

CASE STUDY

Trip pattern of low density residential area in semi urban industrial cluster: predictive modeling

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Received 24 March 2017; revised 15 May 2017; accepted 12 June 2017; available online 1 July 2017

ABSTRACT: This research elucidates the trip pattern of the low-density residential zone in a semi-urban industrial cluster of southwestern Nigeria. These sets of dwellers are often times neglected in the transportation planning process. To achieve the aim of this research, domiciliary information gathering procedure was employed with 0.82 return rates. It was backed up with the focus group discussion method. Data on frequency of trips, per capita trip, modal choice, and socio-economic and demographic data were collected, collated, and analysed. Accordingly, a predictive model was formulated for the trip pattern of the low-density area. This was achieved with the aid of statistical software SPSS version 21. Consequently, the results of the multiple regression models showed that both monthly income and car ownership had a significant positive influence on the work trip while only car ownership positively influences non-work trip. R^2 values of 0.729 and 0.739 were obtained for the descriptive model at 95% confidence level. This established the robustness of the model, the analysis showed that monthly income and car ownership had a significant positive influence on the work trip with an R-square value of 0.729 and 0.739 for work and non-work trip respectively. This indicated that household will embark on more trips with an increase in car ownership and monthly income. However, effective transportation planning and traffic infrastructural development were recommended to meet the demands of the increased number of trips daily.

KEYWORDS: *Density; Predictive model; Transportation Planning; Trip Pattern; Travel behavior*

INTRODUCTION

Transport systems are the veins and arteries of urban areas; linking together social areas and functional

zones. Intra-urban transportation in particular functions to integrate various parts of the city: work, school, and recreation among others into a unified whole (Solanke, 2013). In Nigeria, the population

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growth of the city is growing at an alarming rate; this change in city configuration has an impact on the travel behavior of residents. According to [Egunjobi \(1999\)](#) the city expansion and growth has not been controlled, while [Fuller \(2008\)](#) noted that the high rate of urbanisation experienced over the years had resulted to longer journey and travel time within cities. This increased in spatial interaction triggered by urbanisation and globalisation had resulted in increased movement of goods and people within and outside cities. However, [Oyedepo and Makinde \(2009\)](#) affirm that the goal of trip generation process is to forecast the number of various purpose trips that will begin from and end at each travel analysis zone contained in the area of study. This process usually considers some socio-economic data as input producing trip production/ attraction values as the output. Thus, this study provides an insight into the pattern of trips developed by the high-income household residents in Ota, Ogun State and will help to estimate the same for future years.

Brief Literature Review

Transportation is a process that involves the movement of commuters, goods and services from a given point of origin to a specific destination ([Okoko, 2006](#)), it determines the regional patterns of development, economic viability, environmental impacts and maintenance of socially acceptable levels of quality of life. Generally, it plays an important role for other factors of development i.e. there is no escape from transport and this has helped in generating trips from one place to another. [Adeniji \(2000\)](#) likened transport to the human blood circulatory system whose healthy functioning is a necessary condition for the sustenance of human life.

In a number of cities of the developing world the rapid rise in population, coupled with increasing costs of fuel and limited financial resources available for investment in urban infrastructure has generated severe transport problems. Overall, population growth and increasing urbanisation have led to the rapid growth of large cities, which have been overwhelmed by the sudden increase in travel demand. However, the supply of transport infrastructure lagged far behind demand while public-sector finances, in general, are so limited that funding for transport improvements is grossly inadequate.

In Nigeria, the urban transport system is inadequate both in quality and quantity considering an increase in population growth and depressed economy condition of an average Nigerian. Most of the urban trips in Nigeria are made by road, rail and water-based mode and these accounted for about 95%, and the remaining 5% were mainly by walking ([Oyesiku, 2001](#)). Road transportation accounts for 90-95% of total mobility in Nigeria ([Ogwude, 2016; Ogunbodede, 2008](#)). The authors opined that more than 95% of all urban public transport journeys in Nigeria were provided by private operators using mainly taxis and para-transit buses. However, the uncontrolled increase in population and urban growth in Nigeria necessitates the study on trip pattern.

Trip attraction, generation, distribution is very vital in transportation planning and in travel behaviour analysis. The main factors affecting trip generation include: income ([Busari et al., 2015a; 2015b](#)), vehicle ownership; ([Anable, 2005; Hagman, 2003; Hiscock et al., 2002; Tertoolen et al., 1998](#)). According to [Papacostas \(2000\)](#), the objective of a trip-generation model is to forecast the number of person-trips that will begin from or end in each travel analysis zone within the region.

