Travel Demand Model for a Typical Nigeria University

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Abstract

University campuses have unique transportation requirement that may be characterized with a high concentration of trips during multiple peaks periods. These campuses are often of the largest employers in small to medium size cities. It is therefore critical to examine the factors that are significant to campus travel demand models. One of the major roles of transportation modeling is to forecast travel demand based on changes in the transportation system. The models are used to predict changes in travel and utilization of the transportation system in response to changes in land-use, demographics and socio-economic conditions. This paper presents the result of a research on developing travel demand model for a typical Nigeria University using Federal University of Agriculture, Abeokuta as a case study. Models based on Multinomial logit (MNL) were used to model both the number of trips and the choice of mode to campus. The results showed that 52% of student population makes a single trip per day and about 40% make two trips per day. Moreover, 54% of the student lives very close to campus which is comparable with North Dakota University student with 52.6% living within 3.2km of the campus. The model showed that cost to school, location, income and number of stop trips were the significant variables for the number of trips made by the student. The MNL model for mode choice to campus showed that location, waiting time at bus stop, number of trips, cost to school and time to bus stop are the significant variables. This research can be used for transportation planning and policy decision.

Key words: student, trips, cost to school, model, travel mode, location.

I. INTRODUCTION

University campuses have unique transportation requirement that may be characterized with a high concentration of trips during multiple peaks periods (i.e. morning and afternoon). The trips end that make up a majority of the daily trips made by the University students, staff and faculty members possess one common characteristic: the University's central campus. These campuses are often of the largest employers in small to medium size cities and it is therefore critical to examine the factors affecting campus mobility [1]. Transportation is an important part of campus life for most University students. University communities and student populations typically possess many of the characteristics that make the use of alternative modes of transportation convenient and a necessity [2]. Many Colleges and Universities recognize transit as an effective mode for meeting campus mobility and have developed transit systems to serve those needs.

Thorough studies of data on people's travel behaviour, relationships have been developed to predict how many trips people will make, where they will go, by which mode of transportation and by which specific route. These relationships are the basis for travel demand forecasting. In general, travel demand forecasting attempts to quantify the amount of travel on the transportation system. One of the major roles of transportation modeling is to forecast travel demand based on changes in the transportation system. The models are used to predict changes in travel and utilization of the transportation system in response to changes in land-use, demographics and socio-economic conditions. The travel choice behaviour is also referred to as traveler mode choice, which is the most frequently modeled travel decision. Mode choice problem has been approached by transportation planners in many different ways. In broad way all these approaches can be

classified into two categories – discrete choice models and non-discrete choice models. Discrete choice models include probit model, multinomial logit model and nested logit model. Non-discrete choice models include, regression approach, cross classification tables and diversion curves [3], [4] & [5].

Federal University of Agriculture, Abeokuta (FUNAAB) is located in Odeda local government, Abeokuta, Ogun State, Nigeria, established as one of the three Agriculture Universities in 1988. Presently, there are over 12,000 students and over 2000 staffs teaching and non–teaching who travel to campus nearly every day. FUNAAB has experience a recent surge of on-campus growth which impacts personal mobility to campus. The growth is due to number of factors including: (1) increase in the number of students (2) establishment of new colleges which requires more staff (3) development of campus facilities. The growth occurring on-campus is not met without growing pains. Mobility has become a greater issue. The additional students and staff need to travel greater distances before getting to the campus. This paper presents the result of a research on developing travel demand model for a typical Nigeria University using Federal University of Agriculture, Abeokuta as a case study.

II. METHODOLOGY

A. Data Collection

A traffic survey questionnaire was design and administered to 1500 students at various lecture halls and theatres. There were three sections to the questionnaire. The first section contained socio-economic questions such as gender, age, income and residential area. The second section was specifically designed for students that lived off-campus.

The students were asked on how long it takes to get to their usual bus stop, waiting time at bus stop, cost to campus, number of stops trips per day and choice of mode to campus. The third section was use to rate the transportation system and the riding comfort to campus.

In modeling the choice of mode used to campus, location, income, time to bus stop, waiting time at the bus stop, cost to school and numbers of trips per day were considered as the independent variables. The alternatives for student travel mode used in this study include taxi-cabs, mini-bus, private cabs and the university transit bus. These four modes were identified as the main commute modes to the campus. Software for Social Scientist (SPSS) was used for the analysis

