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Modeling Passenger Mode Choice in Tiruchirappalli City: A Regression Analysis Using Stated Preference Data

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Abstract - The choice of transportation by passengers is vital for urban transportation forecasting and planning in any city. Mode choice represents the third stage in the planning process and significantly influences a traveler's decision-making. Predicting future travel demand relies on modal shares. To analyze mode choice in a city, the efficiency of passenger travel in urban areas is considered. This study examines the behavior of travelers when selecting a mode for various types of trips in Tiruchirappalli city. The evaluation involves the characteristic features of travelers and uses household survey data collected from the Tiruchirappalli Corporation areas, as well as from bus and railway stations, to gather information on intercity travel between Tiruchirappalli and Chennai. The survey was conducted on both weekdays and weekends. A mode choice model was developed using SPSS and NLOGIT 3.0 software, with multinomial logistic regression applied to analyze the mode choice behavior of travelers and their selected modes for intercity travel in Tiruchirappalli city. This investigation utilized Spearman's correlation, multinomial logistic regression analysis, and the Likelihood Ratio test to identify the preferred mode choice of passengers in Tiruchirappalli. The SPSS analysis concluded that for intercity travel, a higher percentage of passengers from Tiruchirappalli prefer buses over trains. The NLOGIT software tool was used to model work trips, shopping trips, and educational trips, evaluating mode choice across different trip purposes. Based on the characteristics of trip frequency and the purpose of the journey, bus travel emerged as the most popular choice among passengers for intercity travel, compared to trains in Tiruchirappalli.

Keywords— Mode choice analysis, Logistic regression, Multinomial logit model, Passenger opinion survey, Correlation for mode chosen, Analysis of travellers' choice.

Introduction

For an urban city the planning methods should leads pathway to sustainable developments in transport planning and ensuring accessibility for all individuals. The residents are connected

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with employment, public service, all kinds of infrastructure facilities are based on the transportation system with cost and time effective. Nowadays, urban areas transportation is extremely intricate because of the several modes involved, based on the quantity and variety of traffic. For this purpose, we need to know what all are the shares of each transportation mode. In the stages of transportation planning process, Mode choice in the third stage in forecasting the future trips with modelling. A trip maker may have different solutions according to their socio-demographical, qualitative and psychological factors. A trip maker comes with a choice out of different available options [1]. Mode Split is the distribution of the overall trips generated among the various available travel modes. It determines the proportion or the percentage of people using a mode of transport as a part of their journey. And also, the trips made in urban areas by the passenger gives impact in the system and it influence the parameters related for planning [2].

Mode choice models constructed based on the passenger's choice of travel modes with the preference of transport to take, e.g. car, public transport or whatever. In the model, the input variables were chosen based on the traveler's usage of mode in proportion with available modes for that particular trip. In the field of travel demand modeling, mode choice is disputably the most significant parameter in identifying the number of vehicles on roadways. The use of transit with more occupancy vehicle modes leads to more efficient use of the roadway infrastructure and less traffic congestion as compared to the use of single-occupancy vehicles. In this, most of the urban trips travel decision is based on the choice of modes by the passengers. This research is intended to find out the travel characteristics of trip makers of Tiruchirappalli city [3]. The modes trips are classified like work, shopping, religious and Educational trips. After understanding the traveler's needs and preferences only we can predict the future travel demand of the city. Understanding the trip behavior can further be used for modeling.

2.Study Area

Tiruchirappalli City Corporation has been chosen as study area for this study which has 65 wards among the four zones of the urban areas. The zones are Aryamangalam, Ponmalai, Srirangam and Abhishekapuram. Figure 1 shows the map of Tiruchirappalli city corporation limits

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Figure 1: Tiruchirappalli City map

Tiruchirappalli, is located on the river cavery with latitude and longitude of 10.7905° N, 78.7047° E. This city is filled with ancient monuments and temples. Tiruchirappalli is the fourth largest town of Tamil Nādu and famous for worship pilgrims. It is located in southern portion of Tamil Nadu with 322 kilometres from Chennai and north direction covers Kanyakumari, Tiruchirappalli sits almost at the geographical centre of the state. The most commonly used modes of Tiruchirappalli are accounted for the study including the state public transport. The main objective of choosing this city as study area because of its development towards transport facilities for passenger facilities [13].

3 Data Collection and Analysis

The data collection was carried using home interview survey in the wards of Trichy Corporation. The standard method of collection of data from the household in the wards represent of Trichy Corporation. About 1% samples were taken from each ward. A simple random sampling technique is used in data collection. The analysis of data has been preferred on statistical method using SPSS and Nlogit software [14]. The modals were generated for individual trips and based on socio economic characteristics and the long trips.