The intra-urban trips are generated for several purposes such as Work, School, Recreation, Shopping, Religious, Social and others. However, of these trips to work and school places, obligatory trips account for more than two-thirds of all trips in urban centers ([Olayemi, 1977; Ayeni, 1979; Solanke, 2005](#)). According to [Aderamo \(2004\)](#) and [Solanke \(2005\)](#), [Nor \(2013\)](#) and [Nor et al. \(2013\)](#) urban areas are associated with the complex development and this is accompanied by intricate patterns of movement. This is because living accommodation and places of other activities such as work, school, recreation etc are no longer in close proximity. Also, the trip generation in urban centres logically is a function of the complex interaction of socio-economic characteristics of urban centres and those of their residents ([Oyesiku, 1990; Hanson and Schwab, 1995](#)).

There are so many methods to develop trip generation models among which are regression model, trip-rate analysis models and cross-classification models (also referred to as category analysis). However, regression analysis estimates the number of trips generated by a zone (dependent variable) as a function of a series of independent variables. [Anderson and](#)

Olander (2002) examined the practicality of using a single internal trip purpose to generate the production and attraction values for traffic analysis zones in small urban community travel models. Their work focused on the reduction of data requirements, and complexity of the trip generation analysis and concluded that, for modelling smaller urban communities, there is no significant advantage in adopting multi-purpose modelling approaches, since the trip productions and attractions for the traffic zones remained almost the same. Hence, this study assessed the trip making behaviour of the low-density residential zone and produced mathematical relationships to synthesise the trip-making pattern based on observed trips, land use and household characteristics.

Study Area

Ota is the capital of Ado-Odo/Ota local government area. It covers an area of 878 square kilometres and lies

between latitude 6°41'2" N and 6°6'82" N and longitude 3°41'2" E and 3°6'82" E (Fig. 1). Ado-Odo/Ota Local Government has an estimated population of 527,242 (Male 261,523 and Female 265,719) (2006 Census) with a population growth rate of 2.53% (Nigeria Population, 2017). The study area comprises of about four hundred and fifty (450) towns, villages and settlements. Olukanni and Akinyinka (2012) stated that the study area also possesses a large market and an important road junction, found north of the Tollgate on the Lagos, Abeokuta expressway. Ota is also well known to be the location of the Canaan Land where the mega church Winner's Chapel, renowned as the world's largest single auditorium is situated. Ota is gradually becoming a busy place because of its proximity to Lagos thereby increasing the migration of people (Olukanni and Akinyinka, 2012).

Reconnaissance survey of the study area was conducted to assess the socio-demographic

