MODE CHOICE MODELLING FOR WORK TRIP- THODUPUZHA MUNICIPALITY

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Abstract - The mode choice model is probably the most important element in transportation planning and policy making. The aim of this study is to develop mode choice model for work trips in Thodupuzha municipality and therefore investigating the factors that affect the employed people's choice for transport modes. A multinomial logic model (MNL) with statistical data processing software SPSS is used for explaining travel patterns and mode choice of employees residing in Thodupuzha municipality. MNL model was developed and identified the factors influencing the mode choice of work trip. The factors that significantly affect the choice of transport modes are: age, distance, ownership of means of transport, average family monthly income, marital status, gender, licence ownership. This study can be used by transportation planners to predict the employed people's behaviour and travel demand analysis.

*Key Words***:** MNL Model, Mode Choice, Utility, Work Trips.

1. INTRODUCTION

Transportation is one sector where the population is the end customer, and hence the analysis of human behavior and their inclusion in modeling becomes critical. Transport situation in most Indian cities is rapidly deteriorating because of the increasing travel demand and inadequate transportation system. Indian cities of all sizes are facing the crisis of urban transport. Despite investments in road infrastructure and plans for land use and transport development, problems of congestion, accidents and pollution are continuously increasing. The existing inefficient transport systems are encouraging people to use personal vehicles which in turn increase the share of private mode of transport, declining public transport share causing various traffic problems. Large cities are facing an unprecedented growth of personal vehicles (two wheelers and cars) and in medium and small cities different forms of public and intermediate public transport provided by informal sectors are struggling to meet the mobility demands of city residents. Public transport plays a major role is reducing traffic problems in urban and has become a major issue in most metropolitan and urban areas in sought of resolving various transport problems.

Efficient transport policies and strategies are required for the proper development of a city considering all the aspects of transportation .For modeling the mode choice model, there is a need of proper analyzing the data. Mode choice analysis is the third step of four-step transportation planning process, coming after trip generation and trip distribution. The trips are basically two types in an urban city: work trips and non-work trips. Non-work trips cannot be analyzed easily because it is having more utility function and complex one having a big role on psychological behavior which is not easy to predict.

The choice of a transport mode is probably one of the most important classic models in transportation planning. Transport modelling is used as an effective tool to manage sustainable development in most of the developed countries. Considerable investments have been made in transport planning and policy making in order to observe the travel behaviour and forecast the future demand of travel. This forecasting needs to incorporate the designing of transport systems, by making use of global infrastructure and understanding the travel behaviour of the residents of the study area, and develop a system that can accommodate the travel demands for the future. Mode choice can be modeled by deep analysis of mode choice behavior, age, gender, education, marital status, income, vehicle owned and based on license ownership.

The choice of a travel mode by the individual for home-to-work trip or even in case of other trips will involve complex decision making processes and is influenced by the attributes of the person and the characteristics of the urban transport systems. Multinomial logistic regression is used to model nominal outcome variables, in which the log odds of the outcomes are modeled as a linear combination of the predictor variables. Multinomial logit model with statistical data processing software SPSS is used for explaining travel patterns and mode choice of employees residing in Thodupuzha Municipality.

2. METHODOLOGY

2.1 Study Area

The selected study area was regions of Thodupuzha Municipality. Thodupuzha is a city in the Indian state of Kerala. The selection of the study area plays an important role in finding out the travel behaviour and mode choice behaviour of the commuters. Thodupuzha Municipality is divided into 35 wards for which elections are held every 5 years. It has a population of 52045 which 25563 are males while 26482 are females as per report released by Census India 2011. Out of the 35 wards, 13 wards were selected randomly for data collection. Study area concentrated on core business and residential area of Thodupuzha Municipality

2.2 Questionnaire Design

Questionnaire was designed in order to fit the objectives of this study. The choice sampling procedure was adopted which has been used for transportation, especially for development of mode choice. Samples were drawn at random and various strata of commuters based on sex, income groups, modes selected, age, occupation and trip length. The data required for the study was collected by home interview survey. Survey data was collected by directly interviewing the commuters working in various public and private sectors. Surveys were conducted at various sub urban regions of Thodupuzha

Municipality. The available modes of transportation in the study areas included bus, car, taxi, motorcycle, auto rickshaw and bicycle. Bus was the only means of public transport and other modes were grouped together as Personal transport modes. The study aimed at studying the travel and mode choice behaviour of the selected areas. Hence, work trip journeys of the commuters were only considered in the survey. The commuters were interviewed about their socio economic characteristics and trip details. The trip details included the origin, destination, mode of travel, travel time and travel cost. The monthly income, age, gender and occupational category of the employee were considered as the case specific regressors.

