International Journal on Emerging Technologies **11**(3): 777-791(2020)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

Evaluation of Commuters' Travel Behavior under Mix Traffic Condition: A Case Study of Vadodara City

Faizi Ahmad Javeed[1], Juremelani Jayesh R.[2] and Bagadia Sanket[2]
[1]M.Tech Student, Department of Civil Engineering, PIET, Parul University (Gujarat), India.
[2]Assistant Professor, Department of Civil Engineering, PIET, Parul University (Gujarat), India.

(Corresponding author: Faizi Ahmad Javeed)
(Received 01 April 2020, Revised 11 May 2020, Accepted 14 May 2020)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The lack of appropriate transportation planning in non-metropolitan and fast growing cities of India, such as Vadodara city of Gujarat state leads to a deficiency of proper transportation planning policies. To mitigate the transportation problems the mode choice model is one of the best options to provide a convincible solution for mixed traffic cities. Many researchers used different models namely: logit model, probit model, extreme value model, etc for different cities to predict future demand. The majority of them focused on generic parameters such as travel costs and travel time for their models. In this paper an attempt made to develop a model that evaluate mode share of commuters for work trips. Total five different models were developed using various parameters. Accuracy was checked for each model and best model was selected for analysis of mode share for work trips. The data was collected through a personal interview by a questionnaire designed in two sections: socio-economic factors and travel characteristics. The available modes in the city are two-wheeler, personal car, auto-rickshaw, public buses, bicycle, and walking. The evaluation was carried out for both motorized and non-motorized modes however; model development was only focused on the motorized modes. 400 sample sizeswere calculated as per the census of the 2011 population of the city, but for further accuracy 465 samples were collected. 12 samples were removed as outliers, and the remaining 453 included in the process. 70% of data was used for the model calibration and 30% was kept for validation purposes. The multinomial logistic regression model was developed by IBM SPSS, the Version 19 software. After a few trails for the model, the fourth trail of the model was selected as the final one for the commuters' travel behavior. The factors such as travel time, travel cost, age, income, and vehicle ownership were the prime parameters affecting the mode choice and developed model. Five models were developed for the data; all significant statistical terms are noted down for each model. The utility function was formulated based on the statistical significance of the model variables. The mode of travel to work trips is the outcome category for the independent variables. The two-wheelers which have the highest demand was considered as reference mode.

Keywords: Mode choice modeling, Multinomial logistic regression model, Statistical approaches, Utility function, Work trips, Travel characteristics, Socio-economics characteristics.

Abbreviations: MNL, Multinomial logit; SPSS, Statistical Package for Social Science; TC, Travel cost; TT, Travel time; TD, Travel Distance; Sig., Significant; P-Value, Probability –Value; LRT, Likelihood Ratio Test; Std, Standard deviation; df, Degree of Freedom; χ^2, Chi-square; Exp (B), Odd Ratio; Uf, Utility function; VehOw, Vehicle Ownership; DL, Driving License; X, Variable.

I. INTRODUCTION

The world has rapidly led to higher growth rates and income, this can also increase the demand for vehicle and mobility. Increasing the number of vehicles in cities will cause some transportation problems such as congestion, accidents, air pollution, delay, economic loss, and disruption of traffic. To alleviate these problems travel demand modeling is the fundamental solution, because of its fundamental rule in public transport and policymaking. It is required to develop the models, and use them based on the individual travel attributes and mode choice. Mode choice modeling is important for predicting the trip makers' mode choice behavior and also for the factors affect the traveler mode. The mode choice model itself divided into two approaches aggregate and disaggregates models. Aggregate mode choice model focuses on the average individuals of trips or the entire zone trips but disaggregate mode choice model considers the individual trip behavior and its functional characteristics of available alternatives [4]. There are three types of disaggregate mode choice models namely: logit model, probit model, extreme value model. Among these types, the logit model is widely used for calibrating the mode choice model. Also, the researcher preferred for its simple mathematical calculations and accurate model formulations as compared to the other two types. The mathematical framework of the logit model is based on the theory of utility maximization hypothesis. Hypothesis means that individuals select their mode of travel at maximizing utility [1]. The choice of a mode depends on many factors such as socio-economics characteristics like age, gender, income, occupation, driving license car ownership, household size, residency, and trip characteristics like travel time, travel cost, distance, etc.

Moreover, some factors may affect the mode choice such as Reliability, comfort, safety, dust, and noise which refer to the level of service factor [2].The mode choice model can be developed for the city travel as well as inter-regional cities. The mode choice model covers the available local and private transport of commuters inside the city but the inter-regional city focuses on the appropriate transport vehicle for long distances. long distance may depend on land and air by vehicle, train, or plane [15]. So many major advances brought considerable changes in the mode choice model. These include shifting from aggregate to disaggregate models and various statistical software and techniques that made the work of researchers quite easy and effective. Logit model can model complex travel behaviors of any population with simple mathematical techniques and thus proves to be the most widely used tool for mode choice modeling. The mathematical framework of logit models is based on the theory of utility maximization [12].

II. LITERATURE REVIEW

From the past few decades, many researchers have developed and analyzed of mode choice models with different methods, approaches, and considered different factors as per their conditions. Few of them were studied as background study of this paper.

Essam and Sadi (2013) studied factors affecting the mode choice model for work trips in developing cities, they have done their work in Gaza city which is a developing city in Palestine country. They collected the data through the initial (pilot) and final questionnaire, socio-economics attributes, trip characteristics, and Likert scale data was collected. 552 questionnaires were randomly selected from 700 and two by three were used for the model calibration and one by three was kept for the validation of the model. They developed the multinomial logit model based on utility function at a confidence level of 95% and evaluated the models by likelihood ratio test [1].

Elharoun *et al*., (2018) developed the mode choice model for Mansoura city in Egypt. They collected the data online through Google form and considered some variables such as travel time, travel cost, driving license, residence status, occupation, income, gender. Microbus, taxi, private care, motorcycle, walking were their modes. Their model was 85% accurate. The calculation shows that the probability of microbus mode using a decrease by increasing its fare, while the private and taxi modes using probability is more as compared to microbus. Also, they found that the increase in microbus fares would increase the probability of people walking [4].

Ding and Zhang (2016) purpose were to predict a mode choice model with individual grouping based on cluster analysis. They investigated for two travel mode transit and car [3].

To collect data, they conducted a preference survey in the city of Nanjing city of China for traveler's socio-economics and trip information. The estimation of the utility function coefficient was calculated through regression based on the SP/RP survey information. Finally, they found that the accuracy rate of mode choice estimation using individual grouping is remarkably higher than without grouping [3].