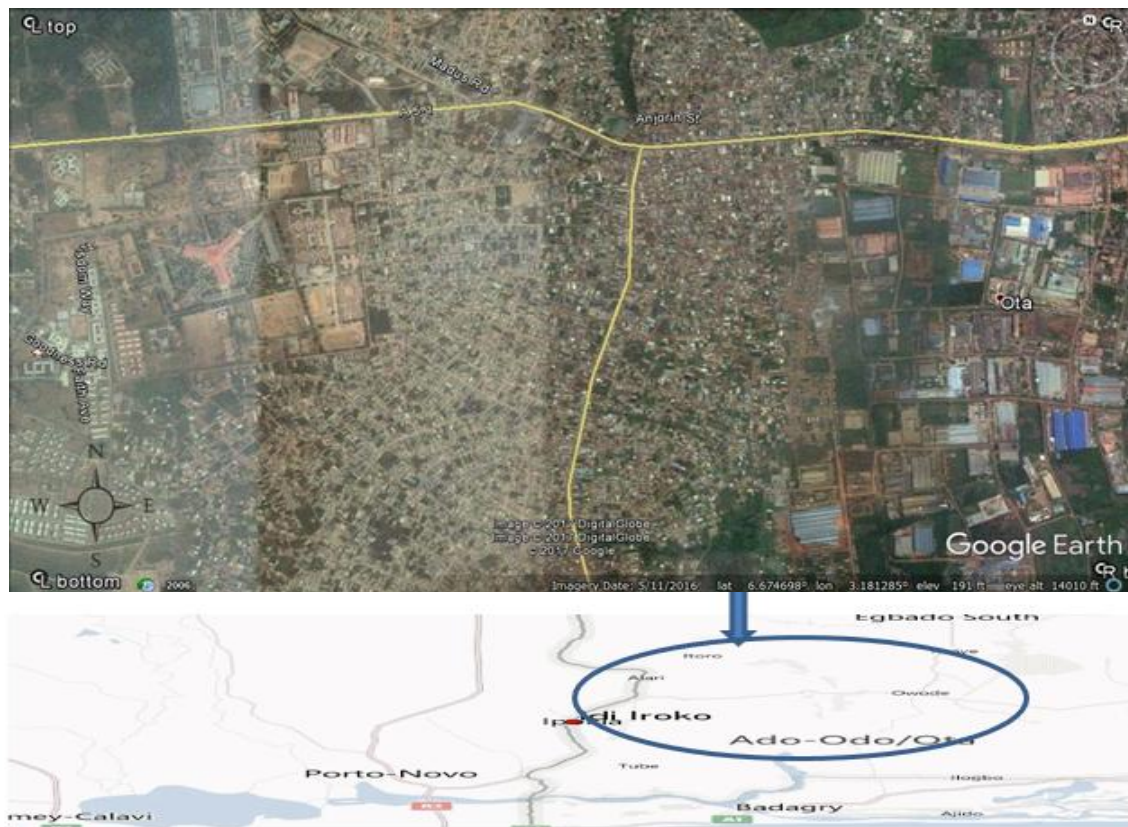


Fig. 1: Map of Ado Odo Ota

characteristics while a research tool in the form of a closed ended and open ended interviewer-administered questionnaire was designed. Data on socio-economic, demographics, trips, modal split, household structure, the frequency of trips and vehicle ownership were collected sorted and analysed. A household survey and focus group discussion approach was employed.

Sampling Procedure

The domiciliary information gathering cards were administered randomly and systematically using face to face approach. Based on the population, 1 in 15 dwelling units was used according to Flaherty as referenced in (Busari *et al.*, 2015a). A total number of 1480 people participated in the research study, which consisted of 892 males and 588 females. The males represented 60.27% of the study, while the females represented 39.73%.

The sampled respondent represents 0.028 of the total population of Ado-Odo Ota local government with 82% return rate.

Analysis of Data

A predictive model of the trip pattern for low-density area in Ado-Odo, Ota, Ogun State was formulated with the number of the trip as dependent variable while occupational status (X_1), monthly income (X_2) and car ownership (X_3) are independent variables. This was achieved with the use of Statistical software SPSS version 21. Besides relevant charts were used to show the statistical relationship.

RESULTS AND DISCUSSIONS

Predictive Model

In this study, the dependent variable is trip days (work trip or non- work trip days) while the independent variables are monthly income, car ownership and occupational status. The multiple regression equations takes the form in the Eq. 1.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad (1)$$

Where:

Y is the dependent variable (trip days); β_0 is the constant or intercept; β_1 , β_2 , and β_3 are regression coefficients, while X_1 is the occupational status, X_2 is the monthly income and X_3 is the car ownership. However, Tables 1 and 2

are the model coefficients and summary of the model parameters.

The model equation is given in Eq. 2 for the work trip days

$$Y = 1.619 + .297X_2 + .112X_3 \quad (2)$$

$$Y = 2.616 + .190X_3 \quad (3)$$

Model Interpretation

The results of the multiple regression models showed that only monthly income and car ownership had a significant positive influence on the work trip days at the 95% confidence level with only car ownership influencing the non-work trip days significantly at the 95% confidence level.

Eqs. 2 and 3 showed that 29.7% increase in monthly income will lead to 191.6% increase in the work trip days and 11.2% increase in car ownership will lead to 173.1% increase in work trip days while 19% increase in car ownership will lead to a 280.6% increase in non - work trip days. An R-square value of 0.729 and 0.739 for work trip and non-work trip days respectively shows the existence of a strong relationship between the dependent variable and the independent variables.

Relationship between income and Car ownership

According to Table 1 it is apparent that the high-income earners reside in the low-density residential zone of the study area. The income analysis was based on the assumption of the Civil service Commission of Nigeria which considers salary earners between Level 0-6 as low income earners, Level 6- 12 as medium income earners while level 12 and above are high-income earners. 51.6% of the respondents fall within the high-income group while the low-income earners have the lowest percentage, 14.7 as seen in Table 1 (Onu and Onu, 2012).

Car Ownership analysis showed that 70% of the respondent owned cars that serves as a means of transportation for both work trips and non-work trips daily (Fig. 2). It could be inferred that car ownership has a positive effect on car ownership as suggested by Busari *et al.* (2015a).

