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Mode Choice Modelling for Work Trips in Thiruvanthpuram City

Sreerag SR[1], S.N. Sachdeva[2] and Shri. S. Shameem[3]

[1]M.Tech, Student NIT Kurukshetra
[2]Dept. of Civil Engg. NIT Kurukshetra
[3]Scientist-E1 NATPAC, Trivandrum
E-mail: [1]sreerag.sr13@gmail.com, [2]snsachdeva@nitkkr.ac.in, [3]shaheems@yahoo.co.in

Abstract—*Thiruvanthpuram city demands transportation planning which is capital city of the Indian state of Kerala. The aim of this study is to develop mode choice model for work trips for Thiruvanthpuram city and identifying the factors that affect the mode choices. The factors considering for mode choice are age, gender, vehicle ownership, monthly income, total travelling time, total travel cost by distance,, total travel cost by distance, total travelling time by distance and distance. The preliminary analysis of the data helps for finding characteristics of the each factor and finding how much it is having importance of selection of mode. A multinomial logit model (MNL) with statistical data processing software NLOGIT is used for identifying mode choice behaviour of Thiruvanthpuram city. This study is also useful for predicting the employed people's behaviour and travel demand analysis. The developing model can be used for predicting the future modal split.*

Keywords*: MNL model, Mode choice, work trips, Thiruvanthpuram city*

1. INTRODUCTION

Mode choice analysis is the third step in the conventional four-step transportation forecasting model. It is the easing the data by mathematical tools. It plays an important role in transportation planning decisions. 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. 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. Travel demand should include the following: transportation attributes, the available mode choices and distribution of the buildings on the city.

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. But in cities most of trips are work trips which can be having similar utility function and can be easily analyzed. Development of the city can be figured out from the change in the work trips. Judging the work trips can convict gender distribution, age behavior, income and economic status of people, the traffic flow of the city and distribution of trip destination. The mammoth role of work trips shall be analyzed and knowing the factors affecting the mode choice. The whole roads are partially or fully depending on work trips. So modeling the work trips on such a city is necessary. The study can attain knowledge of mode choice behavior of the cities. It is also useful for planning for similar cities.

Description of the study city

Thiruvanthpuram is the capital city of the Indian state of Kerala. It is the largest and the most populous city corporation in Kerala and the fifth largest urban agglomeration in Kerala. It is on the west coast of India near the extreme south of the mainland. The city had a population of approximately 1.6million as on 2011 with a population density of 1,500km2.

The city houses many Central and State government offices, organizations, private sector companies, educational institutions, and research institutions. There are distributed government-owned and private-owned medium and large-scale industrial units in Thiruvananthapuram.

2. LITERATURE REVIEW

Ahmed Hamdy Ghareib (1996) is compared and evaluated the predictive ability of logit and probit models when applied in mode choice context. The Database use in this study is the choice set for each individual, socio-characteristics of each individual, trip related variable represented by trip purpose and characteristics of the transport system. **Maria vedin Johanson, et al. (2006)** is discussed effect of attitudes and personality traits on mode choice. **Jiangsping Zhou (2012)** analyzed based on mode choice, multimodal behavior, travel time and the multimodal logit model is used. **R Ashalatha, et al. (2013)** discussed various factors that contribute selection of mode in the city of Thiruvanthpuram and factors influence the commuters use the public transport. Multinomial logit model is used due to more than two choices of modes of travel are available for commuter. **Ipek N Sener (2014)** mentioned the integrated nature of the public health and transportation fields. The study was done by preparing the model in a two dimensional manner by considering active activity and active travel. **Lihui zhang Hai et al. (2014)** pictured discrete multimodal transportation network. Transit network design problem (TNDP) is mainly to optimize the layout of transit routes, the fare levels and service frequencies.

Multi Nominal Logit Model:

Modelling is one important part of the most decision making process. It allows to study the relationships that underlie the decision making and helps to predict the behaviour of the future transportation. A transport model can be defined as a simplified representation of the real world usually implemented in computer software, which describes the impact of transport decisions. Important aspects of the transportation modelling are to predict the travel choice behaviour which is the most frequently modelled travel decisions. It can be done by considering human behaviour dedicated to choice decisions. Normally aggregate models are used in dealing with the travel choice behaviour of individual travellers; however the aggregate models have the limitation of forecasting and estimating of travel choice with aggregated zone data. Disaggregate behavioural models are based on the observed choices behaviour of individual travellers. These models consider that the demand is the result of several decisions of each individual traveller.