Juremalani & Chauhan (2017) developed the mode choice model for work trips by using artificial intelligence techniques. Their objective was to develop the mode choice behavior predicting model using MNL and Fuzzy logic model. They considered 252 sample sizes and four modes namely: two-wheelers, car, shared auto, bus. Travel distance, travel cost, travel time were considered as trip characteristics variables, and gender, income, occupation, and car ownership were considered for personal information. The author used chi-square of independence to find out the dependency of categorical variables and the Pearson test was applied on scale data to determine the correlation. Finally, they observed that the fuzzy logic model gives better prediction accuracy for mode choice [11].

Mode choice modeling of work trips was studied by Ram *et al.,* [6], that there are two criteria for variables which may be classified as quantitative (includes, travel time, travel cost, waiting time, etc.) and qualitative (includes, reliability, comfort, convenience, etc.). Their article considered the India work trips as Transit, Paratransit, and personal vehicles, and the utility for each alternative mode was collected through a questionnaire survey. They used in their paper logit model including utility function formulation [6]. The authors used primary data from the field. Thus, the data collection methods included face to face interviews of individual trip makers traveling along the selected route through a questionnaire survey. The random sampling method was adopted for sampling techniques. The prime technique adopted for model choice analysis is the logit model method. To use the logit model utility function is necessary to develop. They presented some attributes for the formulation of utility functions such as travel cost, travel time, convenience, comfort, reliability, and dust and noise. The individual trip maker in the forming of rating converted to weight vectors. The weight vectors designate the importance of an attribute to a trip maker. They used a psychometric technique for finding the weight vector of each variable [7].

(Research GAP) It is observed that many researchers have developed travel prediction models, however comparison of accuracy different models is not done using qualitative and quantitative parameters.

Implications of existing methods are to study travel behaviors and to predict travel demands of commuters. But, these conventional models have their own constraints which hamper their prediction accuracy.

III. STUDY AREA

Vadodara is one of the largest cities in the Gujarat state of India after Ahmedabad and Surat. This city is also known as Baroda. Vadodara is one of the most multicultural cities in India, located in the South East of Ahmedabad. The district is also called "SanskarNagri" or City of Culture. As per 2019 estimated population is mentioned 20,065,771 inhabitants living in 12 tehsils, 15 towns, and 1,548 villages. 52% is male residents and 48% is the female part. As per data released by Govt. of India for Census 2011, Vadodara city has a population of 1,670,806. In every census since 1931; the city has a population growth of at least 19%. As per the transport is concerned, the city is well connected with other cities of Gujarat states and entire India by highways, airways, and railways. Private transport is utilized by private vehicles namely: Four wheelers, Two-wheelers. Local transport is dependent on public buses, auto-rickshaw, and taxis. Auto rickshaw is very much utilized in the city due to its cheapest rate. However, Vadodara is still suffering an appropriate transportation system. To provide a proper transportation system to the residents of the city, mode choice is the best option to develop a model for trip makers.

Fig. 1. Transport of city.

IV. DATA COLLECTION

The revealed preference survey is carried out to collect the information of commuters in 12 administrative in Vadodara city. The city is divided into four zones and 12 wards. The personal interview was preceded through a questionnaire, designed in two sections. The first section was personal characteristics, the second section was for trip characteristics. The variables such as age, income, household size, gender, occupation, vehicle ownership, driving licenses, travel time, travel cost, travel distance, preferred mode were asked from each person in the ward. Vadodara city has a population of 1,670,806 as per the 2011 census report; according to this population, the sample size would around 400 for work trips mode prediction at 95% confidence level and 5 % margin error of data. Yamane introduced a simple formula to calculate the sample size for a confidence level of 95% and a margin error of 5%. Where N is the population size, n is the sample size and e is the level of precision

$$n = \frac{N}{1+N(e)2}$$

For the achievement of accuracy in the data set, the data collected for 465 sample sizes. 12 samples were removed as outliers in the data. The remaining 453 samples were classified and preliminarily analyzed as in the following Table 1.

Table 1: Zones and wards wise division of Vadodara city.

S.No.	Zone	Administrativewards	Election wards		Sample sizes
1.	East	1	141	—	30
2.	East	2	4	6	45
3.	East	9	5	—	30
4.	North	5	13	—	30
5.	North	7	1	2	45
6.	North	8	3	7	45
7.	South	3	15	16	45
8.	South	4	17	18	45
9.	South	12	19	—	30
10.	West	6	11	12	45
11.	West	10	8	9	45
12.	West	11	10	—	30
Total		12	19		465

V. CHARACTERIZATION OF COMMUTERS

The collected data were assembled in a designed format, and preliminary analysis was done simultaneously. These include the work trips classification based on age, income, family size, gender, driving license, mode of travel, occupation, and work trip makers travel characteristics such as trip cost, trip time and trip distance.

Table 2: Statistical analysis.

Variables	Group	Frequency	Percentage
Age	10-20	48	11
	21-30	87	19
	31-40	123	27.092
	41-50	96	21.145
	51-60	67	15
	61-70	24	5
	71-80	6	1.33
	81-90	2	0.666
	91-100	0	0
	Total	453	100
Gender	Male	348	76.8

	Female	105	23.2
	Total	453	100.0
Income	0-10000	118	26.0
	10001-20000	119	26.3
	20001-30000	89	19.6
	30001-40000	44	9.7
	40001-50000	50	11.0
	50001-60000	22	4.9
	>60000	11	2.4
	Total	453	100.0
Family size	1-4	297	65.6
	5-8	140	30.9
	9-12	16	3.1
	13-16	2	0.4
	Total	453	100.0
Vehicle ownership	Two Wheeler	253	55.8
	Car	74	16.3
	Bicycle	29	6.4
	None	97	21.4
	Total	453	100.0
Driving License	No	125	27.6
	Yes	328	72.4
	Total	453	100.0
Occupation	Private Employee	89	19.6
	Self-Employee	125	27.6
	Daily Wage	30	6.6
	Gove. Employee	147	32.5
	Student	62	13.7
	Total	453	100.0
Mode Of travel	Two-wheeler	252	55.6
	Car	67	14.8
	Bicycle	30	6.6
	Auto Rickshaw	55	12.1
	Public Bus	25	5.5
	Walking	24	5.3
	Total	453	100.0
Distance (Km)	0-10	380	83.8
	11-20	44	9.6
	21-30	25	5.4
	31-40	3	0.6
	41-50	1	0.2
	Total	453	100.0
Travel Cost (INR)	0-10	217	47.8
	11-20	181	24.1
	21-30	33	7.3
	31-40	20	4.5
	41-50	23	5
	51-60	12	2.7
	61-70	11	2.4
	71-80	8	1.7
	81-90	2	0.4
	91-100	13	2.9
	101-110	0	0
	111-120	5	1.1
	Total	453	100.0
Travel Time (mint)	0-10	244	53.7
	11-20	118	26.2
	21-30	58	12.8
	31-40	20	4.4
	41-50	11	2.5
	51-60	2	0.4
	Total	453	100.0

VI. TRIP PARAMETER ANALYSIS

The continuous variables were analyzed for the descriptive statistics, normality tests, and Pearson correlation test. All these mentioned tests are tabulated stepwise in the following tables.

