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THE REGRESSION MODEL IN THE FORECAST OF TRAVEL DEMAND IN AKURE, NIGERIA

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Abstract: This paper examined the application of regression model in the forecast of travel demand in cities using Akure as a reference point. The aim is to examine the effectiveness of regression model in predicting travel demand in any urban environment. The data used for this study was derived from a larger study of Akure and the data were collected in respect of household size, income, number of people owing motorcycle, number of people with personal vehicles, waiting time at bus stop and walking time from house to bus stop as independent variables, while trips to work places, business centers, educational centers, social centers, religious centers, medical centers were also regarded as dependent variables. Correlation matrix of the dependent and independent variables were carried out using stepwise multiple regressions. The regression was used to enable the researcher find the best linear prediction equation for travel demand in Akure. The stepwise multiple regressions adapted was a search procedure that identified the independent variables that possessed strong relationship with the dependent variable, at 0.05 significant level, the total trip accruing from all trips purposes as defined under dependent variable Y1 to Y6 referred to as aggregate trips showed that income is very important in determining travel demand with an equation of this type Y1=2575.25+125.27X6 . It was however discovered that a lot of problems beset the use of statistics in geographic studies. The model exposes some short coming inherent in the application of regression analysis to studies in geography.

Key words: Trip Purposes, Forecast, Travel Demand, Income and Prediction

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INTRODUCTION

The issues of efficient and adequate movement within cities have been a major concern to transport analysts and planners in the recent past and it has continued till date. This is because urbanization, urban expansion and transportation are intricately interwoven (Ikya, 1993; Sada, 1973; Mabogunje, 1968; Onokerhoraye & Omuta, 1978). This is amply displayed by various

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studies concentrating on patterns, volume and problems of city transportation planning. The problems have not been resolved despite various measures adopted in ameliorating them.

The recent trend in urbanization problems shows that transport problems ranked high when compared with problems of housing, congestion, pollution and waste disposal and management. This is because; urbanization in cities especially in developing countries has resulted in the continuous influx of people into the major cities. The rural-urban migration reduces the number of people in the rural areas while at the same time increase that of the cities and consequently the spatial sizes of the cities (Onokerhoraye & Omuta 1978; Ayeni, 1975). There is no doubt, that most cities in the developing countries have a rate of urbanization that is one of the highest in the world. For example, the number of cities of 20,000 people or more rose from 56 in 1956 to 180 in1963 and the proportion of the country population in such cities rose to 19.1%. Ever since 1963, the cities in Nigeria have grown astronomically. This rapid growth in urban population has implication for intra-urban movement, with all its attendant problems.

As the city expands consequent upon the increase in population, the problems get compounded. For example, the commuting distance of Lagos increased from 20 km in 1970 to 35 km in 1995; that of Kaduna increased from 6 km to 10 km during the same period (Ikya, 1993); while that of Akure (a medium Urban centre) increased from 5.2 km in1966 to 6.4 km in 1976; to 10.5 km in 1986 and 13 km in 1996 for the major artery road (Ogunbodede, 2001). It is important therefore, to plan the transport system to meet the needs occasioned by the high population concentration. To do this, we need to identify the factor of travel demand for the analysis and prediction of urban movement. Various studies conducted in Nigeria focused on the problem as they exist. Example of such studies in Nigeria include Adefolalu (1997) traffic congestion in the city of Lagos; Bello (1994) urban transport in a growing city, a study of Ilorin metropolis, Okpala (1981), urban traffic management in Nigeria cities using mass transit priorities as case studies; Ogunsanya (1982) focused his work on human factors in urban traffic congestion while Omiunu (1988) worked on rapid growth and expansion of cities. All these studies have serious implications on existing urban transport services.

However, we need to know the future movement patterns to enable us plan for the transport needs. That being so, geographic analysis of an urban area using statistics to unfold basic framework that is capable of providing insight into land-use pattern and predicting likely transport components for solving them should be undertaken.