The multinomial logit model is the most popular form of discrete choice model used in practical applications where more than two alternatives for choosing from. The consumer, confronting the alternatives will evaluate the usefulness of each of them, based on the attributes of the alternatives and his/her own characteristics and usually, the alternatives give maximum utility will be selected by people(Utility Maximizing Principle).Depending on the distribution of random components different model forms(like logit model, Probit model) originated to describe the choice process mathematically. MNL model is one of the simplest model forms in the logit model framework, where it is assumed that the random components are independently and identically distributed (IID property).

The basic form of MNL model is as follows.

Prob(y_i=j)=

$$\exp(\beta Xij) / \sum_{m=1}^{j} \exp(\beta Xim)$$

This expressions gives the probability of choosing an alternative 'j', by an individual 'I' from a set of 'j' alternatives. The j alternatives are each characterized by a set of K attributes, Xij. (It can be travel time, travel cost, etc. for alternatives considered) .' y_i' is the index of the choice mode

3. PRELIMINARY ANALYSIS

Of the 12949 work trips, 9682 (80%) trips are done by men and 2321(20%) are by women. The age level of employees was from 18 to 96 and the average age of the sample was about 43.More than 50% of the trips are done between the ages of 30 to 60. The two wheeler ownership is 48% so in the traffic there is a huge impact by two wheelers. Only 5% of total work trips are done by income having high (>45,000□).More than 50% of work trips are done having an income level of low (0 to 15,000□). The survey is based on different modes-Walk, Bicycle, Two wheeler, Auto, Taxi, and Car, Mini T bus/tempo, Bus KSRTC, Bus private, Bus school, Bus institution and Train. Most influenced modes are walk, two wheeler, car and bus.

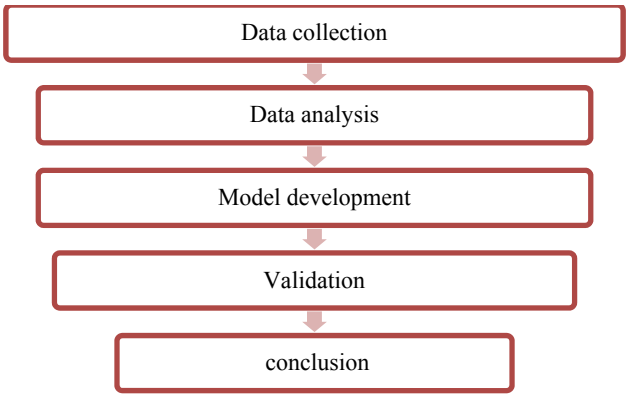
The sample size selected for the study is 250 and the sample acquired the basic necessaries of the whole data.

4. METHODOLOGY

The work intends to find a proper model for work trips to predict the future and finding important characteristics. It is aimed at identifying the various factors that contribute to the selection of a particular mode in the city of The study is restricted to work trips only.. MNL modeling was adopted in the study because of its capability in estimating the mode shares where more than two choices of modes of travel are available for a commuter.

The first phase is collection of the data and there was collected data of Thiruvanthpuram city at the starting of the year 2015. Preliminary analysis is done to studying the data. The third phase is the model development. Work trips are distributed on four modes-Two wheeler, bus, car and walk. The mode selected for the study is two wheeler, Bus and Car. Validation

is the process of checking the model is useful and checking the model is correct. The last phase is concluding the model which is valid and finding the important characteristics on the model.



5. RESULT AND ANALYSIS

There are three modes to be considered which have much importance on mode choice behavior of work trips of Thiruvanthpuram city. They are two wheeler, bus and car. The variables considered are described in Table 1.

Table 1: Description of explanatory variables

Variable	Description
TT	Total Travel Time in minutes
TC	Total Travel cost in Rupees
DIST	Length of the trip in Kilometres
OWNSHIP	Ownership of transport
GDER	Gender of respondent
AGE	Age of respondent in years
INCOME	Income of the respondent
TTDIST	Total travel time per distance(minutes/Km)
TCDIST	Travel cost per distance(rupees/Km)

There are 10 different models are tried by considering different variables. From this 6 models are considered which is having good performance.