A. Normal distribution tests for trip parameters

These tests aim to determine the data normality or abnormality condition, we can select tests (parametric/non-parametric) and model for data. Two methods can be checked for normality either graphical or statistical approaches. Here, we consider the statistical approach. The statistical approaches are based on the descriptive statistics of available data. The mean and median ratio must be equal to 1 or both values of mean and median should be equal, The skewed value to standard error ratio and kurtosis value to standard ratio should give us Z values (-1.96, 1.96). These criteria are fit on data, which means there is normality. Here, we attempted on scale variables such as travel cost, travel distance, travel time as shown in Table 4.

B. Pearson correlation test on generic variables

The data distribution was normal, therefore the Pearson correlation test was used. The result shows that there is a relationship between these variables concerning their coefficient. As shown in Table 5.

Table 3: Descriptive analysis of trip parameters.

S.No.	Variables	Mean	Median	Mode	Std. deviation
1.	Travel Cost	22.83	13	10	25.7
2.	Travel time	14.9	10	10	11.88
3.	Waiting Time	1.98	.00	0	3.47
4	Travel Distance	7.15	5	5	9

Table 4: Normality tests for trip parameters.

Variables	TC (INR)	TT(Mint)	TD(Km)
N	**453**	**453**	**453**
Skewness	-0.275	-0.274	-0.121
Std. Error of Skewness	0.114	0.114	0.114
Kurtosis	0.014	0.141	-0.051
Std. Error of Kurtosis	0.228	0.228	0.228

To find the normality of each parameter: skewness or kurtosis is divided by its related Standard error.

Table 5: Pearson Correlation Test for trip parameters.

Variables relationships		TD(km)	TC(INR)	TT(Mint)
TD (km)	Pearson Correlation	1	0.557**	0.708**
	Sig. (2-tailed)		0.000	0.000
	Correlation	perfect	strong	Very strong
TC (INR)	Pearson Correlation	0.557**	1	0.443**
	Sig. (2-tailed)	0.000		0.000
	Correlation	strong	perfect	weak
TT (Mint)	Pearson Correlation	0.708**	0.443**	1
	Sig. (2-tailed)	0.000	0.000	
	Correlation	Very strong	weak	perfect

VII. MODEL DEVELOPMENT

The Multinomial Logistic regression is one of the appropriate models for polytomous variables, this means when the outcome is more than two categories. This model can be applied to any type of predictors: nominal, ordinal, and interval/ratio. However, this model is often preferred when the outcome variable is categorical and data is observational, not experimental at all [21]. Statistics such as alteration history, parameter coefficients, asymptotic covariance and correlation matrices, likelihood-ratio tests for model and partial effects, –2 log-likelihood. Pearson and deviance chi-square goodness of fit. Cox and Snell, Nagelkerke, and McFadden $R2$. Data on the dependent variable should be categorical. Independent variables can be factors or covariates. In general, factors should be categorical variables, and covariates should be continuous variables [21].

It is assumed that the odds ratio of any two categories is independent of all other response categories. In the model, a reference category should be decided. Odds ratio value is given by the software; the reference category is compared to independents variables values. The significance and ability of explanations of variations can be checked by the pseudo-R-square values [6].Five models were developed for the data; all significant statistical terms are noted down for each model. Different variables were considered in each trail than the utility function was made based on the statistical significance of the model variables. The mode of travel to work trips is the outcome category for the independent variables. The two-wheeler which has the highest demand is considered as reference mode for comparison of other modes. The model developed for motorized traffic only such as four-wheelers, two-wheelers, auto-rickshaw, and public bus. The non-motorized such as bicycle and walking are negligible due to their less utilization to work trips. The utility function was created based on the following forms [1].

U car = Constant + β_1(Car TT) + β_2 (Car TC) + β_3(Car DIST)

U bike = Constant + β_1(bike TT) + β_2 (bike TC) + β_3(bike DIST)

U auto = Constant + β_1(utoTT) + β_2 (autoTC) + β_3(auto DIST)

U bus = Constant + β_1(bus TT) + β_2 (bus TC) + β_3(bus DIST)

A. Model Caliberation

Travel time and cost variables were attempted for the first model, the following is the result of multinomial logistic regression model for deterministic parameters.

The Model Fitting Information Table 6 shows various indices for assessing the intercept only model (sometimes referred to as the null model) and the final model which includes all the predictors and the intercept (sometimes called the full model). The -2 Log-Likelihood (-2LL) should be lower for the full model than it is for the null model; lower values indicate better fit. The -2 LL is a likelihood ratio and represents the unexplained variance in the outcome variable. Therefore, the smaller the value, the better the fit. The Likelihood Ratio chi-square test is an alternative test of goodness-of-fit. As with most chi-square based tests however, it is prone to inflation as sample size increases. Here, we see model fit is significant χ^2= 213.581, $p < 0.005$, which indicates our full model predicts significantly better, or more accurately than the null model. To be clear, we want the *p*-value to be *less than* our established cut off (generally 0.05) to indicate a good fit. The Pseudo R-Square column displays three metrics that have been developed to provide a number familiar to those who have used traditional, standard multiple regressions. They are treated as measures of effect size, similar to how R^2 is treated in standard multiple regressions. However, these metrics do not represent the amount of variance in the outcome variable accounted for by the predictor variables. Higher values indicate better fit, also the values explain the percentage of data falls in the model, but they should be interpreted with caution. Here, the values are quite good for the model. The range values are 0-1, our model is in the range limit. The statistics in the Likelihood Ratio Tests table are the same types as those reported for the null and full models above in the Model Fitting Information part. Here, however, each element of the model is being compared to the full model in such a way as to allow the research to determine if it (each element) should be included in the full model. In other words, does each element (predictor) contribute meaningfully to the full effect ? For instance, we see that the travel cost and travel time predictors display a significant ($p = 0.000$) chi-square which could be included in the model. To be clear, if the *p*-value is *greater than* your established cut off (generally 0.05) for a predictor then that predictor could not contribute significantly to the full (final) model and should be dropped from the model.

Table 6: Model one (travel time, travel cost) result.

X	Model fitting information: -2 Log Likelihood			R^2	Likelihood ratio Tests: $\chi 2 = -2(LL_R.LL_U)$		
	model	χ^2	Sig.		Effect	χ^2	Sig.
TC & TT	Intercept (473.6)			0.53	371.69 (Intercept)	111.64	0.00
				0.60	438.18 (TC)	178.13	0.00
	Final (260.1)	213.6	0.00	0.36	371.68 (TT)	111.64	0.00

Table 7: Parameter Estimates of independent variables.