3.1 Characteristics of mode choices

Table 1 reveals the characteristics of modes considered for data collection to evaluate the choice of passenger [15]. The questionnaire is prepared manually based on the literature, which is then collected in bus stands and railway stations of the selected places by means of person-to-person interview. These collected data are converted into softcopy by using spreadsheet. From

the spreadsheet the data are converted in different format in diverse platforms [16] to identify the passenger's choice of travel.

Table 1 Characteristics of mode choices

S.No	Parameters	Options
1	Modal choices available for intercity travel	2-Wheeler Auto Bus Car Flight Taxi Train
2	Mode used to reach Origin and Destination of the Trip	Walk Bus Auto Car Taxi 2-Wheeler Others (mention)
3	Mode Choice - Reason	Economy Fast Comfortable Others (mention)
4	Trip Frequency	Daily weekly Monthly Occasionally
5	Journey-Purpose	Work Business Education Social and Recreation Tourism Others
6	Journey Details	Journey Time (expected) Trip Distance (Km) Trip cost
7	Personal details (if willing to share the information)	Name and Age Education Level Job Details Monthly Income

The questionnaire framed for the information regarding the starting place and ending place of the trip, mode used for the trip, travel time, present expenditure, etc. The passenger willing to shift the current mode of travel to other existing modes with expense was investigated. Also, the

requirements of additional facilities or systems like nonstop buses, trains and centralized monitoring facility. The collected data are tabulated in Table .2 by considering majorly about trip frequency, reason for mode choice and purpose of journey [17].

3.2 SPSS analysis for Intercity travel

In this study, SPSS tool is one of the statistical tool used for identification of passenger trips based on their trip frequency and purpose of journey. In addition to that socio economic characteristics are also considered for constructing the model [18]. In this spearman's correlation has been checked for the collected data. The study has one dependent variable and multiple in dependent variables so that Multinominal Logistic regression analysis has been done to identify the preferred mode choice of Tiruchirappalli passenger [19].

3.2.1 Spearman's Correlation

The correlation between mode chosen by the passengers i.e. Bus and Train, trip frequency, Reason for this mode choice, purpose of journey and educational level were correlated using Spearman's test. Spearman's rho is used for ordinal data. It is a non-parametric test. In this analysis, Null hypothesis is represented as H0 and H1 as alternate hypothesis or research hypothesis. The results of correlation were tabulated below in the table 2.

There was a significant positive correlation between the mode chosen versus trip frequency and purpose of journey as rs (trip frequency) =0.19, p<.001, rs (purpose of journey) =.25, p<. 001.In case of reason for this mode choice and educational level there was a negative correlation as rs (Reason for mc) =-.16 and rs (Educational level) = -. 05, p<. 001.

The correlation between trip frequency versus all other variables, it shows positive correlation for mode chosen, purpose of journey and educational level as rs (mode chosen) = 0.19, p<.001, rs (purpose of journey) =.20, p<. 001and rs (Educational level) = -.13. There was a negative correlation for rs (Reason for mc) =-.14, p<.001.

Table 2: Correlations

Spearman's rho		Mode chosen	Trip Frequency	Reason for this Mode Choice	Purpose of Journey	Educational level
Mode chosen	Correlation Coefficient	1.000	.195**	-.167**	.250**	-.054*

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	Sig. (2-tailed)	.	.000	.000	.000	.028
	N	1677	1677	1677	1677	1676
Trip Frequency	Correlation Coefficient	.195**	1.000	-.144**	.209**	.013
	Sig. (2-tailed)	.000	.	.000	.000	.591
	N	1677	1677	1677	1677	1676
Reason for this Mode Choice	Correlation Coefficient	-.167**	-.144**	1.000	-.168**	-.001
	Sig. (2-tailed)	.000	.000	.	.000	.980
	N	1677	1677	1677	1677	1676
Purpose of Journey	Correlation Coefficient	.250**	.209**	-.168**	1.000	-.010
	Sig. (2-tailed)	.000	.000	.000	.	.691
	N	1677	1677	1677	1677	1676
Educational level	Correlation Coefficient	-.054*	.013	-.001	-.010	1.000
	Sig. (2-tailed)	.028	.591	.980	.691	.
	N	1676	1676	1676	1676	1676

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation between Reason for this mode choice(mc) versus all other variables, it shows negative correlation for mode chosen r_s = -0.16, trip frequency r_s =-0.14, purpose of journey r_s = -0.16, and educational level r_s = -0.001, as p<.001 [20].

