International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-3 Issue-3, August 2013

Mode Choice Modelling for Work Trips in Calicut City

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Abstract*— Transportation modelling plays an important role in supporting transportation planning. Work trips are centre of focus of urban transportation planning and policy analysis. This may causes congestion in peak hours in the urban transportation network. One of the important aspects of transportation modelling is to predict the travel choice behaviour. The travel choice behaviour is also referred to as traveller mode choice, which is the most frequently modelled travel decision. It involves a specific aspect of human behaviour dedicated to choice decisions. With a model, as simplified representation of a part of reality provides a better understanding and interpreting of these complex systems. This paper investigates mode choice behaviour of employers in Calicut city. A multinomial logit model (MNL) with statistical data processing software SPSS was used for explaining travel patterns and mode choice of employees residing in Calicut city. MNL model was developed and identified the factors influencing the mode choice of work trips.MNL is widely used model in the discrete choice model and it has many computational advantages.

Index Terms*— MNL model, Mode choice, Utility, work trips, employees.

I. INTRODUCTION

Transportation modelling plays an important role in supporting transportation planning. One of the major roles of transportation modelling is to forecast travel demand based on changes in the transportation system. There are different types of models that have been developed to create actual travel patterns of people and existing demand conditions. The models are used to predict changes in travel pattern and utilization of the transportation system in response to changes in land-use, demographics and socio-economic conditions [1]. Work trips are centre of focus of urban transportation planning and policy analysis. This may causes congestion in peak hours in the urban transportation network [1]. One of the important aspects of transportation modelling is to predict the travel choice behaviour. The travel choice behaviour is also referred to as traveller mode choice, which is the most frequently modelled travel decision. It involves a specific aspect of human behaviour dedicated to choice decisions. With a model, as simplified representation of a part of reality provides a better understanding and interpreting of these complex systems. Calicut city has selected for study for this modelling purpose. This paper investigates mode choice behaviour of a work trip for employers in Calicut city. Mode choice model is a principal component of travel demand analysis [2]. The city consists of different categories of people living in different zones and mode selection also depending upon various factors like age, income, comfort [3]etc. The current study was to develop a comprehensive mode choice model for Calicut City which will be capable to predict modal shares of different modes of transport.

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 [3]. It will be influenced by the attributes of the person and the characteristics of the urban transport systems. A multinomial logit model with statistical data processing software SPSS was used for explaining travel patterns and mode choice of employees residing in Calicut city. It is widely used model in the discrete choice model and it has many computational advantages. For a traveller in a City, the available modes and route choices for a trip are sometimes numerous.

II. SCOPE OF THE STUDY

Calicut is the one of the developing city in the state of Kerala; the offices and main activity are located in the centre of the city. Different types of modes are using for various activity like work trips, school trips, leisure trips etc. Demands for both private and public transport have been increasing day by day. Without understanding the traveler's needs and preferences it's very difficult to make solutions for present conditions in the city. This study may be helpful to find mode choice behavior of work trips in the city. The limited number of studies dealing with work trips suggests that these also play a significant part in the choice of transport mode for this type of trips.

This study focused on home-to-work trip and work to home trips. This group of travellers is one of the largest in number and they may create congestion in peak hours. It enables to understand travel demand behavior to work trips and constraints that travelers face. The study identified the factors effecting mode choice for work trips and also make model for work trips in the city of Calicut.

III. OBJECTIVES

The main objective of this thesis is,

- To identify the various variables that influences the mode choice behaviour of employees.
- To develop a model of travel mode choice for work trip in Calicut City.

IV. LITERATURE REVIEW

As far as mode choice is concerned, the results highlight the importance of contextual and individual factors besides mode characteristics (travel time, cost and comfort). The car ownership decision is found to be mostly related to income levels of the households, contextual constraints and location issues.

Manuscript published on 30 August 2013.
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The mode choice modelling to work has the central to the evaluation of the efforts to mitigate traffic congestion [4]. Work trips in any urban area are always at the centre of focus in urban transportation planning and policy analyses.

Work trips in aggregation define peak versus off-peak-period traffic flow in the urban transportation network. Although activity based modelling practice extends beyond peak-period travel, commuting activities are always at the centre of all modelling approaches [5].