Mode of Travel		B	Std. Error	Wald	df	Sig.	Exp(B)
Car	Intercept	-3.90	0.544	51.48	1	0.00	
	Travel Cost	0.114	0.018	41.85	1	0.00	1.121
	Travel Time	-0.088	0.039	5.097	1	0.02	0.916
Auto	Intercept	-1.50	0.401	14.01	1	0.00	
	Travel Cost	-0.201	0.048	17.60	1	0.00	0.818
	Travel Time	0.201	0.038	27.32	1	0.00	1.223
Public Bus	Intercept	-1.85	0.526	12.46	1	0.00	
	Travel Cost	-0.227	0.064	12.71	1	0.00	0.797
	Travel Time	0.206	0.048	18.56	1	0.00	1.229

(a) The reference category is: Two-wheeler
(b) Dependent variables: Travel mode
(c) Independent variables: Travel cost, Travel time.

The Parameter Estimates Table 7 shows the logistic coefficient (B) for each predictor variable for each alternative category of the outcome variable. Alternative category meaning, not the reference category. The logistic coefficient is the expected amount of change in the logit for each one-unit change in the predictor. The logit is what is being predicted; it is the odds of membership in the category of the outcome variable which has been specified (here the first value: Two-wheeler was specified, rather than the alternative values car, auto or bus). The closer a logistic coefficient is to zero, the less influence the predictor has in predicting the logit. The table also displays the standard error should be lesser than 2 which is authentic here, Wald statistic, *df*, Sig. ($p<0.005$) here we have all the predictors significant; as well as the Exp(B) (Odd ratio). The Wald test (and associated *p*-value) is used to evaluate whether or not the logistic coefficient is different than zero. The Exp(B) (Odd ratio) is the odds ratio associated with each predictor. We expect predictors which increase the logit to display Exp(B) (Odd ratio) greater than 1.0, those predictors which do not affect the logit will display an Exp(B) (Odd ratio) of 1.0 and predictors which decease the logit will have Exp(B) (Odd ratio) values less than 1.0. simply we can interpret for the above predictors with reference mode as. Travel cost of the car, auto, and bus is 1.121, 0.818, 0.797 times of two-wheeler respectively. Likewise, the travel time of the car, auto, and bus is 0.916, 1.223, 1.229 times of two-wheeler respectively. The following utility functions can be formulated from the above parameters for model one:

Reference mode: Two-wheeler

$$U_{car} = -3.9 + 0.114\ (TC) - 0.088\ (TT) \quad (1)$$

$$U_{auto} = -1.5 - 0.201(TC) + 0.201\ (TT) \quad (2)$$

$$U_{bus} = -1.85 - 0.227(TC) + 0.206\ (TT) \quad (3)$$

The Classification Table 8 indicates how well our full model correctly classifies cases. A perfect model would show only values on the diagonal correctly classifying all cases. Adding across the rows represents the number of cases in each category in the actual data and adding down the columns represents the number of cases in each category as classified by the full model. The key piece of information is the overall percentage in the lower right corner which shows our model (with all predictors and the constant) is 73.8% accurate; which is not fair and we need to go for few more trails to obtain a higher percentage of accuracy. The second model was trailed for the variables of travel cost, travel time, and travel distance. The following table is the multi logistic regression model result in the second model.

Table 9 shows, the model fitting information of the second model, according to the values of intercept only and final models -2 log likelihood values are in the limit (561.033, 332.772 respectively) and final model chi-square value is 228.2 which has cut off value Sig. ($p>0.00$), this means that the final model is significant and all parameters affect the model and we reject the null model or intercept model and accept the alternative hypothesis which is the final model. The table indicates that 63 % of data fall in the model which is increased as compared in the first model; still, there is a variance of data in the model. The result of likelihood ratio tests of the second model determines that all predictors affect the model and each variable is statistically Sig. ($p>0.00$) so, we can include three of them in the model.

Table 8: Model Icorrection classification (prediction).

Observed	Predicted				
	Two-wheeler	Car	Auto	Public Bus	Correct %
Two-wheeler	166	8	6	0	92.2%
Car	14	38	0	0	73.1%
Auto Rickshaw	28	0	7	0	20.0%
Public Bus	15	0	4	0	.0%
Overall %	78.0	16.1	5.9	0	**73.8%**

Table 9: Model II (travel time, travel cost & distance) result.

X	Model fitting information:-2 Log-Likelihood			R^2	Likelihood ratio Tests: $\chi 2 = -2(LL_{R}.LL_{U})$		
	model	χ^2	Sig.		Effect	χ^2	Sig.
TC, TT, & TD	Intercept (561.0)			0.55	443.36 (Intercept)	110.59	0.00
				0.63	510 (TC)	177	0.00
	Final (332.8)	228.2	0.00		359.88 (TT)	27.1	0.00
				0.38	347.45 (TT)	14.7	0.00

Table 10: Parameter Estimates of independent variables.

Mode of Travel		B	Std. Error	Wald	df	Sig.	Exp(B)
Car	Intercept	-4.01	0.560	51.41	1	0.00	
	Travel Cost	0.111	0.018	39.78	1	0.00	1.12
	Travel Time	-0.111	0.045	6.033	1	0.01	0.895
	Travel Distance	0.069	0.062	1.260	1	0.26	1.07
Auto	Intercept	-1.46	0.420	12.18	1	0.00	
	Travel Cost	-0.247	0.055	20.48	1	0.00	0.781
	Travel Time	0.158	0.042	14.34	1	0.00	1.17
	Travel Distance	0.172	0.064	7.179	1	0.00	1.19
Public Bus	Intercept	-1.83	0.535	11.77	1	0.00	
	Travel Cost	-0.287	0.071	16.24	1	0.00	0.751
	Travel Time	0.147	0.053	7.688	1	0.01	1.16
	Travel Distance	0.223	.071	9.750	1	0.00	1.25

(a) The reference category is: Two-wheeler
(b) Dependent variables: Travel mode
(c) Independent variables: Travel cost, Travel time & Travel distance.