B. Multinomial Logit Model (MNL)

A MNL model is a qualitative response variable characterizes a decision from discrete alternatives as a function of attributes associated with each alternative, along with the individual's characteristics. The model has been used successfully in discrete-choice processes in the field of econometrics, marketing and transportation. The choice probability of alternative i is equal to the probability of the utility of alternative i , U_{ik}, which is greater than or equal to the utility of all other alternatives in the choice set A_k. This can b*e* written as

$$P_{ik} = P\,(U_{ik} > U_{jk}\ \forall i \neq j\ \varepsilon\ A_k) \qquad (1)$$

Where P_{ik} is the probability of ith alternative for the kth individual and U_{ik} is the utility of the ith alternative for the kth individual. Each utility can be divided into two components:

$$U_{ik} = V_{ik} + \varepsilon_{ik}, \qquad (2)$$

$$V_{ik} = b_0 + \sum b_m x_{imk} \qquad (3)$$

Where V_{ik} is the systematic or representative, components of the utility i,

$b_m(m=0,1,\ldots,n)$ is constant, x_{imk} is the m_{th} attribute of the i_{th} alternative for the kth individual, and ε_{ik}, is the random variable, which is called disturbances. Assuming that all of the disturbances are independently and identically distributed (IID) and have the same distribution, the MNL model is as follows:

$$P_{ik} = \sum \frac{e^{V_{ik}}}{e^{V_{jk}}} \qquad (4)$$

III. RESULTS AND DISCUSSION

The summary of the variables used in the modeling is presented in Table 1. Out of 1500 questionnaires administered in the travel survey, 1300 respondent had complete data that could be used for analysis thus representing about 87% response rate.

A. School Trip travel demand model

The results in Table 1 showed that 52% of student population makes a single trip per day and about 40% take two trips per day. The statistics revealed that 54% of the student stays at camp which is about 5km to campus while 26%, 8% and 12% stayed at Obantoko (12km away from campus), hostel and other zones respectively. Comparing this with report on three Universities in America, North Dakota State University (NDSU), Minnesota State University, Moorhead (MSUM) and Concordia College [6] showed that 52.6% lived within 3.2km of campus for NDSU student, less than 30% student for MSUM live within 1.6km of campus while Concordia College have almost 30% student living more than 3.2km from the campus. Student spending more than ₦50 to school were about 48% of the respondent, while 24% and 26% spent less than ₦50 and more than ₦100 per trip respectively.

Table 2 present the model developed for number of trips made by the student per day. The result showed that cost to school, location, income and number of stop trips were the significant variables that determined the number of trips made by the student. This model justifies the fact that student staying very close to the campus and spending less that ₦50 are likely to make more than a single trip per day. Peterson *et. al.*[6] in their summary reported that majority of Concordia College Student travel to school twice(four, one-way trips), 15% of the respondents make three trips (Six, one-way) to school each day. The proximity of many students to campus allows for movement from home often for classes. The parameter with significant negative coefficient decreases the likelihood of that response category with respect to the reference category.

B. Mode Choice model

Mode choice modeling predicts students' mode choice decisions and hence induced travel demand for each mode or demand distribution across modes. In constructing the model the variables included in the predictions that were considered significant are location, waiting time at bus stops, numbers of trips per day, income, time to bus stop and cost to school. The results of the survey analysis and the mode choice model from Texas A&M University students showed some similarity with FUNAAB in terms of travel cost, and income, as important factors in the student's choice of mode [7]. The likelihood ratio tests showed that income is not significant in the choice of mode, since the significance test is greater than 0.05 (Table 3). The likelihood ratio checks the contribution of each effect to the model. In their analysis [6], the respondents were asked to indicate how important the following factors were in deciding on their choice of mode, NDSU student clearly indicated that time and convenience are the two most important factors (close to 90%), while MSUM indicates convenience, time and parking availability as the factors

influencing student choice of mode. In understanding the practical usefulness of the MNL regression model for choice model, Table 4 shows the classification table. For each case, the predicted response category is chosen by selecting the category with the highest model-predicted probability. Of the cases used to create the model, 338 of the 468 student who chose taxi-cabs are classified correctly. Out of 546 students, 416 chose mini-buses are also classified correctly; overall, 78% of the cases are classified correctly. This compares favourably to the "null" or intercept-only model, which classifies all cases as the modal category. According to the case processing summary (Table 1), the modal category for taxi-cabs, minibus and private cabs are 36%, 42% and 42% respectively. Thus, the null model classifies the mode choice correctly the percentages stated above of the time.