The correlation between Purpose of Journey versus all other variables, it shows positive correlation for mode chosen rs = 0.25, trip frequency rs =0.20. The negative correlation between Reason for this mode choice(mc)r_s = -0.16, and educational level r_s = -0.10, as p<.001.

The correlation between educational level versus all other variables, it shows positive correlation for trip frequency r_s =0.13.and the negative correlation for mode chosen r_s = -0.05, Reason for this mode choice(mc)r_s = -0.001, and purpose of journey r_s = -0.01, as p<.001.

Since we are accepting the alternate hypothesis H1. Based on the spearson's correlation values, the variables of mode chosen has less significant value i.e., <0.05. which concludes that rejecting null hypothesis.

3.3 Multinominal Logistic regression

In Multinominal Logistic regression the dependent variable should be nominal data or ordinal data based on that the input for analysis is given as bus and train [21]. In covariates the continuous variables such as age and monthly income are given [39].

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H0 – There is no significant impact in the mode chosen on the age , income level and educational level.(null hypothesis)
H1 – There is significant impact. (Alternate hypothesis)
The input parameters are listed in the table 3

Table 3.Case Processing Summary

		N	Marginal Percentage
Trip Frequency	Bus	1045	62.4%
	Train	631	37.6%
	Daily	33	2.0%
	weekly	295	17.6%
	Monthly	663	39.6%
	Occasionally	685	40.9%
Reason for this Mode Choice	cheap	230	13.7%
	Fast	338	20.2%
	Comfortable	939	56.0%
	Others	169	10.1%
Purpose of Journey	Work	409	24.4%
	Business	385	23.0%
	Education	290	17.3%
	Social and Recreation	59	3.5%
	Tourism	123	7.3%
	Others	410	24.5%
Educational level	School	35	2.1%
	Diploma	501	29.9%
	UG Degree	524	31.3%
	PG Degree	517	30.8%
	5	99	5.9%
Mode used to reach origin	Walk	95	5.7%
	Bus	711	42.4%
	Auto	243	14.5%
	car	191	11.4%
	Taxi	172	10.3%
	Two wheeler	254	15.2%
	others	10	0.6%

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	Walk	87	5.2%
	Bus	1191	71.1%
	Auto	94	5.6%
Mode used to reach destination	car	75	4.5%
	Taxi	73	4.4%
	Two wheeler	155	9.2%
	others	1	0.1%
Valid		1676	100.0%
Missing		1	
Total		1677	
Subpopulation		1631[a]	

a. The dependent variable has only one value observed in 1622 (99.4%) subpopulations.

3.3.1. Step Summary

In Forward Entry method only that interaction which are significant will appear in the result. The chi-square value is based on likelihood ratio test. Here the variables V9-monthly income, V10-Gender and V11- Age were not significant and the Trip frequency (V4), Reason for this mode choice (V5) and Purpose of journey (V6) were significant. In Table 4, the chi-square statistic of V4*V6 (306.918, $p<0.05$) and V4*V5(68.876, $p< 0.05$) were significant, indicating that this interaction has a significant effect on the mode chosen by the passenger.

Table 4: Step Summary

Model	Action	Effect(s)	Model Fitting Criteria	Effect Selection Tests		
			-2 Log Likelihood	Chi-Square[a]	df	Sig.
0	Entered	Intercept, V10, V9, V11	2116.324	.		
1	Entered	V4 * V6	1809.406	306.918	22	.000
2	Entered	V4 * V5	1740.530	68.876	12	.000

Stepwise Method: Forward Entry

a. The chi-square for entry is based on the likelihood ratio test.

3.3.2 Model fitting Information

The model fitness was assessed using Chi-square statistic. The Chi-square value was 467.092 as shown in table 5 and the p-value was less than 0.05. This proves that there is a

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significant relationship between the dependent variable mode chosen and the independent variables such as trip frequency, Reason for this mode choice, purpose of journey and educational level in the final model. The Pseudo R-square measures are Cox and snell (0.243), Nagelkerke's (0.331)and McFadden (.210). The model accounts for 21% to 33.1% of the variance and represents relatively good sized effects [22].

Table 5:Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	2207.622			
Final	1740.530	467.092	37	.000

3.3.3 Likelihood Ratio test

The likelihood ratio test proves that the independent or predictor variables like Gender, Trip frequency (V4), Reason for this mode choice (V5) and Purpose of journey (V6) were significant, which proves that these predictors contribute significantly to the final model as shown in table 6.