Table 10 indicates the parameter estimates of alternative modes of the model. The std.error, Wald, *df* are accurate. However, some of the predictors are statistically insignificant; these would be dropped from the model. For instance, travel distance Sig(p<0.262). Exp B(Odd ratio) values for each variable can be interpreted in such a way that travel cost of the car, auto, bus values are 1.118, 0.781, 0.751 times of two-wheeler respectively, likewise, the travel time and travel distance can be interpreted same. The following utility functions can be formulated from the above parameters for model two:

Reference mode: Two-wheeler

$$U_{car} = -4.1 + 0.111\ (TC) - 0.111\ (TT) \quad (4)$$

$$U_{auto} = -1.46 - 0.247(TC) + 0.158\ (TT) + 0.172\ (TD) \quad (5)$$

$$U_{bus} = -1.83 - 0.287(TC) + 0.147\ (TT) + 0.223\ (TD) \quad (6)$$

Table 11 shows the classification of each case correction in the model. The overall percentages are 76.2%, increased as compared to the first model but still not satisfactory .we can trail for the third model to add some socio-economics factors.

The above developed two models were based on continuous variables or scale data. However, the model correction and goodness of fit are not to the point of satisfactory as explained in their interpretations. To develop an accurate model, it is needed to trail some socio-economic parameters. The third model is attempted for adding two variables of age and income which are the most important factors affecting the socio-economic of a trip maker. The result is tabulated.

Table 11: Model II correction classification (prediction).

Observed	Predicted				
	Two-wheeler	Car	Auto Rickshaw	Public Bus	Percent Correct
Two-wheeler	167	7	6	0	92.8%
Car	14	38	0	0	73.1%
Auto Rickshaw	24	0	11	0	31.4%
Public Bus	12	0	5	2	10.5%
Overall %	75.9	15.7	7.7	0.7	**76.2%**

Table 12: Model III(TT, TC, TD, Age & Income) result.

X	Model fitting information:-2 Log-Likelihood			R^2	Likelihood ratioTests: $\chi 2 = -2(LL_R - LL_U)$		
	model	χ^2	Sig.		Effect	χ^2	Sig.
TC, TT, TD, Age, & Income	Intercept (594.0)			0.62	392.2 (Intercept)	71.1	0.00
	Final (321.12)	272.9	0.00		447.7 (TC)	126.6	0.00
					341.1 (TT)	19.95	0.00
				0.70	334.65 (TT)	13.53	0.00
				0.46	333.64 (Age)	12.51	0.01
					344.64 (Income)	23.52	0.00

Table 12 shows the model fitting information of the third model, according to the values of intercept only and final models -2log likelihood values are in the limit (594.070, 321.117 respectively) and final model chi-square value is 272.9 which has cut off value Sig. (p>0.00), this means that the final model is significant. The alternative hypothesis is accepted and the null hypothesis is rejected in this case. The table indicates that 70.3% of data fall in the model which is increased as compared in the second model; still, there is a variance of data in the model. It indicates the result of the likelihood ratio tests of the third model, this determines that all predictors affect the model and each variable is statistically Sig. (p>0.000).

Table 13 indicates the parameter estimates of alternative modes of model the std. error, Wald, *df* are accurate. However, some of the predictors are statistically insignificant; these would be dropped from the model. For instance, travel distance Sig(p<0.465) in car, age Sig(p<0.212) in auto and income Sig(p<0.192). Exp B(Odd ratio) values for each variable can be interpreted in such a way that the travel time of the car, auto, bus values are 0.906, 1.16, 1.147 times of two-wheeler respectively, likewise, the travel cost, age, income, and travel distance can be interpreted same. The following utility functions can be formulated from the above parameters for model three:

Reference mode: Two-wheeler

U_{car} = -8.42 + 0.117 (TC) – 0.098 (TT) – 0.051 (Age) – 0.761 (Income) (7)

U_{auto} = -1.24 – 0.232(TC) + 0.158 (TT)+ 0.159 (TD) – 0.439 (Income) (8)

U_{bus} = 0.471 – 0.256(TC) + 0.137 (TT) + 0.223 (TD) – 0.052 (Age) (9)

Table 14 shows the classification of each case correction in the model. The overall percentages are 81.1%, increased as compared to the second model which is satisfactory and good. We can trail for the fourth model to add vehicle ownership variable to the third model and evaluate the result. The fourth model was considered to add vehicle ownership to the input variables of the third model. The output was not satisfactory for such data and then it was decided to omit the travel distance and to develop a model for travel cost, travel time, age, and income and vehicle ownership variables. The result of these variables as the fourth model was given by software is arranged in the following table.

Table 13: Parameter Estimates of independent variables.

Mode of Travel		B	Std. Error	Wald	df	Sig.	Exp(B)
Car	Intercept	-8.42	1.455	33.549	1	0.00	
	Travel Cost	0.117	0.021	32.334	1	0.00	1.12
	Travel Time	-0.098	0.055	3.223	1	0.07	0.906
	Travel Distance	-0.054	0.074	0.533	1	0.47	0.947
	Age	0.051	0.022	5.544	1	0.02	1.05
	Income	0.761	0.211	13.056	1	0.00	2.14
Auto	Intercept	-1.24	0.724	2.937	1	0.09	
	Travel Cost	-0.232	.054	18.767	1	0.00	0.793
	Travel Time	0.148	0.043	12.038	1	0.00	1.16
	Travel Distance	0.159	0.060	7.148	1	0.01	1.17
	Age	0.022	0.017	1.560	1	0.21	1.02
	Income	-0.439	0.197	4.958	1	0.03	0.645
Public Bus	Intercept	0.471	0.879	0.287	1	0.59	
	Travel Cost	-0.256	0.068	13.975	1	0.00	0.775
	Travel Time	0.137	0.058	5.634	1	0.02	1.15
	Travel Distance	0.219	0.073	9.034	1	0.003	1.244
	Age	-0.052	0.029	3.270	1	0.07	0.949
	Income	-0.382	0.293	1.703	1	0.19	0.683

(a) The reference category is: Two-wheeler
(b) Dependent variables: Travel mode
(c) Independent variables: Travel cost, Travel time, Travel distance, Age & Income.

Table 14: Model III correction classification (prediction).

Observed	Predicted				
	Two-wheeler	Car	Auto Rickshaw	Public Bus	Percent Correct
Two-wheeler	171	3	4	2	95.0%
Car	9	43	0	0	82.7%
Auto Rickshaw	18	0	13	4	37.1%
Public Bus	11	0	3	5	26.3%
Overall %	73.1	16.1	7.0	3.8	**81.1%**

Table 15 shows the model fitting information of the fourth model, according to the values of intercept only and final models -2 log likelihood values are in the limit (592.7, 155.2 respectively) the values are in the criteria of fitting and final model chi-square value is 437.52 which has cut off value Sig. (p>0.00), this means that the final model is significant, and the intercept model is rejected. The table also indicates that 90% of data fall in the model which is increased as compared to the third model; means there is less variance and sufficient data falls in the model. It indicates the result of the likelihood ratio tests of the fourth model, this determines that all predictors affect the model and each variable is statistically Sig. (p>0.00). All variables can be included in the utility function model because of the Sig. values are lesser than p= 0.05.