Previous studies aimed at quantitatively determining the future movement patterns contain inaccuracies. This is particularly so with the use of the regression methods which as explained by Ogunsanya (1984) are filled with problems. The paper presented here is therefore concerned on the application of regression model on travel demand with a view to exposing some of the problems and finding more suitable quantitative technique of analysis which could be used to improve forecasting power of variables. This will go a long way to assist transport policy makers to plan with data knowing fully well that planning without facts is as good as making no efforts.

AIM

The main purpose of this paper is to search for a suitable technique of forecasting travel demand of commuters in cities. This is done by identifying factors that influence trip generation in the city of Akure and invoke a regression model to predict travel demand.

CONCEPTUAL ISSUES AND LITERATURE REVIEW

A lot of theoretical works have been carried out on urban public transportation (Ullman, 1956; Adeniji, 1987; Ogunsanya, 1992a; Anderson, 1958; Cooley, 1971). The concept of spatial interaction is very important in studying relationship. In the quest for the basis of spatial interaction, Ullman (1956) postulated three principles which are relevant to this study. These are complementarity, intervening opportunities and transferability. Complementarity implies a real differentiation and the existence of supply and demand in different areas which can result in interaction, intervening opportunity sets up a constraint as to the possibility of interaction taking place between two places even if the condition of complementarily is fulfilled. Transferability relates to the case with which such demand could be met and it is measured in real terms of transfer and time costs.

Nakkash and Greco (1972) employed linear regression model to relate trip frequency to household location with respect to the other elements of the spatial system. The result of the study shows that there was no significant relationship between trip frequency and the type of road. Based on this varied sets of hypothesis concerning trip frequency need be postulated. The hypothesis must identify the relationship between trip frequency and the socio-economic characteristics of trip makers using variables such as age, income, length of stay in the city, size of household, member of workers per household, annual house rent and marital status. Various statistical techniques have been adopted to relate transport studies with land use in urban areas. For example, Ogunsanya (1986) examined the usefulness of graph theory in intra-urban network flow estimation. Although the use of graph theory in intra-urban network flow had hitherto been largely focused on regional network especially in developed countries, Ogunsanya applied it to an urban area where he regarded intersection or junctions as nodes and the roads as links. This enabled him to abstract an urban road network flow estimation of Barnsley. Other works on transportation network include that of Kansky (1963), Gauthier (1968), Garrison (1960) Nystuen and Dacey (1961). These researchers have applied graph theory to the study of transportation network and came up with results that are of immense use in the area of transport planning,

Ayeni (1983) examined the development of an urban land use transportation model for the city of Lagos (Nigeria). He provided a synthesis of the social characteristics of urban transportation system into rudiments of urban land use and transport system modeling. He was able to identify some of the controversial links between land use and transportation model. The model constitute an approach for identifying the nature, characteristics and magnitude of urban transportation problem, sorting these out into their various components in space, monitoring them as well as designing effective and efficient routes and network system for their solution.

In the analysis of vehicles concentrations on roads, Omiunu (1988) applied the index of percentage of vehicular concentration on some selected roads (25 roads) in Benin city (Nigeria) using the formula:

$$IVC = \frac{TVM}{TVY} \times \frac{100}{1}$$

Where IVC = index of vehicular concentration
TVM = Total vehicular traffic per month
TVY = total vehicular traffic for the year.

Both TVM and TVY were based on peak hours from 7.30 – 8.30 am, 12.30-2.30 pm and 5.30 – 7.30 pm .The formula according to Ominnu was adapted from Winifred Ashton’s work on the theory of traffic flow. Ogunsanya (1984) demonstrated the usefulness of isochrones in traffic congestion. He interpreted the spacing of isochrones in a similar way as a contour in a topographical map. The close isochrones indicate the steep or highly congested area depending on the spacing of the isochrones. Areas where the space is even, indicated even travel time and thus, low or absence of traffic congestion.