The importance of mode choice in transportation policy analysis and decision making has led to a variety of methods for predicting the effects of policy measures on travellers' mode choices [6]. Residential choice location is influenced by many variables including socio-economic characteristics, life cycle, location of work and other major activities such as schools, shopping, family and friend, real estate values, and characteristics of the residential and workplace area. Living close to the workplace reduces vehicle kilometre of travel and thus contribute to a more sustainable transportation system. [7].

The choice of a travel mode by the individual during the morning home-to-work trip or even in case of other trips could involve complex decision making processes largely influenced by the attributes of the person and the characteristics of the urban transport systems [8]

V. METHODOLOGY

The study area is generally regarded as the geographical region in which transport planning needs to be done. Private transport has always dominated in the present scenario, it serves as the most reliable, comfortable and time-efficient mode. Due to these reasons, most of the people forced to use private vehicles, instead of using public transport. These reasons have highly accounted for increasing road congestion, environmental pollution and traffic hazards. Frame work of the study as shown in Fig .2

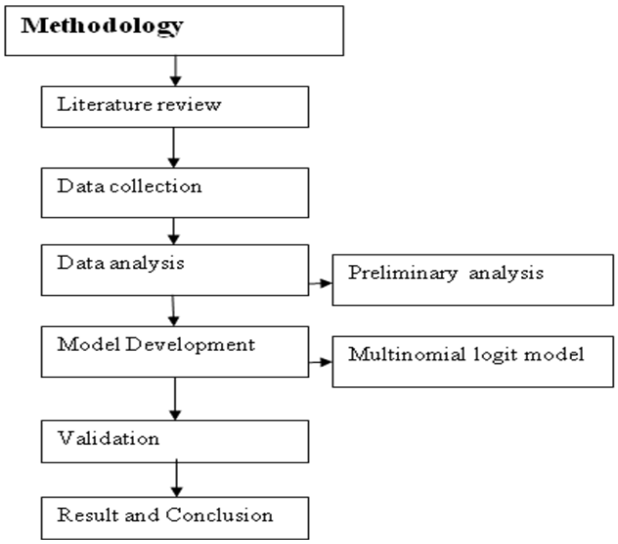

Fig 2 Frame Work of the Study

A. Study Area

Calicut city is selected as the study area. Calicut is the third largest city in Kerala and the hub of north Kerala with a metropolitan population of 2,030,519 as per 2011 census. Calicut is fast emerging as a prominent educational, commercial and trade centre having well established national/international trade routes. Calicut city alone accounts for 40% of the urban population in the District and is experiencing a rapid growth in urban population. Map of Calicut city as shown in fig. 1

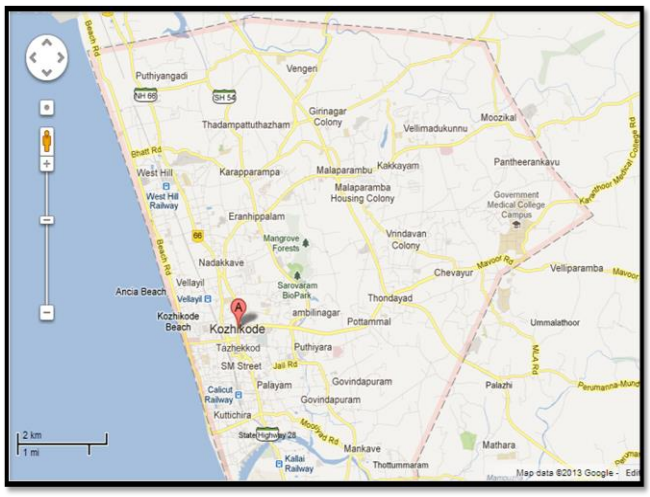

Fig. 1 Calicut City

B. Data Collection

Based on the previous literature review, the questionnaire was designed in order to fit the objectives of this study. However, the length of the questionnaire as well as the accuracy associated with the responses of respondents was also taken into account. Using an above-designed questionnaire, the data collection method was implemented through a survey of face-to-face interview including two stages. The first stage was a pilot survey in order to improve the clarity, validity, and content of the questionnaire. In this stage, the questionnaires were delivered to twenty employees. After receiving their feedbacks, a final standard version of the questionnaire was used in the next survey stage. The individual dataset was obtained through the direct interviews with employees in Calicut city, only individuals were interviewed.