Table 15: Model IV (TT, TC, Age, Income & vehicle) result.

X	Model fitting information: -2 Log-Likelihood			R^2	Likelihood ratioTests: $\chi 2 = -2(LL_R\text{-}LL_U)$		
	Model	χ^2	**Sig.**		**Effect**	χ^2	**Sig.**
TC, TT, Age, Income, & Veh Ow	Intercept(592.7)			0.78	281.1 (Intercept)	125.9	0.00
					222.66 (TC)	67.5	0.00
				0.90	180.3 (TT)	25.15	0.00
	Final (155.2)	437.52	0.00		167.9 (Age)	12.75	0.01
				0.74	164.58 (Income)	9.42	0.02
					333.27 Vehicle	178.1	0.00

Table 16: Parameter Estimates of independent variables.

Mode of Travel		B	Std. Error	Wald	df	Sig.	Exp(B)
Car	Intercept	-11.5	1.96	34.64	1	0.00	
	Travel Cost	0.097	.022	18.65	1	0.00	1.10
	Travel Time	-0.103	0.057	3.263	1	0.07	0.902
	Age	0.049	0.027	3.194	1	0.07	1.05
	Income	0.439	0.230	3.628	1	0.06	1.55
	Vehicle ownership	2.99	0.651	21.00	1	0.00	19.8
Auto	Intercept	-11	2.58	18.3	1	0.00	
	Travel Cost	-0.334	0.123	7.324	1	0.01	0.716
	Travel Time	0.314	0.102	9.414	1	0.00	1.37
	Age	0.100	0.044	5.065	1	0.02	1.11
	Income	-0.657	0.420	2.449	1	0.011	0.518
	Vehicle ownership	4.02	0.810	24.6	1	0.00	55.7
Public Bus	Intercept	-10.3	2.88	12.75	1	0.00	
	Travel Cost	-0.363	0.139	6.872	1	0.01	0.695
	Travel Time	0.341	0.111	9.341	1	0.00	1.41
	Age	0.035	0.051	.483	1	0.05	1.04
	Income	-0.537	0.477	1.267	1	0.03	0.585
	Vehicle ownership	4.16	0.880	22.35	1	0.00	64.2

(a) The reference category is: Two wheeler
(b) Dependent variables :Travel mode
(c) Independent variables : Travel cost , Travel time, Age, Income & Vehicle ownership

The following utility functions can be formulated from the above parameters for model four:
Reference mode: Two wheeler

U_{car} = -11.54 + 0.097 (TC) – 0.049 (TT) + 0.049 (Age) – 0.439 (Income)+ 2.985(vehicle ownership) (10)

U_{auto} = -11.04 – 0.334(TC) + 0.314 (TT)+ 0.10 (Age) - 0.657(Income) – 4.019 (vehicle ownership) (11)

U_{bus} = -10.29 - 0.363 (TC) + 0.341 (TT) + 0.035 (Age) – 0.537 (Income) +4.162(vehicle ownership) (12)

Table 17 shows the classification of each case correction in the model. The overall percentages are 90%, increased as compared to the third model which is very good. We can trail for the last model to add more socio-economics variables to the fourth model and evaluate the result than we will decide for the final model.

Table 18 shows the model fitting information of the fifth model, according to the values of intercept only and final models -2 log likelihood values are in the limit (594.07, 128.47 respectively) the values are in the criteria of fitting and final model chi-square value is 465.6 which has cut off value Sig. ($p>0.00$), this means that the final model is significant and accepted. The table indicates that almost 92 % of data falls in the model which is increased as compared in the fourth model; means there is less variance and sufficient data falls in the model. It indicates the result of the likelihood ratio tests of the fifth model, this determines that some predictors affect the model and each variable is statistically Sig. ($p>0.00$), some predictors are statistically insignificant Sig. ($p<0.05$). For instance travel distance Sig($p = 0.185$). The variables which p-value is greater than 0.05, those all will drop from the model due to their insignificance. These insignificant variables are travel distance, income, gender, family size, driving license and occupation their respected Sig. values are (0.189, 0.224, 0.098, 0.185, 0.321, and 0.124 respectively).

Table 17: Model IV correction classification (prediction).

Observed	Predicted				
	Two-wheeler	**Car**	**Auto**	**Public Bus**	**Correct %**
Two-wheeler	176	2	2	0	97.8%
Car	3	49	0	0	94.2%
Auto	4	1	25	5	71.4%
Public Bus	1	0	11	7	36.8%
Overall %	64.3	18.2	13.3	4.2	**90%**

Table 18: Model last (All Variables) result.

X	Model fitting information:-2 Log-Likelihood			R^2	Likelihood ratio Tests: $\chi 2 = -2(LL_R - LL_U)$		
	model	χ^2	**Sig.**		**Effect**	χ^2	**Sig.**
All	Intercept (594.1)				146.16 (Intercept)	17.68	0.00
					195.6 (TC)	67.14	0.00
				0.8	140.12 (TT)	11.74	0.01
					133.25 (TD)	4.78	0.19
				0.92	144.1 (Age)	15.63	0.00
	Final (128.47)	465.6	0.00		132.84 (Income)	4.36	0.23
				0.78	134.77 (Gender)	6.29	0.01
					133.29 (Family Size)	4.82	0.19
					131.97 (DL)	3.5	0.32
					134.22 Occupation	5.75	0.124

Table 19 indicates the parameter estimates of alternative modes of model .the std.error, Wald, *df* are accurate. Some predictors are statistically significant; these all will be considered in the model. But, some are not that will be dropped from the model. ExpB(Odd ratio) values for each variable can be interpreted as in previous models with compared to two wheelers. The following utility functions can be formulated from the above parameters for model fifth:

Reference mode: Two wheeler

U_{car} = -18.78 - 0.109 (TC) + 0.079 (Age) + 4.145 (vehicle ownership) (13)

U_{auto} = -16.909 – 0.761(TC) + 0.414 (TT)+ 2.997 (Gender) - 1.190 (family size) + 5.265 (vehicle ownership) (14)

U_{bus} = -14.453 - 0.802 (TC) + 0.431 (TT) - 1.255 (family size) +5.468 (vehicle ownership) (15)

Table 19: Parameter Estimates of independent variables.