Ogunsanya (1985) also used the basic concepts of graph theory and Makov chain model to build a link probability value on the basis of modal flow values obtained from a road junction count. To do this, urban network is regarded as a circuit consisting of junctions which are nodes in the network and each road is joined by a link which is Uni-or-bi-directional. In the compilation, it was assumed that all links in the work are equal.

Existing studies (Ullman, 1956; Hay & Smith, 1970; Goddard, 1970; Ogunsanya,1982; Ogunbodede, 2005) have shown on regional or macro scale that some pattern discerning techniques can be used in the identification of spatial pattern of flows between regions. One of such method is the non-routed cartographic techniques. Ogunsanya (1982) used the non-routed cartographic techniques to depict the result of the overall pattern of intra-metropolitan freight flow between fourteen (14) sectors in the city of Lagos. The overall pattern appears rather blurred indicating the complexity of intra-metropolitan freight flow and the inefficiency of the non-routed flow map in described the pattern. Ogunbodede (2005) also applied the same technique to the city of Akure and finally come up with a pattern of dominant flow of commuter traffic on the basis of which land use zones can be structured. This method, according to Ogunbodede (2005), enable us to identify each functional land use region on the basis of the intensity of interactions, specific flow may be identified as dominating others. This was done in order to identify the overall structure of commuter's movement within the city of Akure.

In an attempt to overcome the defects of the cartographic techniques in discerning flow pattern, Berry (1966) demonstrated how factor analysis can be used. Similarly, Goddard (1970) used it in explaining the pattern of taxi flow in central London and Kano (1976) in showing the pattern of freight flows between U.S.A metropolitan centres, while Ogunsaya (1982) applied it to freight movement in Nigeria. The result of the factor analysis was better than the non-routed cartographic techniques. This is because the solution helped in the identification of major *''consuming''* region and their important *''producing''* sources.

Bello (1994), Aderamo (1990), Arosanyin (1998), Asuquo (1981), Ayeni (1983), Nwoke (1988), Ugonabo (1988) and Nie et al., (1975) have extensively used regression analysis in their various studies. Of importance, in the application of regression analysis and its usefulness in research work for geographical studies are the works of Aderamo (1990), Bello (1994) and Oyegun (1980) among others. The regression analysis was used to find the best linear prediction equation for trip generation purpose in addition to identifying the explanatory ability of independent variables in the study area.

THE STUDY AREA

Akure the capital city of Ondo State is the study area. It is located in the South –Western part of Nigeria. It lies between Latitude 70 151 North of the Equator and Longitude 50 51 East of the Greenwich Meridian. The study area is centrally located in relation to other surrounding towns in Ondo State of Nigeria. The Socio –Economic activities such as trading and commerce as well as its political influence over the years were responsible for the rapid development of the city. This has led to the sharp increase in population as recorded in the 2006 census, which put the population of Akure to about 433,950 People [N P C 2006]. As a centrally located point of human agglomeration, within the State, movement of people and goods in the town has faced a lot of challenges. The traffic challenges are enormous and had deferred past planning strategies hence the need for a model to forecast travels demand in cities.

MATERIAL AND METHODS

The data used for this study was derived from a larger study of Akure (Ogunbodede, 2001). Since the study was on a model in the forecast of travel demand, the base year for deriving the equation was assumed not to be too significant. The data were collected in respect of household size, income, number of people owing motorcycle, number of people with personal vehicles, waiting time at bus stop and walking time from house to bus stop. All these data were regarded as independent variables. Trips generated to work places, business centers, educational centers, social centers, religious centers, medical centers were also regarded as dependent variables. This independent variables were regressed for each dependent variables to enable us derive the best linear equation for the study area. The data (independent and dependent variables) were collected and stated as shown below:

Table 1. Definition of Independent Variable (X1 to X6) and Dependent variables (Y1 to Y7)
Sources; Author's report 2014