Table 6: Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	1740.530[a]	.000	0	.
V10	1741.533	1.003	1	.317
V9	1821.387	80.857	1	.000
V11	1742.514	1.984	1	.159
V4 * V5	1809.406	68.876	12	.000
V4 * V6	1940.351	199.821	19	.000

Based on the parameter estimates given in table 7, the mode chosen bus has more respondent with reference to train. Among the independent variables of V9-monthly income, V10-Gender and V11- Age, V9-montly income has more significant which has the value of less than 0.05 and increases 1.784 times of the passenger mode choice based on their monthly income whereas gender and age are less significant when compared with it [23].

Table 7:Parameter Estimates

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Mode chosen		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Bus	Intercept	-.412	.610	.456	1	.499			
	V10	-.147	.147	1.005	1	.316	.863	.648	1.151
	V9	.579	.066	76.506	1	.000	1.784	1.567	2.031
	V11	.077	.055	1.979	1	.159	1.080	.970	1.204
	[V4=1] * [V5=1]	-39.209	8250.068	.000	1	.996	9.372E-018	.000	.[b]
	[V4=1] * [V5=2]	-38.444	.000	.	1	.	2.014E-017	2.014E-017	2.014E-017
	[V4=1] * [V5=3]	-20.099	7529.898	.000	1	.998	1.867E-009	.000	.[b]
	[V4=1] * [V5=4]	-.466	1.272	.134	1	.714	.628	.052	7.601
	[V4=2] * [V5=1]	-2.578	.705	13.386	1	.000	.076	.019	.302
	[V4=2] * [V5=2]	.121	.743	.027	1	.871	1.129	.263	4.846
	[V4=2] * [V5=3]	-.850	.617	1.897	1	.168	.428	.128	1.433
	[V4=2] * [V5=4]	-.388	.797	.237	1	.626	.679	.142	3.233
	[V4=3] * [V5=1]	-2.916	.648	20.253	1	.000	.054	.015	.193
	[V4=3] * [V5=2]	-2.040	.607	11.296	1	.001	.130	.040	.427
	[V4=3] * [V5=3]	-1.838	.586	9.839	1	.002	.159	.050	.502
	[V4=3] * [V5=4]	-2.063	.646	10.193	1	.001	.127	.036	.451
	[V4=4] * [V5=1]	-2.140	.544	15.481	1	.000	.118	.040	.342
	[V4=4] * [V5=2]	-1.679	.540	9.663	1	.002	.187	.065	.538
	[V4=4] * [V5=3]	-1.962	.521	14.198	1	.000	.141	.051	.390
	[V4=4] * [V5=4]	0[c]	.	.	0	.	.	.	.
	[V4=1] * [V6=1]	19.309	7529.898	.000	1	.998	243060185.319	.000	.[b]
	[V4=1] * [V6=3]	56.139	8247.903	.000	1	.995	2404400226146432200000000.000	.000	.[b]
	[V4=1] * [V6=4]	18.006	.000	.	1	.	66069727.827	66069727.827	66069727.827
	[V4=1] * [V6=5]	-.151	11703.605	.000	1	1.000	.860	.000	.[b]
	[V4=1] * [V6=6]	0[c]	.	.	0	.	.	.	.
	[V4=2] * [V6=1]	.906	.472	3.677	1	.055	2.474	.980	6.247

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[V4=2] * [V6=2]	1.779	.492	13.104	1	.000	5.927	2.261	15.533
[V4=2] * [V6=3]	.670	.417	2.579	1	.108	1.954	.863	4.425
[V4=2] * [V6=4]	.749	.752	.990	1	.320	2.114	.484	9.235
[V4=2] * [V6=5]	1.275	.822	2.403	1	.121	3.577	.714	17.921
[V4=2] * [V6=6]	0[c]	.	.	0	.	.	.	.
[V4=3] * [V6=1]	2.333	.315	54.730	1	.000	10.312	5.557	19.134
[V4=3] * [V6=2]	1.544	.294	27.581	1	.000	4.685	2.633	8.336
[V4=3] * [V6=3]	2.198	.365	36.305	1	.000	9.009	4.407	18.418
[V4=3] * [V6=4]	20.090	2999.870	.000	1	.995	530776311.242	.000	.[b]
[V4=3] * [V6=5]	1.823	.465	15.380	1	.000	6.188	2.489	15.387
[V4=3] * [V6=6]	0[c]	.	.	0	.	.	.	.
[V4=4] * [V6=1]	1.197	.241	24.704	1	.000	3.309	2.064	5.305
[V4=4] * [V6=2]	.254	.258	.971	1	.325	1.289	.778	2.138
[V4=4] * [V6=3]	.762	.250	9.292	1	.002	2.142	1.312	3.495
[V4=4] * [V6=4]	20.029	3511.162	.000	1	.995	499282761.778	.000	.[b]
[V4=4] * [V6=5]	1.917	.312	37.643	1	.000	6.799	3.686	12.543
[V4=4] * [V6=6]	0[c]	.	.	0	.	.	.	.