Mode of Travel		B	Std. Error	Wald	df	Sig.	Exp(B)
Car	Intercept	-18.78	6.047	9.649	1	0.00	
	Travel Cost	0.109	0.028	15.61	1	0.00	1.115
	Travel Time	-0.061	0.065	0.865	1	0.35	.941
	Age	0.079	0.037	4.520	1	0.03	1.082
	Income	0.387	0.324	1.430	1	0.23	1.473
	Vehicle ownership	4.145	0.924	20.120	1	.00	63.145
	Gender	-0.063	1.284	0.002	1	0.96	0.939
	Family Size	-0.269	0.242	1.238	1	0.27	0.764
	Driving License	3.050	1.846	2.728	1	0.01	21.11
	Occupation	-0.507	0.352	2.075	1	0.15	0.602
	Travel Distance	-0.052	0.103	0.259	1	0.61	0.949
Auto	Intercept	-16.91	6.780	6.220	1	0.01	
	Travel Cost	-0.761	0.300	6.452	1	0.01	0.467
	Travel Time	0.414	0.163	6.467	1	0.01	1.513
	Age	0.110	0.073	2.284	1	0.13	1.117
	Income	-0.722	0.731	0.974	1	0.33	0.486
	Vehicle ownership	5.265	1.351	15.197	1	0.00	193.42
	Gender	2.997	1.408	4.531	1	0.03	20.04
	Family Size	-1.190	.665	3.204	1	0.07	.304
	Driving License	1.131	1.537	0.541	1	0.46	3.099
	Occupation	0.757	0.583	1.689	1	0.19	2.133
	Travel Distance	0.467	0.302	2.396	1	.12	1.596
Public Bus	Intercept	-14.45	7.097	4.148	1	0.04	
	Travel Cost	-0.802	0.304	6.964	1	0.01	0.448
	Travel Time	0.431	0.170	6.390	1	0.01	1.538
	Age	0.028	0.077	0.135	1	0.71	1.029
	Income	-0.650	0.779	0.696	1	0.40	0.522
	Vehicle ownership	5.468	1.403	15.19	1	0.00	237.1
	Gender	2.290	1.531	2.238	1	0.14	9.877
	Family Size	-1.255	0.677	3.437	1	0.06	0.285
	Driving License	1.813	1.643	1.219	1	0.27	6.132
	Occupation	0.433	0.622	0.485	1	0.47	1.542
	Travel Distance	0.519	0.305	2.902	1	0.09	1.680

(a) The reference category is: Two wheeler
(b) Dependent variables :Travel mode
(c) Independent variables : All variables

Table 20: Model four correction classification (prediction).

Observed	Predicted				
	Two-wheeler	**Car**	**Auto Rickshaw**	**Public Bus**	**Percent Correct**
Two-wheeler	174	2	3	1	96.7%
Car	4	48	0	0	92.3%
Auto Rickshaw	3	0	27	5	77.1%
Public Bus	1	0	10	8	42.1%
Overall %	63.6	17.5	14.0	4.9	**89.9%**

Table 20 shows the classification of each case correction in the model. The overall percentage is 89.9%, which is almost the same percentage as in the fourth model. From the above five trails, we can get the below result.

VIII. MODELS RESULT

The above-developed models were the trial process based on input parameters to the software. The result of the software for each model attempt was discussed and analyzed one by one in each arranged table. Here, it is required to conclude the five models and select the optimized one for the city work trips model. After the selection of the appropriate model, the validation of that model will be carried out on the specified data for the validation. The following is the optimized table concluded from all models.

According to the optimization Table 21, each model fitting information is correct and to the criteria. The multinomial logistic model says that the null model fitting value should be greater than the final model. The difference between these two models is given as the chi-square value. The chi-square value is described by Sig. value. The Sig. value shows that in each model the final model is the statistically accurate model and our alternative hypothesis is accepted. The next column is pseudo R- square values. The software will give us three values: Cox and Snell, Nagelkerke, McFadden. All these values are mentioned in each model respectively. Our concerned value is Nagelkerke. This value explains the falls of data. Whenever the variables increase simultaneously the value will be increased. As we have in the optimization table in each model is having more variables, the value of Nagelkerke is increased.

The likelihood ratio test column was explained in each model section. Here, in the table shows those four top models parameters contribute meaningfully except last model some parameters. The model classification correction is also given by SPSS software. The highest of these five models is the fourth model with 90%, later on, is the fifth model. The first model has the lowest percentage 73.8%. The correction of model percentage is shown in following the figure. Now, the comparison between all these trailed models can be analyzed as: The fourth model with parameters of travel time, travel cost as generic variables and age, income, vehicle variables as socio-economic variables are important parameters for the model. These all variables contribute significantly and the p-value is also lesser than 0.05 cut off value. The percentage of prediction is 90% percent and is the highest among all. In the end, we can conclude that the fourth model is an accurate and satisfactory model for the city motorized transport for work trips. The fourth model decision is taken concerning the pseudo R- square, likelihood ratio test, model fitting information, and more importantly the model percentage correction is higher than every model. The validation of the model will be done for this fourth model for further accuracy and authentication purposes for the specific data separated for it.

Table 21: Optimization table for developed models.

Model	X	Model fitting information	R^2	Likelihood Ratio Test	Correction %
1st	TT, TC	(473.631) intercept, (260.05) final model	0.601	Each element contribute meaningfully to the final model	73.8
2nd	TT,TC,TD	(561.03) intercept (332.77) final model	0.629	Each element contribute meaningfully to the final model	76.2
3rd	TT, TC, TD, Age, income	(594.07) intercept, (321.117) final model	0.703	Each element contribute meaningfully to the final model	81.1
4th	TT, TC, Age, Income, vehicle ownership	(594.070) intercept, (128.473) Final model	0.896	Each element contribute meaningfully to the final model	90
Last	All	(261.495) intercept, (97.576) final model	0.919	Some elements contribute meaningfully to the final model and few are not	89.9

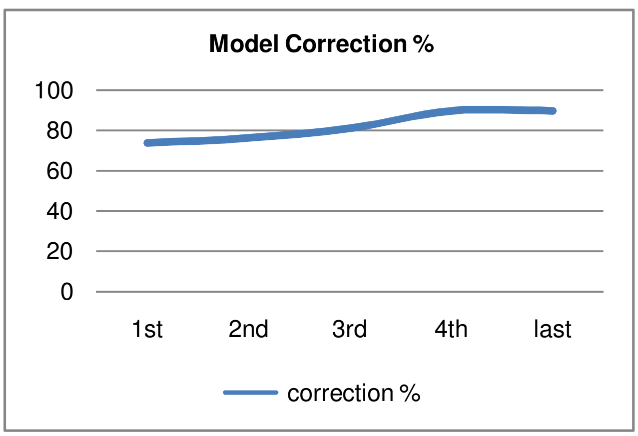

Fig. 2. Model correction graph.