Notation	Variables	Surrogate Measure
X_1	Walking time	Average walking time from residence to the nearest bus stop.
X_2	Waiting time	Average waiting time to get to bus at bus stop.
X_3	Vehicle ownership	Average number of vehicles owned in a house.
X_4	Motorcycle	Average number of motorcycle owned in a house.
X_5	Household size	Average number of people living in a house.
X_6	Income	Average income earned by a household head.
Y_1	Working trips	Average trips generated by going to place of work.
Y_2	Business trips	Average trips generated by going to business zones.
Y_3	Educational trips	Average trips generated by going to education centers
Y_4	Social trips	Average trips generated by going to social areas.
Y_5	Religious trips	Average trips generated by going to religious centers.
Y_6	Medical trips	Average trips generated by going to medical centers.
Y_7	Total trips	Average trips generated by all purpose of movement (i.e. y_1 to y_6).

MODELING PROCEDURE

The regression analysis is used in this study to enable the researcher find the best linear prediction equation for travel demand in the study area.

Conceptually, travel demand is a function of a set of independent variables.

$Y = F(x_1,x_2,x_3\ldots\ldots\ldots\ldots\ldots x_7)$

This relationship can be made operational using a multiple regression equation (see equation 1).

$Y = a + b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_nx_{n+e\ldots\ldots}$ equation I

Where

Y = represents trip which is dependent on some variables

A = represents the intercept of the regression plane

b1 ……. bn represents the weight determined by empirical evidence (partial regression coefficients)

x_1……. x_n represents the explanatory variables (predictors) which are independent.

Correlation matrix of the dependent and independent variables were carried out using stepwise multiple regressions. This is a search procedure with a prime focus on identifying the independent variable(s) that actually posses strong relationship with the dependent variables. The stepwise multiple regressions involves among other procedure adding one variable at a time to the regression equation.

The outline of the steps in stepwise procedure as reported in Ogunsanya (1984) is as shown below;

Step1: Complete the simple correlation coefficient between the dependent and independent variables and select the variables with the highest coefficient, say X4 for the regression equation.

Step 2: Compute the partial correlation coefficients and select the variables with the highest partial coefficient as the next variables, say x1.

Step 3: compute regression equation Z = (x4, x1) and using criteria f1 to exclude and f2 to include, decision is made whether to retain x4 in the light of including x1. The partial correlation coefficients for the remaining variables are computed and the next variable x2, is selected as in step 2.

Step 4: The regression equation z + f (x4, x1, x2) is then computed and x4 and x2 are examined as to whether they should be retained before an additional variable to be included is determined as in step 3. This continues until all the variables are exhausted and the final best equation selected.

Consequently, in this model, it can be explained that trip generation is a function of a set of independent variables, as stated below;

$$Y = f\,(X_1, X_2, X_3, \text{----------------}X_n)$$

This relationship can be made operational using a multiple regression of the form

$$Y = a + b_1x_1 + b_2x_2 + \text{------------}+b_nx_n + e \quad \text{equation 1}$$

Where

Y - Represents trip generation (Dependent variables)
a - Represents the intercept of the regression plane
f - Represents the functional relationship between Y and x
$b_{1\,-}\,b_{n\,-}$ represents the weights determined by empirical evidence (Independent variables).

In this study, trip generation by purpose such as work, business/shopping, educational, social/ recreational, religious/ worshipping and medical were regarded as dependent variables (i.e. predicted). Independent variables represent the explanatory variables (i.e. predictors x_1……..x_6 in table 1).