Table 1: Model Coefficients

	Work Trips					Non-Work Trips				
	B	S.E	Beta	t	Sig.	B	S.E	Beta	t	Sig.
(Constant)	1.619	.200		8.096	.000	2.616	.118		22.108	.000
Occupational status	.004	.054	.002	.078	.938	.036	.032	.033	1.140	.254
Income	.297	.085	.108	3.486	.001	-.072	.050	-.044	-1.426	.154
Car	.112	.053	.063	2.140	.033	.190	.031	.177	6.146	.000

Table 2: Summary of the Model Parameters

	Work Trips					Non-Work Trips			
	R	R Square	Adjusted R Square	S.E		R	R Square	Adjusted R Square	S.E
1	.606a	.729	.699	2.018	1	.628a	.739	.0719	1.199

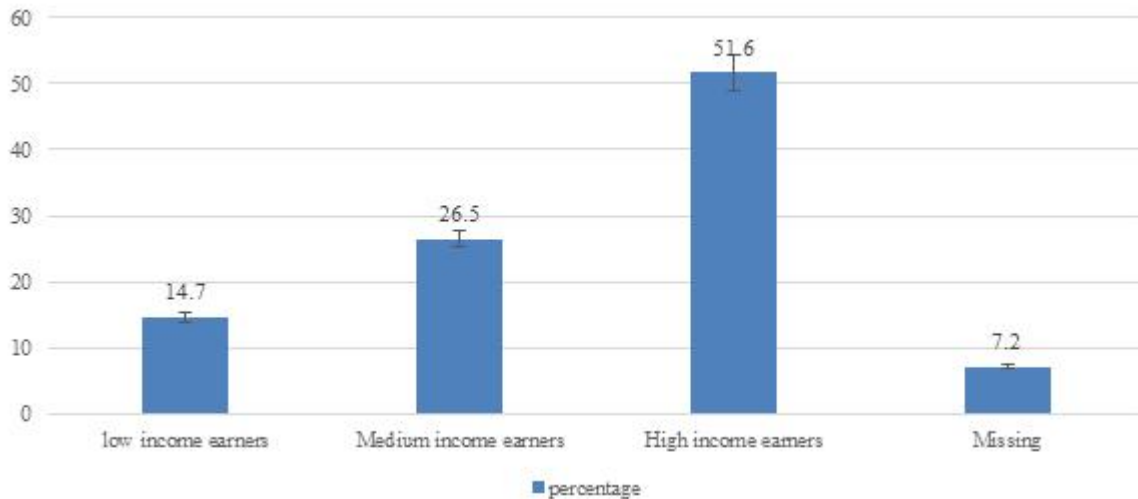


Fig. 2: Income Distribution of the study area

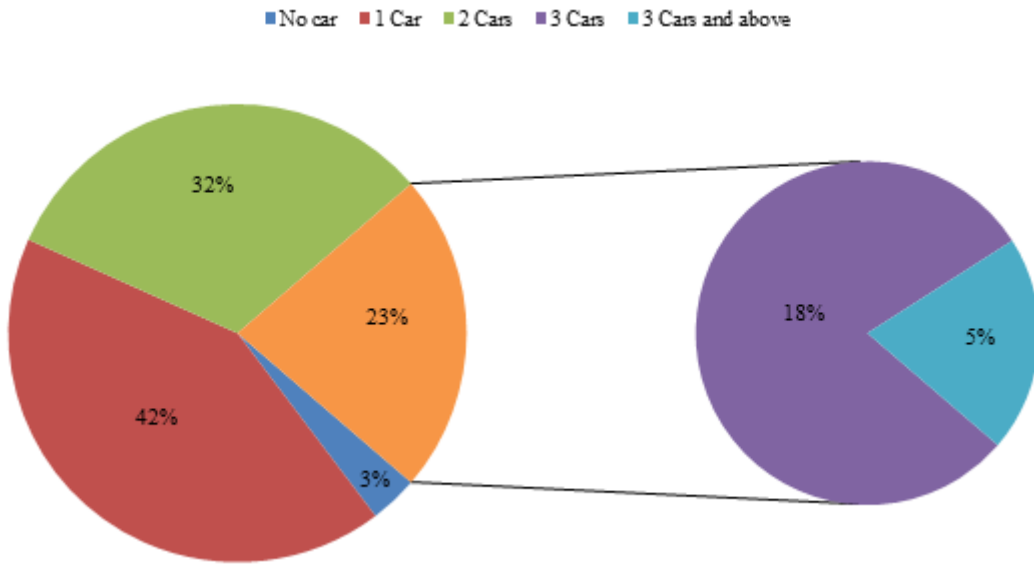


Fig. 3: Car ownership

Modal Split

The modal choice distribution of low-density residential zone showed that 70% of the respondents depend on the use of a personal car for both work and non-work trip. This is due to its availability. Besides, most of the respondents work far away from home, this is to buttress the findings of [Owolabi \(2010\)](#) which states that car ownership increases the propensity to make trips especially long distance trip (Fig. 4). This is followed by the use of bus most of the respondents indicate that buses are preferred because of its flexibility and availability. The use of motorcycle in this zone is low, this may be due to the safety issues, and also, some of the respondents avoids it due to the strong restriction placed on it on some selected roads within and outside the study area and the strong restriction placed on it.