A convenient sample of 514 employees was interviewed in Calicut city. Random sampling method was adopted for sampling technique. Data collected from different categories of employees in Calicut city .Work trip was taken from 3 categories of employees i.e., Govt, private and self employees as shown in Table I. The business activities are located at centre of the city. These data may be identify the current travel behaviour of and also reveals factors effecting the selection of modes.

Table I Data collection details

Si No	Category	Departments/offices
1	Govt.	Labour Court, Pension Treasury, Mining and Geology District office, soil conservation, soil survey department. Pathology department, Medical College Kozhikode, SBI Kozhikode, police station and SBI, Palayam.

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2	Private	Baby Memorial Hospital, Service Bank Chalappuram Aswini Diagnostic Services Calicut, KSFE, Kalyan kendra ,Gulf Bazar, Cochin Bakery, Focus dentacare, Muthoot Bankers, Mahindra Motors, Kannankandy Kitchen Interiors and WITCO.
2	Self	Shops at SM Street , Palayam,Kuthiravattom

C. Theoretical Foundation

Multinomial Logit Model

To understand the relations between characteristics and mode choice of the employees, a multinomial logit model (MNL) is applied to distinguish the difference among the mode usage of these three categories of employees[7]. MNL is the simplest and most popular practical discrete choice model; it is based on the random utility theory that each option Aj Ɛ A has associated a net utility U_{jq} for individual. It is assumed that U_{jq} has two components,

$$U_{jq} = V_{jq} + \varepsilon_{jq}$$

This includes a measurable part Vjq and a random part Ɛjq. The measurable part is V_{jq} considered as a function of measured attributes x; thus V_{jq} is often formulated as a linear combination of x, such as the following:

$$Vj_{jq} = \sum \theta_{kj} X_{jkq}$$

Where the parameter θ are often assumed to be the same. Based on the hypothesis of rational choice, Probability of alternative i chosen by individual q can be formulated as:

$$P_n = e^{Vn} / (\sum_{m=M} e^{V_m})$$

P_n is probability that the individual select the mode n
V_n is utility of mode n
V_m is utility of any mode
M is set of all available travelers mode

The closed form of the MNL is to estimate (maximum likelihood estimation procedure), interpret and use. The MNL model was developed. For development of the models, the following choices were considered in the universal choice set: car, two-wheeler, bus, auto and walking. Two-wheeler was taken as base mode. TIME (total travel time in Minutes) and COST (total travel cost) were the obtained for each of the five modes. Travel time and travel cost represent mode related attributes; all other things being equal, a faster mode of travel is more likely to be chosen than a slower mode and a less expensive mode is more likely to be chosen than a costlier mode.

Multinomial logit models are used to model relationships between a polytomous response variable and a set of regressor variables. The term "multinomial logit model" includes, in a broad sense, a variety of models. The cumulative logit model is used when the response of an individual unit is restricted to one of a finite number of ordinal values[8].

The specific assumptions that lead to the Multinomial Logit Model are (1) the error components are extreme-value (or Gumbel) distributed, (2) the error components are identically and independently distributed across alternatives, and (3) the error components are identically and independently distributed across observations/individuals[8]. Assumptions are discussed below,

The most common assumption for error distributions in the statistical and modeling is that errors are distributed normally. There are good theoretical and practical reasons for using the normal distribution for many modeling applications. The Gumbel distribution is selected because it has computational advantages in a context where maximization is important, closely approximates the normal distribution and produces a closed-form probabilistic choice model. The three assumptions, taken together, lead to the mathematical structure known as the Multinomial Logit Model (MNL), which gives the choice probabilities of each alternative as a function of the systematic portion of the utility of all the alternatives [8].

VI. PRELIMINARY ANALYSIS

Table II represents descriptive statistics on the demographic profile of employees. 514 data collected, from this 14 are rejected due to missing values and other reasons, 500 data were taken for the analysis of work trips.

Table II Descriptive statistics on the demographic profile of employees

Demographic Variable			Category	Frequency	Percentage (%)
Age	0		18-35	231	46.2
	1		36-45	165	33
	2		Over 45	104	20.8
Gender	0		Female	163	32.6
	1		Male	337	67.4
Occupation	0		Govt.	113	22.6
	1		Private	242	48.4
	2		Self	145	29
Income Level	0	Low	1000-15000	42	8.4
	1	Medium	15001-45000	339	67.8
	2	High	>45000	119	23.8

A. Preliminary analysis result

The age level of employees was from 18 to 65 and the average age in the sample was about 45. Of the three groups, the 18-35 age range occupied the highest proportion (46.2%), while the second and the third accounted for 33% and 20.80%, respectively. From the 500 employees, there were 163 female employees (approximately 32.6%) while male employees accounted for slightly above 67.4%.