For the good model it has to meet model statistics. Standard error of every coefficient should be less than 2.The standard error of each estimate is considered and if it is less great than 2 the model does not considered. Also we need to check expected sign of estimators. All models with a wrong sign of estimators would not consider as a valid model. The travelling cost per distance and travelling cost per distance should be negative because when the utility of mode will be higher if the two variables getting lesser.

NLOGIT software will provide the log likelihood function and prediction ability of the predicted model. The model having higher predictability will perform well but it want to meet the all other model statistics. Mcfaddens pseudo Rsquare will fall between 0 and 1 and it can be calculated by

$$R^2=1-\frac{\ln L(Model\ with\ predictors)}{\ln L(Model\ without\ predictors)}$$

L= Estimated likelihood

If a model has a very low likelihood, then the log of the likelihood will have a larger magnitude than the log of a more likely model. McFadden's would be higher for the model with greater likelihood.

From the six models the best performing model is Model 2 which is qualifying all the demands of a good model. Even the model 1 is having a good performance but it has less McFadden pseudo Rsquare value than Model 2.So the model from the testing model is Model 2.

$U_{Two\ wheeler}$= -1497.16+ (-14.1259) TTDIST+ (-1.5427) TCDIST

U_{Bus}=-1667.61+ (-14.1259) TTDIST+ (-1.5427) TCDIST

U_{Car}= (-14.1259) TTDIST+ (-1.5427) TCDIST

The model was calibrated for data set of 250 and validated using a sample of 290.The prediction ability of the model is given in the Table 2

Variable	Mode	Estimated coefficient					
		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
TT		-0.0824				0.59718	0.39642
TC		-12.4518				0.187	0.4623
TTDIST			-14.1259	-3.51524	-0.22054		
TCDIST			-1.54272	-0.29777	-0.96618		
Mode specific variable							
CONSTANT	Two wheeler	-174.286	-1497.16	-433.006	-163.178	7.3993	-120.85
CONSTANT	Bus	-109.248	-1667.61	-577.849	-333.3	0.3992	-247.346
INCOME	Two wheeler					-4.1128	31218.3
INCOME	Bus						31224.9
INCOME	Car						31223.5
AGE	Two wheeler			0.02385	121.601		
AGE	Bus				125.563	6.99103	
AGE	Car				129.076	7.3993	
Model statistics							

STANDARD ERROR	OK	OK	OK	NOT OK	OK	NOT OK
SIGNIFICENCE OF COEFFICIENT	OK	OK	NOT OK	OK	NOT OK	OK
SIGN OF COEFFICIENT	OK	OK	OK	NOT OK	NOT OK	NOT OK
LOG LIKELIHOOD FUNCTION	- 84.41569767	- 71.804884	- 57.27014535	- 23.7863	- 87.609	- 87.609
MCFADDEN PSUDO R2 VALUE	0.26518369	0.37495749	0.50147854	0.792946	0.237387	0.237387
PREDICTABILITY	66.86%	73.4%	73.25%	93%	88.95 %	72.10 %
MODEL	OK	BEST(OK)	NOT OK	NOT OK	NOT OK	NOT OK

Table 2: Prediction ability of Model

	Predicted			
Observed	**TW**	**Bus**	**Car**	**Percent correct**
TW	66	30	4	66%
Bus	26	91	1	77.1%
Car	3	2	27	84.4%
Overall percentage	35.84%	49.45%	14.7%	73.4%

The result of validation is given in Table 4. The overall correctly predicted percentage indicates the percent of cases where the actual choices and the predicted choices of the individuals match. The present model is 79% accurate which is good.

Table 4: Validation

	Predicted			
Observed	**TW**	**Bus**	**Car**	**Percent correct**
TW	74	28	5	69.16%
Bus	22	120	2	83.3%
Car	2	2	35	89.7%
Overall percentage	32.3%	52.4%	15.3%	79%

6. CONCLUSION

Mode choice can be modeled by deep analysis of mode choice behavior, multi-mode characteristics, travel characteristics and attitudinal behavior. It gives attitudinal behavior in future. Modeling work trips are easy which can be collected easily and it has higher thrust on traffic characteristic. Travel time and travel cost have a significant role on mode choice. Even travel time per distance and travel cost per distance which is having same characteristics of travel time and travel cost can develop good model. The developed model is able to predict the choice behavior of commuters in Thiruvanthpuram city. The developed model will be helpful to identify travel demand analysis and identifying transport policies for Thiruvanthpuram city.

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