.320) of the variability in the dependent variable is explained by the set of independent variables used in the model.

Table 4.2: Pseudo R-Square

Step	Cox and Snell R^2	Nagelkerke R^2
	0.284	**0.320**

Furthermore, evaluating the usefulness for logistic models, this involves comparing the overall percentage accuracy. The result reveals that the classification accuracy rate was 50% which was lower than the proportional by chance accuracy criteria of 56.6% (Bayaga, 2010), suggesting that the model is fairly useful. In addition, the goodness of fit result (table 4.3) shows that the model adequately fits the data with

Table 4.3: Classification

	Predicted			
Observed	**School**	**Market**	**Work**	**Percent Correct**
School	15	24	14	28.3%
Market	5	41	27	56.2%
Work	8	22	44	59.5%
Overall Percentage	**14.0%**	**43.5%**	**42.5%**	**50.0%**

The relationship of independent and dependent variables using **t**he likelihood ratio test (table 4.4) reveals that among the predictor variables (sex, age, occupation and income) used in the model to predict the probability of the dependent variable (type of trip or movement), only occupation was significant (X^2 = 60.506, $p<0.01$) and contributed the highest to the variability in the dependent variable. This implies that occupation accounted for most of the various trips made by road users in the area. This perhaps is evident as commuters were observed to embark on school, work and market trips which indeed cut across the three predominant occupations (students, civil servants or workers and traders/shoppers) across the urban space. Other socioeconomic factors that influenced the variability in trips made across the metropolis and major routes included age, income and sex (table 4.4). Age perhaps is the second determinant of trip pattern across the transport environment, as it cut across road users of various occupations that move for different reasons. Indeed, trip is age specific, as it is only the active member of the population that makes most of the trips in the area. This is indeed obvious, as majority

(91%) of the road users in the area comprised individuals within the ages of 18 – 50 years who move daily to make ends meet.

Table 4.4: Likelihood ratio tests

Effect	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	1.570E2	.000	0	.
Sex	158.115	1.132	2	.568
Age	162.589	5.605	4	.231
Occupation	217.490	60.506	4	.000
Income	158.363	1.379	2	.502

DISCUSSION

The result of socio-economic characteristics of the respondents shows that most of the road users in Akure metropolis are principally civil servants and students. It also reveals that majority of the road users earn between N10, 000 - N20, 000 monthly. The major problems experienced along the major routes in the area include traffic hold-ups, narrowness of roads and scarcity of vehicles. The study observed that even where there are expansions of roads, most especially along Oba-Adesida roads, the indiscriminate parking of cars (private cars) along the major roads drastically reduce the transport corridor, thereby inhibit traffic for free flow. The resultant effect includes delay in movement, traffic congestion, and excessive fuel combustion. The causes of urban transport problems includes road side parking, road narrowness, street hawking/ trading and poor traffic control system which has been put on hold free vehicular movement. This result corroborates the findings of Ogunsanya (2000) that urban traffic problems are characterized by route inadequacy, poor management, human misuse, increased demand and absence of traffic planning policy. In addition, the volume flow reveals that the peak hours of vehicular traffic is usually experienced between 8-10am in the morning due to movement of commuters to offices, school, and market. The study further reveals that the type of trips made by commuters in the area is significantly related to their socio economic characteristics (sex, income, education and occupation), most especially their occupation; as it principally accounts for most of the trips made by road users in the area.

CONCLUSION/RECOMMENDATIONS

The study has shown that traffic hold-ups and narrowness of roads are the major transport problems that characterized the transport corridor of the major roads in the area. The study observed that even where there are expansions of roads, most especially along Oba-Adesida roads, the indiscriminate parking of cars (private cars) along the major roads drastically reduce the transport corridor, thereby inhibit traffic flow. The study further identifies occupation as the principal cause of most of the trips made by road users in the area, which perhaps has significant effect on the volume of traffic experienced in the area. However, in order to tackle the increasing traffic problems in Akure Metropolis, it is essential among others for government to develop inter-modalism system of transportation that will enhance the public in accessing efficient and effective means of transport. The private and public sectors can jointly develop such intermodolism. Similarly, government should provide adequate parking facilities such as

an idealized bus stop, loading bay and commercial parks in order to improve the free flow of traffic. In addition, Oba-Adesida round about, Agbabiaka road junction by-chicken republic junction and Ondo-roads should be equipped with both manual and digitized traffic control system.

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