About the occupation of employees, out of 500 respondents, 113 employees (22.6%) worked in government offices, 242 worked in private sector (48.4%) and 145 were in business(29%) sector. Finally, monthly individual income of employees in the sample is also displayed in Table 2. The income level between employees was from 1000 to 150000 and the average income in the sample was about 75000. Of three groups, the 15001- 45000 (medium income) income range occupied the highest proportion (67.8%), while the first (1000-15000) and the third (>45000) accounted 8.4% and 23.8%, respectively.

4.2.1 Travel Mode Chosen by Employees

The employees were chosen set of alternatives, such as: car, two-wheeler, bus, auto rickshaw and walk. They were coded as follows: 1 =car, 2 = two-wheeler, 3 = bus, 4 = auto and 5 = walk. In the model, each employee must choose one mode, of the five travel modes.

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Two-wheeler is chosen as the reference alternative because majority of employees choosing this mode than other mode for work trips. Fig 9 shows mode split of employees in city. The distribution of mode split shown in Table III.

Table III Mode split

Mode	Frequency	Percent
Car	46	9.2
Two wheeler	313	62.6
Bus	130	26
Auto	10	2
Walk	1	0.2

From this chart Two wheelers are the most prominently (62.8%) used for work trips, this may due to less consumption of fuel and less space needed for parking.26% of employees are choosing bus as their mode because of low cost and followed by car (9.2%).The percentage of mode selection of auto and walk is very less (<5%), hence this data excluded for the analysis .Mode split as shown in fig 3

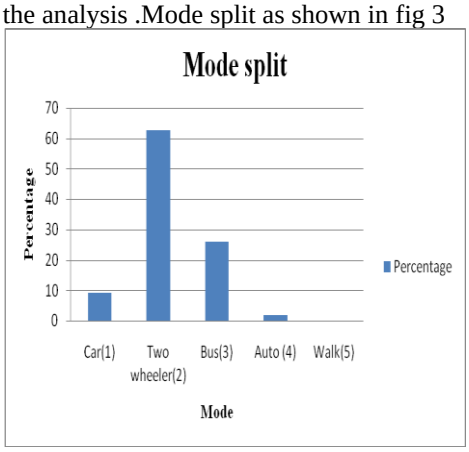

Fig .3 Mode split

Fig. 4 shows relationship between gender and mode choice behaviour of employees. In this analysis 55% of male employees are selecting two- wheeler as regular mode for work trips. This may due to less cost of fuel and less space for parking places of their offices. But 19.4 % of females are preferring bus as their regular mode for work trips because of less bus fare.

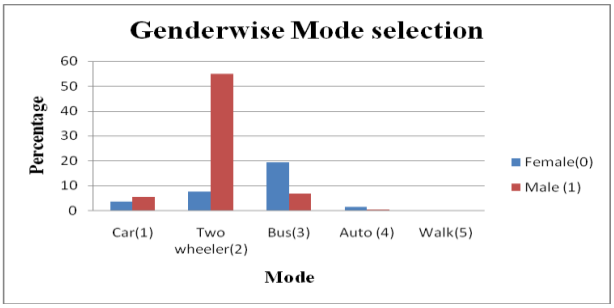

Fig .4 Gender wise mode selection

The age wise mode selection of employees is shown in fig.5.From the age group 18-35 is choosing two- wheeler (32.2%) as their mode for work trip and followed by bus and car.

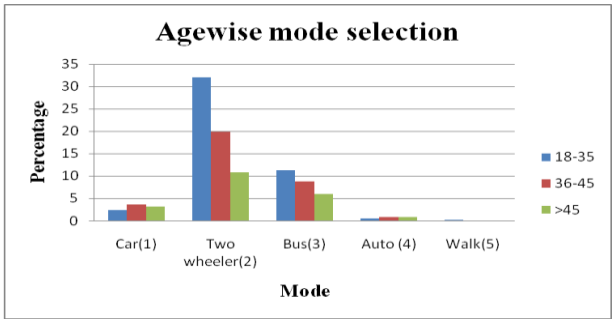

Fig.5 Age wise mode selection

The employees are divided in to three different categories based on income. The grouping started with the lowest income level, i.e. less than15000 and high income level was greater than 45000. Fig. 6 income wise mode selection of employees in the city. Considering the Medium income level people, 46.2% of employees are using two wheeler and 18.2% are selecting bus as their mode and very less number of people choosing car as a mode (2.2%).Lower income groups were choosing bus and two- wheeler as their mode for work trips.