Frequency of Trips

The frequency of trips indicates that most of the respondents engage in compulsory trip work or business trip (Fig. 5). 1.2% and 1.4 % indicated that they engaged on trips once and twice weekly. The frequency of the daily trips with the use personal cars accounts for the high traffic congestion experienced along Sango, Oju-Ore, and Tollgate axis of the study area.

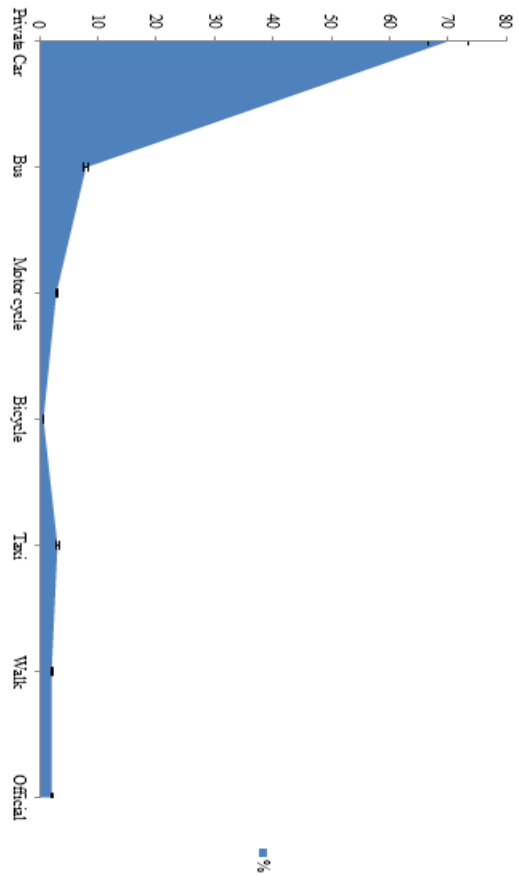


Fig. 4: Modal Split of the Study Area.

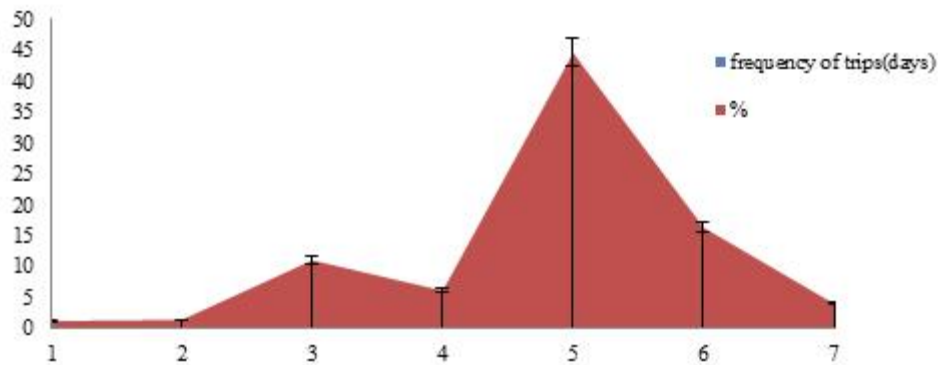


Fig. 5: Frequency of Trips

CONCLUSION

This study assessed the trip pattern of the low-density residential zone in Ado-Odo Ota local government area of Ogun state. The results of the multiple regression models showed that both monthly income and car ownership had a significant positive influence on the work trip days at the 95% confidence level with only car ownership influencing the non-work trip days significant at the 95% confidence level.

The result show that a household will embark on more work trips with an increase in car ownership and monthly income while there will be an increase in the number of non-work trip days with an increase in car ownership. The high dependence of this zone on the private car especially for work trips accounts for the high congestion rate in the morning and evening peak hours daily. To this end, the need for effective transportation planning and traffic infrastructural development are recommended to meet the demands of the increased number of trips daily.

Recommendation

From the research, increase in car ownership had a positive effect on work trip. Hence, the need for an effective mass transportation scheme is recommended to reduce traffic congestion on major arterial roads. Hence, further research should assess the Bus Rapid Transit (BRT) potential of the study area.

ACKNOWLEDGEMENT

The authors would like to thank the anonymous reviewers for their valuable comments and suggestions to improve the quality of the paper.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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