2.3 Sample Size Calculation

It is impractical and unnecessary to interview all the residents of the study area. Since travel patterns tend to be uniform in a particular zone, it is sufficient if a sampling procedure is employed. The size of the sample is usually determined on the basis of the population of the study area, and the standards of the Bureau of Public Roads (B.P.R) are often used. The sample is selected in an unbiased way from the register of elector's or valuation list. A number of techniques are available for the home-interview survey. The full interview technique involves interviewing as many members of the households as possible and directly recording all the information. In the home questionnaire technique the interviewer collect only details of the household characteristics, leaving forms for household residents to complete in regard to travel information. The above technique is more speedy and it may be possible to cover about 20 household per day. Since the population of Thodupuzha municipality is 52045 which is under 1,50,000 and thus the sample size is selected as 1 in 20 households.

2.4 Data Collection

Details of population and area map were collected from Municipal office of the selected area. Using the designed questionnaire, the data collection method was implemented through home interview survey Total of 600 household samples were collected from the study area which consist of total of 2027 individuals. Random sampling method was adopted for sampling technique. These data may identify the current travel behaviour and also reveals factors effecting the selection of modes.

2.4 Data Entry And Coding

The data collected from the respondents through the questionnaire survey was fed into the computer and appropriate statistical analysis will be carried out. The analysis includes coding and sorting of the input data. This sorted data will be processed in the form of tables and charts. The sorting and processing of the coded data will be done using Microsoft Excel. The important socio-economic characteristics such as age, gender, monthly income, vehicle ownership were analyzed. This data may identify current travel behaviour of employees in Thodupuzha and also reveals factors affecting the selection of modes. Descriptive statistics on the demographic profile of employees will be tabulated. Age, gender and income level may be regarded as the demographic variable. Travel modes chosen by the employees will be tabulated

2.5 Development of models

Several statistical techniques are available for developing mode choice models for work trips. Mode choice modeling can be regarded as a pattern recognition problem in which multiple human behaviour patterns reflected from explanatory variables determine the choices between alternatives or classes. The variables that are used for model building includes travel mode, travel time, travel cost, sex, number of working members in the household, annual income, comfort, and safety. The dependent variables in this case are discrete and hence linear regression is not appropriate. Modeling generally involves: 1) Specification of the model like Logit, Probit etc; 2) Identification of variables; 3) Considering the form in which the variable enter the utility function; and 4) Identifying individual's choice set. The available data was divided into two parts- testing data and validating data. The amount of data that is to be used for the testing and validating purpose depends on the availability of the data. Any model has to be validated using some data. In general two-third of the full data is used for testing purpose and the remaining data is used for validation. The model predictions are compared with the information not used in the model estimation. The process is randomized for eliminating bias in sample selection for validation. The software used for modeling is SPSS (Statistical Package for the Social Sciences). It is a software package used for statistical analysis and is now officially named "IBM SPSS Statistics". SPSS is a comprehensive and flexible statistical analysis and data management solution. SPSS can take data from almost any type of file and use them to generate tabulated reports, charts, and plots of distributions and trends, descriptive statistics, and conduct complex statistical analysis. The software is used for developing models like:
1. Multinomial Logit models
 2. Nested Logit models
3. Random parameter logit models
4. Probit models
5. Artificial Neural Network models
Here multinomial logit model is being developed.