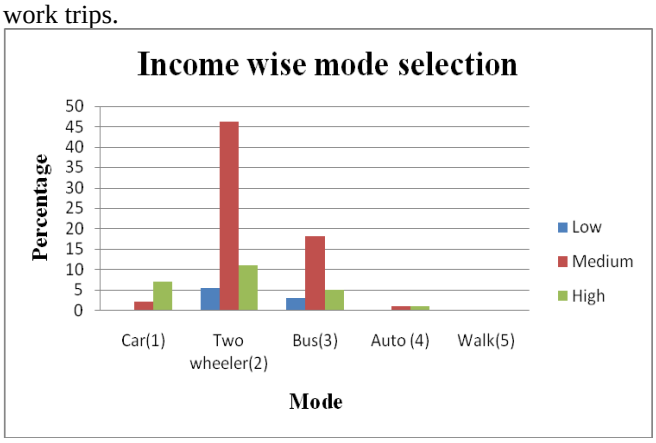

Fig.6 Income wise mode selection

Fig.7 shows details of vehicle ownership of employees. This chart shows 56.6 % of employees having one car and 84.6% having one two-wheeler.

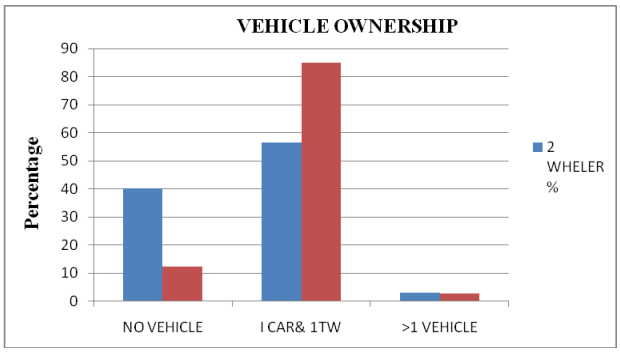

Fig .7 Details of Vehicle ownership

In the city, Two wheelers are the most prominently (62.8%) used mode for work trips, followed by bus and car and very less (<5%) are selecting auto and walk for their trip purpose. 55% of male employees are selecting two- wheeler and 19.4 % of females are preferring bus as regular mode for work trips. In the city, 56.6 % of employees are having car and 84.6% having two-wheeler ownership.

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VII. MODEL FORMULATION AND VALIDATION

In the formulation of MNL model, three categories of mode usage, namely: ie bus, car and two wheeler would serve as the alternatives that be adopted by employees. On the other hand, explanatory variables are (1) Age (numerical variables, recorded in integer); (2) Gender (dummy variable, male: 1; female: 0); (3) Marital status (dummy variable, married: 1; unmarried: 0); (4) Employment status (dummy variable, Govt: 0; Private :1 and self : 2); and (5) Head of the house 6) vehicle license ownership (Two-wheeler ,car) ,these are applied into the model to formulate the measurable utility .

In this study, how employee's mode usage would change as they are getting older is our major concern. Therefore, age is selected as an explanatory variable. Besides, dummy variables are also introduced into this model. The variable "gender" is designed to tell if there is any difference of mode choice between men and women. The variable "employment status" is designed to realize if these respondents have to commute routinely or not. The last variable "vehicle driver license ownership" is introduced to realize if the employees are allowed to drive own vehicle or bus for work trip.

A. *Preliminary analysis result*

The software used for modelling is SPSS (Statistical Package for the Social Sciences).

SPSS Statistics 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 analyses. 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.

B. *Multinomial logit model*

Multinomial logit models are used to model relationships between a polytomous response variable and a set of regression variables. Logistic regression can be extended to handle responses that are *polytomous*, i.e. taking $r > 2$ categories. (The word *polychotomous* is sometimes used, but this word does not exist) .When analyzing a polytomous response, it is important to note whether the response is *ordinal* (consisting of ordered categories) or *nominal* (consisting of unordered categories) [8]. Some types of models are appropriate only for ordinal responses; other models may be used whether the response is ordinal or nominal. If the response is ordinal, we do not necessarily have to take the ordering into account, but it often helps if we do.