Table 1: Statistical summary

Case Processing Summary

		N	Marginal Percentage
Mode2shl	taxicab	468	36.0%
	minibus	546	42.0%
	privatecabs	78	6.0%
	unaab	208	16.0%
location	1	338	26.0%
	2	702	54.0%
	3	104	8.0%
	4	156	12.0%
income	<10	780	60.0%
	10-50	494	38.0%
	>50	26	2.0%
tme2bstop	<5mins	494	38.0%
	<10mins	520	40.0%
	>10mins	182	14.0%
	>20mins	104	8.0%
wtmebstop	0	26	2.0%
	<5mins	208	16.0%
	<10mins	312	24.0%
	<20mins	364	28.0%
	>30mins	390	30.0%
cost2schl	0	26	2.0%
	<50	312	24.0%
	>50	624	48.0%
	>100	378	26.0%
Trips	0	26	2.0%
	1	676	52.0%
	2	520	40.0%
	3	52	4.0%
	4	26	2.0%
Valid		1300	100.0%
Missing		0	
Total		1300	
Subpopulation		1196[a]	

Table 2: Coefficient for trip model analysis

Model	Un-standardized coeff. B	Std. Error	Standardized Coeffs. beta	t	Sig.
Constant	1.538	0.189		8.127	0.000
Cost2shl	0.141	0.071	0.127	1.979	0.049
Location	-0.168	0.067	-0.159	-2.502	0.013
Income	0.131	0.081	0.088	1.605	0.109
No. of stop trips	0.264	0.044	0.324	6.005	0.000

Table 3: Likelihood Ratio test for Mode choice to campus

Likelihood Ratio Tests

Effect	Model Fitting Criteria: -2 Log Likelihood of Reduced Model	Likelihood Ratio Tests: Chi-Square	Df	Sig.
Intercept	49.076	.000	0	.
Location	57.836	8.759	3	.033
wtmebstop	57.069	7.993	3	.046
Trips	59.174	10.097	3	.018
Income	49.768	.691	6	.995
tme2bstop	74.752	25.676	9	.002
cost2schl	71.203	22.127	9	.008

Table 4: Classification Table for choice model

Classification

Observed	Predicted				
	taxicab	minibus	privatecabs	unaab	Percent Correct
Taxicab	338	104	0	26	72.2%
Minibus	104	416	0	26	76.2%
privatecabs	0	0	78	0	100.0%
Unaab	26	0	0	182	87.5%
Overall Percentage	36.0%	40.0%	6.0%	18.0%	78.0%

IV. CONCLUSION

This study had identified and highlighted independent variables that were significant statistically in modeling travel demand model for a typical University in Nigeria. A traffic survey questionnaire was design and administered to 1500 students at various lecture halls and theatres. Out of 1500 questionnaires administered in the travel survey, 1300 respondent had complete data that could be used for analysis thus representing about 87% response rate. The results showed that 52% of student population makes a single trip per day and about 40% take two trips per day. The statistics revealed that 54% of the student lives very close to campus which is comparable with North Dakota University student with 52.6% living within 3.2km of the campus. On cost to school about 48% of the respondent spent more than ₦50 while 24% and 26% spent less than ₦50 and more than ₦100 per trip respectively. Also, model result showed that cost to school, location, income and number of stop trips were the significant variables that determined the number of trips made by the student. The MNL model for mode choice to campus showed that location, waiting time at bus stop, number of trips, cost to school and time to bus stop are the significant variables in determining the choice of mode. This

study has been able to identify factors that determine the choice of mode and that income of the student is not a major factor in the choice of mode. This research can also assist in transportation planning and policy decision. Further investigation on travel demand is proposed along with integrating staff mobility need model into the present approach.

REFERENCES

[1] Aldrete- Sanchez, R., Shelton, J. and Cheu, R. L. (2009). Integrating the Transportation System with a University Campus Transportation Master Plan: A case Study. A Technical report submitted to Texas Dept. of Transportation. Pp. 138.

[2] Daggett, J. and Gutkowski, R. (2003). University Transportation Survey: Transportation in University Communities. Journal of Transportation Research Board, vol. 1835. pp. 42-49

[3] Mohammadian, A. and Miller, E. J. (2002). A comparison of the performance of Nested Logit Models and Artificial Neural Networks for predicting household automobile choices: Comparison of Performance. TRR 1807, TRB National Research Council, pp. 92-100.

[4] Quandt, R. E and Baumol, W. J. (2002). The Demand for Abstract Transport modes: Theory and Measurement. Journal of Regional Sci. 6 (2), 13-26.

[5] Xie, C., Lu, J. and Parkany, E. (2003). Work Travel Mode Choice modeling using data mining: decision trees and neural network. Presented at TRB 82nd Annual meeting, Washington D. C.

[6] Peterson, D., Hough, J., Hegland, G., Miller, J. and Ulmer, D. (2005). Small Urban University Transit: A Tri-Campus Case Study. Report, Dept. of Transportation, University Transportation Centres Program.

[7] Mahlawat, M., Rayan, S., Kuchangi, S., Pantil, S. and Burris, M. (2007). Examination of Student Travel Mode Choice. Presented at TRB 86th Annual meetinh, Washington D.C.