Table 2. Correlation Matrix of the Dependent and Independent Variables
Source: Computer Output

	X1	X2	X3	X4	X5	X6	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X1	1.0000												
X2	0.6561	1.0000											
X3	0.1381	0.0136	1.0000										
X4	-0.5827	-0.3473	-0.0586	1.0000									
X5	0.3136	-0.5210	0.0781	-0.0470	1.0000								
X6	-0.3898	0.1855	0.0071	0.2689	-0.4537	1.000							
Y1	-0.2210	-0.2137	0.1197	0.0395	0.4090	0,0003	1.000						
Y2	-0.4193	-0.5028	-0.1714	-0.3231	0.4861	-0.0818	-0.1027	1.000					
Y3	0.1845	0.2501	0.1972	-0.3808	0.0675	0.3235	0.2660	-0.0590	1.000				
Y4	-0.2549	0.0873	0.1386	0.5351	0.1007	0.3883	-0.1798	-0.3051	0.3157	1.000			
Y5	0.1842	-0.2567	-0.1892	-0.1552	0.4528	-0.2721	0.0344	0.0747	0.4688	0.2832	1.000		
Y6	0.0833	0.0854	-0.2049	-0.3643	0.6605	-0.2381	0.5563	0.1075	0.4521	0.0647	0.5145	1.000	
Y7	0.2172	0.2628	0.0734	0.3062	0.6682	0.0486	0.2590	0.5268	0.6746	0.2657	0.6726	0.6849	1.000

RESULTS OF THE REGRESSION MODEL

Before further discussing the output explaining the relationship between the dependent variable Y1 (1, 2….7) and independent variables X1 (1, 2-------6), it is pertinent to consider the coefficients of correlation variables listed in Table 2. The coefficient of correlation quantifies the relationship between two observed geographic factors and shows the direction and strength of relationship between the variables.

a) **Correlation Result**

Table 2 shows the coefficient of the correlation which indicates the strength and direction of variables examined. The results of the dependent variable (Y_1= 1, 2…..6) for work trips shows that there are two correlation coefficient of r x_1 y_1= 0.22: rx_2y_1 = -0.21; rx_3y_1= 0.12; rx_4y_1 =0.04; rx_5 y_1= 0, 41 and rx_6 y_1= 0.00

Business trip (Y_2) has negative and low correlation coefficient of rx_1y_2 = 0.42; rx_2 y_2 = 0.50; rx_3y_2= 0.17; rx_4 y_2= 0.32; rx_5 y_2= 0.49 and rx_6 y_2= 0.08

Education trips (Y_3) has low correlation coefficient of rx_1 y_3=0.19; rx_2 y_3=0.25; rx_3 y_3;0.20; rx_4 y_3= 0.38; rx_5 y_3= 0.07; rx_6 y_3= 0.32. However, motorcycle (X_4) has negative correlation with educational trips

Social trips (Y_4) has a generally low correlation coefficient of rx1 y_4= 0.26; rx_2 y_4 = 0.09; rx_3y_4= 0.14; rx_4 y_4= 0.54; rx_5 y_4= 0.10; rx_6 y_4 =0.39.

Religious trips (Y_5) has the following correlation coefficient rx1 y_5 = 0.18; rx_2 y_5=0.26; rx_3 y_5= 0.19; rx_4 y_5= 0.16; rx_5 y_5= 0.45 and rx_6 y_5= 0.27.

Medical trips (Y_6) shows that half of the coefficient of correlation is positive while the other half is negative. The dependent variable (Y_6) has the following correlation coefficient of rx1 y_6 =0.08; rx_2 y_6= 0.09; rx_3 y_6 = 0.20; rx_4 y_6= 0.36; rx_5 y_6 =0. 66 and rx_6 y_6 = 024 (See table 2)

Table 2 further revealed that many of the independent variables (X_i =1,2 …….6) have low inter correlation coefficient. In the study, however, rx_2 *1 has a high correlation of 0.66. In like manner the inter- correlations between the independent and dependent variables were generated

b) **Regression Result**

Urban trips are made for a number of reasons. The major one is to travel to places of employment from a place of residence. All trips under this category are regarded as work trips with this equation.