IX. MODEL VALIDATION

Model validation was already considered a very important phase to evaluate the accuracy and performance of the model. It is a prime objective is to assure the ability of modal split prediction for the data other than calibration. The test for validation was conducted for 124 observations which are 30% of the whole data. This test was preceded for model fourth. The validation model result is statistically accurate, the null model value (261.495), and the final model is (79.57). Model fitting information is statistically significant (p= 0.00) for chi-square value of 181.92. The Nagelkerke value is 0.876, this means 87.6% data falls in the validated model. According to the likelihood ratio test, all the parameters in the model (travel time, travel cost, income, age, vehicle ownership) are affecting and important for the model. The correction percentage is given in the below table.

.**Table 22: Model four correction classification (prediction).**

Observed	Predicted				
	Two-wheeler	**Car**	**Auto Rickshaw**	**Public Bus**	**Correction %**
Two-wheeler	73	1	3	0	94.8%
Car	2	17	0	0	89.5%
Auto Rickshaw	2	0	18	0	90.0%
Public Bus	1	0	4	3	37.5%
Overall %	62.9	14.5	20.2	2.4	**89.5%**

The overall percentage of prediction is 89.5%. The fourth model has 90%. The difference is very less. This means that our fourth model can predicate very well.

X. CONCLUSION

In this paper an attempt made to develop a model that evaluate mode share of commuters for work trips. Total five different models were developed using various parameters. Accuracy was checked for each model and best model was selected for analysis of mode share for work trips. It may be concluded that almost 89%commuters are utilizing motorized traffic and the remaining 11% is non-motorized traffic in the city. Travel time, travel cost, age, income, and vehicle ownership are the main factors affecting the mode utilization by commuters to workplaces. These factors were assessed by developing the multinomial logistic model for regular trips of the commuters. The model is 90 % percent accurate and convincing to the work trip makers. This model was decided after five trails (models) by favorable conditions related to each model predication correction and accuracy percentage that is specified in each trail. The calibrated model is validated too which fits enough. The evaluation of travelers' behavior indicates that55.6% trip makers travel by two-wheeler to work and 14.8%, 12.1%, 5.5% travel by car, auto-rickshaw, and public bus respectively.

XI. FUTURE SCOPE

Mode choice model is not only limited to work trips in a city similar models can be developed other than workplace trips. This work can be used to assist the mode choice model for intercity, recreational, shopping, and study trips in Vadodara city. The study will be helpful for future evaluation in other relevant smart developing cities.

Conflict of Interest. The authors confirm that there are no known conflicts of interest associated with this publication of this paper.

REFERENCES

[1]. Essam, A., Sadi, A., (2013). Factors affecting mode choice of work trips in developing cities –Gaza as a case study. *Journal of Transportation Technologies,* 247-259.

[2]. Al-Ahmadi, H. M. (2006). Development of intercity mode choice models for Saudi Arabia. *Engineering Sciences*, *17*(1), 3-21.

[3]. Ding, L., & Zhang, N. (2016). A travel mode choice model using individual grouping based on cluster analysis. *Procedia engineering*, *137*(1), 786-795.

[4]. Elharoun, M., Shahdah, U. E., & El-Badawy, S. M. (2018). Developing a Mode Choice Model for Mansoura City in Egypt. *International Journal for Traffic & Transport Engineering*, *8*(4), 528-542.

[5]. Zenina, N., & Borisov, A. (2011). Transportation Mode Choice Analysis Based on Classification Methods. *Scientific Journal of Riga Technical University Computer Science. Information Technology and Management Science*, *45*(1), 49-53.

[6]. Ram, C., Sen, S., & Sudip, K, R. (2016). Mode choice modeling of work trips.A case study of Kolkata. Proc. of the 4th *international conference on advances in civil, structural, and environmental engineering.*

[7]. Ortuzar, J., & Willumsen, L. G. (2011). Modeling transport. John Wiley & Sons.

[8]. Richarson, A. J. (2003). Creative thinking about transportation planning. Proceeding of the 82nd annual meeting of the transportation research board.

[9]. Sreerag, S. R. Sachdeva, S. N., & Shameem, S. (2016). Mode choice modeling for work trips in Thiruvanthruram city. *Journal of Basic and Applied Engineering Research*, *3*(4), 381-384.

[10]. Sven, M., Stefan, T., & Knut, H. (2008). Travel to school mode choice modeling and patterns of school choice in urban areas. *Journal of Transport Geography, 16*, 342-357.

[11]. Juremalani, J., & Chauhan, K. A. (2017). Comparison of Different Mode Choice Models for Work Trips Using Data Mining Process. *Indian Journal of Science and Technology*, *10*, 1-3.

[12]. Minal, C. H. & Sekhar, R. (2014). Mode choice analysis. *International Journal for Traffic and Transport Engineering, 15m* 269-285.

[13]. Zailinawati, A. H., Peter, S., & Danielle, M. (2006). Doing a pilot study. *Malaysian Family Physician, 12*, 70-74.

[14]. Prasad, B., & Kumar, M. (2018). Development of the mode choice model of a trip maker for Hyderabad metropolitan city. *International Journal of Engineering & Technology, 11*, 1-7.

[15]. Arnab, J., & Varun, V. (2016). Analyzing mode choice for inter-regional travel in India. *Transportation Research Procedia, 9*, 5220–5234.

[16]. Faizi, A. J., Jayesh, J. R., Sanket, B., & Juremalani, D. (2019). A critical appraisal om mode choice model for work trips. *International Journal of Advanced Engineering & Technology, 9*, 1766-1760.

[17]. Faizi, A. J., & Jayesh, J. R. (2020). Developing of mode choice model for regular trips based on the pilot study. *International Journal of Engineering Applied Science and Technology, 4*, 153-158.

[18]. Juremalani, J. R. (2020). Assessment of Urban Accessibility for Mix Land-Use Neighbourhoods using Travel Behaviour Pattern. Ph. D. Thesis SVNIT, Surat, Print.

[19]. Prasad, B., & Molugaram, K. (2018). Development of mode choice models of a trip maker for Hyderabad metropolitan city. *International Journal of Engineering & Technology, 7*, 1-7.
[20]. Asgari, H., Zaman, N., & Jin, X. (2017). Understanding immigrants' mode choice behavior in Florida: analysis of neighborhood effects and cultural assimilation. *Transportation research procedia*, *25*, 3083-3099.
[21]. Vidana-Bencomo, J. O., Balal, E., Anderson, J. C., & Hernandez, S. (2018). Modeling route choice criteria from home to major streets: A discrete choice approach. *International journal of transportation science and technology*, *7*(1), 74-88.
[22]. Schwab, J. A. (2002). Multinomial logistic regression: Basic relationships and complete problems. http://www.utexas.edu/courses/schwab/sw388r7/Solving Problems/.

How to cite this article: Javeed, F. A., Juremelani J. R. and Sanket, B. (2020). Evaluation of Commuters' Travel Behavior under Mix Traffic Condition: A Case Study of Vadodara City. *International Journal on Emerging Technologies*, *11*(3): 777–791.