Using the natural ordering can of the above models; the MNL is the simplest and most popular model [9]. The important assumption of this model is that the random components of the utilities of various alternatives are independently and identically distributed (IID). This hypothesis creates several advantages in applications because calculation of choice probabilities, presentation, and interpretation of the parameters are easy [1] However, because the IID assumption is often violated (i.e., the similarities amongst alternatives in a choice set are ignored) in practice, the applications of the MNL are limited (McFadden, 1978) [10]. To overcome part of this limitation, researchers have proposed an application of the NMNL model in which the random components of the utility function are correlated within each of the groupings [8] The MNL model is

- lead to a simpler
- more economical model and
- Increase the power to detect relationships with other variables.

C. *Model result*

The discrete choice data was analyzed using the SPSS 16.0 MNL program. 514 samples were collected, from this 25 samples are rejected due to missing values and other reasons, 489 samples were taken for model formulation. The program ran with different models using various attributes to ascertain the essential attributes to the model. Of the attributes selected, two separate models (with the intercept only and with all the coefficients) were run using the same MNL analysis.

Estimation results of the MNL model are displayed in Table VIII. 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-R2 value of 0.896 (Table IV), indicating that approximately 89.6% 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 IV Pseudo R- Square

Pseudo R-Square	
Cox and Snell	0.735
Nagelkerke	0.896
McFadden	0.773

Likelihood ratio test (Table V) 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 time, cost, waiting time, income, two-wheeler ownership, age and gender contributes significantly to explaining the mode choice.

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Table V Likelihood ratio test

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	191.328	0	0	.
Time	379.188	187.86	2	0.000
Cost	413.623	222.295	2	0.000
Waiting time	201.296	9.967	2	0.007
Income	207.439	16.111	2	0.000
TW ownership	207.184	15.856	2	0.000
Age	201.291	9.963	4	0.041
Gender	224.043	32.715	2	0.000

Table VI shows the model fitting information about the model. This is the Likelihood Ratio (LR) Chi-Square test that at least one of the predictors' regression coefficients is not equal to zero in the model. The LR Chi-Square statistic can be calculated by -2xL(null model) - (-2xL(fitted model)) = 841.213 – 191.328 = 649.885 where L(null model) is from the log likelihood with just the response variable in the model (Intercept Only) and L(fitted model) is the log likelihood from the final iteration with all the parameters. This test is analogous to the F-test for R^2 value in multiple regressions which test whether or not the improvement in the model associated with the additional variables is statistically significant. In this model, chi-square value of 649.885 has significance (0.000) and is less than 0.001, so there is a significant relationship between the dependent variable and the set of independent variables

Table VI Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	841.213			
Final	191.328	649.885	16	0

The data clearly indicated that the said attributes were indeed viable and provide the best fit to the data. The null model serves as a benchmark against which we compare the fit of the final choice model and because the null model is more complete model with other mode choices, a likelihood ratio test statistic is valid (Table VII)

Table VII Model goodness-of-fit

Goodness-of-Fit			
	Chi-Square	Df	Significance
Pearson	1258.508	794	0.000
Deviance	191.328	794	1.000

The parameter estimates of the minimum acceptable model are given in Table VIII. The degrees of freedom (df) of the chi-square distribution used to test the LR Chi-Square statistic and is defined by the number of predictors in the model (seven predictors in two models). The term 'Significance' is the probability getting a LR test statistic being as extreme as, or more so, than the observed statistic under the null hypothesis; the null hypothesis is that all of the regression coefficients in the model are equal to zero. In other words, this is the probability of obtaining this chi-square statistic (649.885), or one more extreme, if there is in fact no effect of the predictor variables. This p-value is compared to a specified alpha level, our willingness to accept a type I error, which is typically set at 0.05 or 0.01. The small p-value from the LR test, <0.00001, would lead us to conclude that at least one of the regression coefficients in the model is not equal to zero. The parameter of the chi-square distribution used to test the null hypothesis is defined by the degrees of freedom in the prior column.