$Y_1 = 44.71 + 4.\ 61\ x_1\ - 0.83x_2 + 0.22x_3\ + 0.29\ x_4 + 13.81x_5 + 2.07\ x_6$

Trips to commercial zones are made for the purpose of shopping or selling of goods as revealed by this Business trip (Y_2) equation.

$Y_2 = 4063.31 – 164.56x_1 – 48.20x_2 – 1.88x3 – 29.13x_4 – 9.02x5\ – 0.99x_6$

Trips to educational institutions by pupils or parents are common and represented by Y_3. The regression summary is as shown below.

$Y_3 = – 1339.25 – 0.52\ x_1 – 17.\ 02x_2 +0.19x_3 – 0.20x_4 + 45.33x_5 +20.\ 77x_6$.

Social trips (Y_4) are trips made after the day's work to friends and relations either to great or congratulate or sympathize with the lost. It also extends to trips made to recreation centers such as beer parlors, hotels or club houses and it is summarized here as

$Y_4 = –1358.\ 09 + 49.42x_1 +24.04x_2 +0.38x_3 +12.63x_4 +38.80x_5 +9.37x_{6.}$

Religious trips (Y_5) are trips made to churches and mosques in the city of Akure. Such trips are common on Sundays and Fridays respectively. The regression summary of this is

$Y_5 = – 1372.55 +176.\ 62x_1 – 63.03x_2 –2.94x_3 + 4.12x_4 +46.18x_5 +13.13x_6$

Medical trips(Y_6) are trips made to Health centers such as hospitals/clinics and chemist/ pharmaceutical stores for treatment or to buy drug(s). The summary of the regression is as stated below.

$Y6 = –468.65 + 33.36x_1 +21.93x_2 –1.99x_3– 1.49x_4 +49.93x_5 +5.01x_6$

However, regression for total trips (Y_7) i.e (Y_1 to Y_6) is a summary of all independent variables against the dependent variables (Y_7) i.e total trips which is $Y_7 = 2575.25 + 125.27x_6$

Where Y_7 = total trips and x_6 = income.

The result shows that whatever purpose a trip is undertaken, the issue of finance is prominent in determining movement. The result further confirms early study of Ayeni (1979) and Mrakpor (1986) on the importance 0f income among other socio-economic variables in trip generation.

The coefficient of determination (R^2) is 0.4465 implying that 44.65% of the total variance is explained by sole variable (income), it further lend credence to the importance role income plays in journey making.

The examinations showed that some problems hindered the use of regression model as discussed thereafter.

PROBLEMS CONFRONTING THE USE OF TECHNIQUES IN GEOGRAPHIC STUDIES

A lot of problems beset the use of statistics in geographic studies. Prominent among such problem is lack of originality in the type and variety of statistic used. Geographers have not been able to develop their mathematical instruments to solve man-environment problems. Hence, they depend largely on models built by other disciplines for adaptation and application. For example, the Gravity Model used by population and transport geographers was borrowed from the Newtonian laws of Physics. Thus, the interrelation and application of the variables in use is subject to controversies. Similarly in regression model there is problem of standardization of some socio-economic variable such as age, sex income etc. alternate solutions of the income is the use of logit and probit models. These model are yet to be accessed by most researchers in the field of geography, hence the need for training in this area.

Quantitative techniques in geographical studies became prominent since 1950 (quantitative revolution). While some bought the idea, some still believe that descriptive analysis is the best. This is probably based on their mathematical background which makes anything written in formula or figures a threat to their studies. These scholars abound in developing countries. This is aptly displayed by few numbers of scholars that are compliant in computers application in their various studies. This has increased the gap, quality of research and standard of papers written by scholars in developed countries when compared with the developed world.

CONCLUSION

Today, things have changed. Most studies have resulted to using statistics to analyze the past, present and infer about likely pattern of events in the nearest future. The studies presented here is the application of real life data in the forecast of travel demand in a rapidly developing urban environment. It is envisaged that the regression model will expose some of the short coming inherent in its application to studies in geography.

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