3. MODEL RESULT

The discrete choice data was analyzed using the IBM SPSS 23.00 MNL program. 827 samples were collected, from this 22 samples are rejected due to missing values and other reasons, 555 samples were taken for model formulation and 250 samples were kept for validation. The program ran with different models using various attributes to ascertain the essential attributes to the model. Estimation results of the MNL model are obtained. According to the results obtained, the relationship between the modal choice variable and the set of independent variables is significant. The MNL model is much better than only a constant model. Further, it has a relatively high pseudo-R^2 value of 0.984 (Table 1), indicating that approximately 98.4% of the variation in the dependent variable (modal choice) can be explained by the estimated MNL regression model. Thus, it can be concluded that the MNL model fits the sample data well. The Cox and Snell R^2 measure operates like R^2, with higher values indicating greater model fit. This measure is limited in that it cannot reach the maximum value of 1. So Nagelkerke proposed a modification

that had the range from 0 to 1. Nagelkerke's measure is relied for indicating the strength of the relationship.

Table 1 Pseudo R-Square

Cox and Snell	.790
Nagelkerke	.984
McFadden	.674

Likelihood ratio test (Table 2) indicates the contribution of the variable to the overall relationship between the dependent and individual independent variable in differentiating between the groups specified by the dependent variable. The likelihood ratio test is a hypothesis test that the variable contributes to the reduction in error measured by the -2 log likelihood statistic In this model, the variables age, gender, income, license, distance and educational qualification contributes significantly to explaining the mode choice.

Table 2 Likelihood Ratio Test

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	456.746[a]	0	0	.
Gender	493.725[b]	36.979	5	0
Age	496.072[b]	39.327	15	0
License Ownership	448.265[b]	27.615	5	.013
Income	421.133[b]	23.462	15	.009
Educational Qualification	498.774[b]	42.029	25	0
Distance	506.408	68.268	15	.024

Two Wheeler model:

$U (TW) = 338.235 - 1.830[A=1] - 2.157[I=2] + 1.939[EQ=0] - 1.328[EQ=1] + 2.341[EQ=2] + 4.731[EQ=3] + 4.495[EQ=4] - 336.327[D=0] - 336.792[D=1]$

Where,

U(TW)	Utility of mode
A=1	Age (18-25)
I=2	20001-50000
EQ=0	Education - Below SSLC
EQ=1	SSLC
EQ=2	Plus 2
EQ=3	Graduate
EQ=4	Postgraduate
D=0	Distance <5km
D=1	5-15km

Bus model

$U (BUS) = 128.095 - .936[G=0] - 1.474[A=1] + 1.123[L=0] + 1.453[I=0] - 2.4[I=2] - 1.837[EQ=1] + 2.828[EQ=2] + 3.481[EQ=3] + 3.676[EQ=4] - 126.427[D=0] - 126.621[D=1]$

Where,

U(BUS)	Utility of mode
G=0	Male
A=1	Age (18-25)
L=0	Without Licence
I=0	Income below 5000
I=2	20001-50000
EQ=1	SSLC
EQ=2	Plus 2
EQ=3	Graduate
EQ=4	Postgraduate
D=0	<5km
D=1	5-15km

Car model:

$U (CAR) = 234.682 - 1.110[G=0] - 4.529[A=1] - 1.987[A=2] - 1.069[I=1] - 2.871[I=2] - 3.024[EQ=1] + 3.034[EQ=3] + 3.743[EQ=4] - 229.849[D=0] - 230.805[D=1]$

Where,

U (CAR)	Utility of mode
G=0	Male
A=1	Age (18-25)
A=2	Age (25-55)
I=1	5000-20000
I=2	20001-50000
EQ=1	SSLC
EQ=3	Graduate
EQ=4	Postgraduate
D=0	<5km
D=1	5-15km

4. CONCLUSION

A mode choice model was developed for work trip for Thodupuzha muncipality. Age, gender, income, license, marital status and distance are proved to be the significant factors that influence the mode usage of the employees, and the model of employee's mode choice formulated in this study is also convincible. This work trip is essentially an attempt to identify the various variables that influences the mode choice behaviour of employees. The investigation was conducted through a comprehensive analysis of geographic, transportation, and personal statistics, principally with the aid of the logit model.

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BIOGRAPHY

Pretina George is working as Assistant Professor in the Department of Civil Engineering at MGMCET, Ernakulam for 7 years. She received her M.Tech. Degree in Transportation Engineering from RIT, Kottayam and B.tech. degree in Civil Engineering from ICET, Ernakulam. She has published four papers in various International journals.