Table VIII Parameter estimate

MODE		B	Std. Error	Wald	df	Sig.	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
1	Intercept	-5.213	1.44	13.096	1	0		
	Time	-0.211	0.052	16.741	1	0	0.732	0.896
	Cost	0.166	0.028	34.358	1	0	1.117	1.248
	Waiting time	0.193	0.204	0.895	1	0.344	0.813	1.807
	Income	2.689	0.775	12.033	1	0.001	3.221	67.275
	TW ownership	0.25	0.653	0.147	1	0.702	0.357	4.615
	[Age=0]	-2.131	0.894	5.685	1	0.017	0.021	0.684
	[Age=1]	-2.311	0.919	6.317	1	0.012	0.016	0.601
	[Age=2]	0	.	.	0	.	.	.
	[Gender=0]	1.22	0.758	2.589	1	0.108	0.766	14.982
	[Gender=1]	0	.	.	0	.	.	.
3	Intercept	-0.512	1.215	0.178	1	0.673		
	Time	0.319	0.052	37.534	1	0	1.243	1.524
	Cost	-0.438	0.074	34.793	1	0	0.558	0.747
	Waiting time	0.244	0.076	10.346	1	0.001	1.1	1.481
	Income	-0.311	0.506	0.378	1	0.538	0.272	1.975
	TW ownership	-3.179	0.91	12.207	1	0	0.007	0.248
	[Age=0]	-0.079	0.857	0.009	1	0.927	0.172	4.953
	[Age=1]	0.425	0.858	0.245	1	0.621	0.285	8.217
	[Age=2]	0	.	.	0	.	.	.
	[Gender=0]	2.7	0.506	28.49	1	0	5.522	40.121
	[Gender=1]	0	.	.	0	.	.	.

a. The reference category is: 2.(Two-wheeler)

b. This parameter is set to zero because it is redundant.

A. Interpretation of result

1) Car Relative to Two- Wheeler

a) Cost and Time

The multinomial log-odds of cost preferring car relative to two -wheeler would be expected to increase by 0.166 units while holding all other variables in the model constant, but the time decreases by 0.211 units. The Wald test statistic for the predictor cost is 34.358 an associated p-value of 0.000., the regression coefficient for cost has been found to be statistically significant, the Wald test statistic for the predictor time is 16.741 with an associated p-value of 0.000, which is less than 0.05, and hence it is significant. Since the utility of a mode decreases as the mode becomes more expensive. Hence it would significant to accept the null hypothesis and conclude that the commuters are less likely to prefer car as their mode than two-wheeler.

b) Income

The multinomial log-odds of income preferring car relative to two -wheeler would be expected to increase by 2.689 units while holding all other variables in the model constant. P-value of income is 0.000, hence it is significant.

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c) Age

The multinomial log-odds for [Age=0] and [Age=1] relative to [Age=2] are -2.131 and - 2.311 preferring the reference mode, which means the employees who has age greater than 45 are more likely to prefer car as their work purposes. It may be due to the convenience.

The p- value of Two-wheeler ownership, waiting time and gender are greater than 0.05, hence these are not significant

2) Bus Relative to Two- Wheeler

a) Cost and Time

The multinomial log-odds of cost preferring bus relative to two -wheeler would be expected to decreases by 0.438 units while holding all other variables in the model constant, but the time increases by .319 units. The Wald test statistic for cost and time are 34.793 and 34.534 with an associated p-value are 0.000, which is less than 0.05, and hence it is significant.

b) Waiting time

The multinomial log-odds of waiting time preferring bus relative to two -wheeler would be expected to increases by 0.244 units while holding all other variables in the model constant, The Wald test statistic for waiting time is 10.346 with an associated p-value are 0.001, which is less than 0.05, and hence it is significant.

c) Vehicle Ownership

Two-Wheeler- the coefficient of two wheeler owner ships is -3.179 of preferring bus relative to two- wheeler would be expected to decrease in 3.179 units while holding all other variables in the model constant. The commuter who are having two-wheeler, they may less likely to prefer bus than two- wheeler. The Wald test statistic for two –wheeler owner ship is 12.20 with an associated p-value of 0.000, hence it would significant to accept the null hypothesis and conclude that the commuters are less likely to prefer bus as their mode than two-wheeler.

d) Gender

The coefficient of female relative to male is 2.700 units, which is higher for preferring the reference mode, given all other predictor variables in the model are held constant. In other words, females are more likely than male to prefer bus for their work trip purposes than reference mode.

The coefficient of Intercept is -0.512 with an associated p-value of 0.673., hence it would not significant to accept the null hypothesis and conclude that the commuters are less likely to prefer bus as their mode than two-wheeler.

The p- value for age and income are greater than 0.05, and hence these are not significant

The empirical utility functions for different mode are:

$V_{(CAR)}$ = -5.213 – 0.211(TT) +0.166(TC) +2.689 (INC) - 2.131(AGE=0) - 2.311(AGE=1)

$V_{(BUS)}$ = -0.512 +0.319 (T.T) -0.438 (T.C) +2.44 (WT) - 3.179(TW) +2.700(GEN=0)

The prediction success of the model is given in Table IX. The validation run was also made with the same model specification. The model was calibrated for data set of 326 cases and validated using hold-out sample of 163.

Table IXClassification (Prediction success)

Observed	Predicted			
	1	2	3	Percent Correct
1	62	14	0	81.60%
2	10	165	10	89.20%
3	1	15	98	86.00%
Overall Percentage	19.50%	51.70%	28.80%	86.70%

The result of validation is aggregated in Table X. 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 92% accurate; the difference is only 5.3%, which is excellent or good.

Table X Classification (Validation Success)

Observed	Predicted			
	1	2	3	Percent Correct
1	22	6	0	78.60%
2	2	225	4	97.40%
3	0	14	53	79.10%
Overall Percentage	7.40%	75.20%	17.50%	92.00%

VIII. CONCLUSION AND DISCUSSION

A. Discussion

The Multinomial logit model for mode choice analysis of work trips was developed. The significant deterministic variables include the total travel time and travel cost for each mode of transport. The utility ranking and probability of choosing modes, the two-wheeler is always at the top level because of it less fuel consumption, followed by the bus. The utility for buses necessarily does not indicate users' willingness to prefer the service, rather it may represent that people are forced to use that mode of transport due to unavailability of suitable alternatives before them. It implies that the improvement of this system will attract people who choose their mode as private car.

The business activities and offices are locating in the centre of the city, these leads traffic congestion and other environmental problems. The existing transportation system is a major bottleneck for the development of the city. Unplanned urbanization, especially poor transportation planning and lower land utilization efficiency, has turned the city into a dangerous urban jungle. The existing road-based transportation system provides inefficient, unproductive, and unsafe level of services. To maintain the economic viability of this city and to keep its environment sustainable, an energy efficient mass transportation system is imperative.

Results of the multinomial logit model analysis demonstrated that these five factors (age, gender, income time and cost) were strongly related to considerations of the employees of their travel. The sign of each coefficient generated in the MNL model is convincible and consistent with the hypothesis. In terms of the hypothesis the mode choice of workers affected mainly by time and cost.

In Calicut the Two -wheelers are used by most of road users for their trip purposes. Thus empirical results in this study do identify the relations between mode choice and characteristics of employees in Calicut city.

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B. Conclusion

A mode choice model was developed for work trip for Calicut city. Age, gender, income, time and cost 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.

Findings from this study can be summarized as follows:

- Main factors influencing work trip of employees are age, gender, income, waiting time, two-wheeler ownership, time and cost.
- Employees (62.8%) would choose two-wheeler for their trip.
- Bus is chosen by females who are not having driving licence of car or Two-wheeler.
- Differences were found between female and male for selecting the mode for their work trips, the female (19.4%) tend to choose bus but male (55%)are preferring two wheeler for their work trip.
- The age group 18-35 is choosing two- wheeler (32.2%) for their work trip purposes and followed by bus and car.
- Age group (>45) are choosing car for their work trip purposes, it may be due to the comfort of the journey.
- The Medium income level people ,46.2% of employees are using two wheeler and 18.2% are selecting bus as their mode and very less number of people choosing car as a mode, i.e. less than 10%.Lower income groups were choosing bus and two- wheeler for their work trips.
- Regarding vehicle ownership, 56.6 % of employees having one car and 84.6% having one two-wheeler.
- Auto and Walk are found to be less (<5%) popular among the working groups.

IX. ACKNOWLEDGMENT

The authors owe thanks to all people for their support during the making of the paper. We would also like to thank the faculty of Department of Civil Engineering at Rajiv Institute Technology, Kottayam for their kind patronage and encouragement that made this paper possible

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