a. The reference category is: Train.

b. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

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

Similarly Trip frequency (V4) has been compared with reason for this mode choice (V5) and Purpose of journey (V6). In V4*V5 analysis, there was less significant i.e p value greater than 0.05 and accept the alternate hypothesis. Trip frequency increases 1.129 times as the reason for mode choice varies. Hence it has positive significant and accepting the alternate hypothesis shows bus are mostly used mode among the peoples of Trichy. In case of V4*V6 combination, there was a significant positive correlation and the p value is less than 0.05 and hence accepting the null hypothesis. Trip frequency increases 5 to 6 times when we considered purpose of journey and shows highly correlated with the variables. From this SPSS analysis, it concludes for intercity travel the mode chosen by passengers of Tiruchirappalli are bus in higher percentage when compared with train.

4 Development of Mode Choice Models using Nlogit Software

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4.1 Modeling of Work Trips

The modeling of work trips for Tirchy city were shown in table 8 with the effects of the multinomial logit modeling. Model is formulated using personal and travel variables. The method of maximum likelihood estimation is considered with the coefficients of logit model. In developing model, the modes considered are two wheelers, bus, car, cycle for work trips. Two wheeler is considered as the base mode for alternate specific constant due to widely used mode for work trips[34]. The time and cost of travel coefficients have a negative sign indicating that as time and cost increases, less preferred. Both coefficients are statistically substantial at 95% confidence interval. Low income group's shows negative utility for personalized modes like two-wheeler and car [24]. Number of automobiles in the domestic has an optimistic influence on two-wheeler and car, while negative effects influence on bus and walk mode.

The possession of driving license positively influences the utility of personalized mode like car and two wheelers. Age group 21-30 has a confident influence on two wheelers and undesirable influence on car. Age group 41-50 has a optimistic influence on bus and undesirable utility for two wheelers. For work trips having distances less than 5 km shows positive utility for walk mode. But for distances greater than 5-10 km walk mode shows negative utility. For work trips having distances greater than 30km bus shows positive utility. Self-employed person's shows negative utility for bus mode [25]. Daily waged persons show positive utility for walk mode. Private employees show positive utility for private employees [35].

Table 8 Parameter estimates of Work trips

Variables	**Two wheeler**		**Bus**		**Car**		**Walk**		**Cycle**	
	Coefficient	**t-value**	**Coefficient**	**t-value**	**Coefficient**	**t-value**	**Coefficient**	**t-value**	**Coefficient**	**t-value**
Constant			-0.26	-0.48	-1.69	-2.19	0.95	1.55	-3.9	-3.15
Travel time	-0.04	-3.78	-0.04	-3.78	-0.04	-3.78	-0.04	-3.78	-0.04	-3.78
Travel Cost	-0.03	-2.07	-0.03	-2.07	-0.03	-2.07	-0.03	-2.07	-0.03	-2.07
Low income group	-1.49	2.16			-3.07	-2.16				

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Middle income group					-1.93	-3.41				
High income group					3.21	4.83				
No of automobiles	1.40	2.16	-2.85	-4.14	1.35	1.55	-0.74	1.92		
License	2.70	4.0			3.89	5.3				
Age 21-30	1.17	2.2			1.91	1.46				
Age 41-50	-1.11	-2.13	1.04	1.91						
Distance <5 km							1.98	2.16		
Distance 5-10 km							-3.02	-1.97		
Distance 10-20km					3.41	3.58				
Distance >30km			3.04	2.4						

The complete goodness of fit is tested by chi square test. Results are shown below.

About 1/3rd data is kept for validation.

Log likelihood of constants only model :240.37

Log likelihood of model :144.23

Chi-squared [46 df] :192.27 >71.20 (at 99.9% confidence)

ρ^2 :0.51

% correctly predicted : 75%

Based on the chi-square value 192.27 greater than the value of 99% confidence level with likelihood model. The predicted percentage for work trips are 75% with respect to the collected samples[36]. The results

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of work trips have coefficient of modes and their variables with t value are shown in the figure 2. The work trips have both the positive and negative value based on the time and distance travelled by the passenger in Tiruchirappalli city[37].

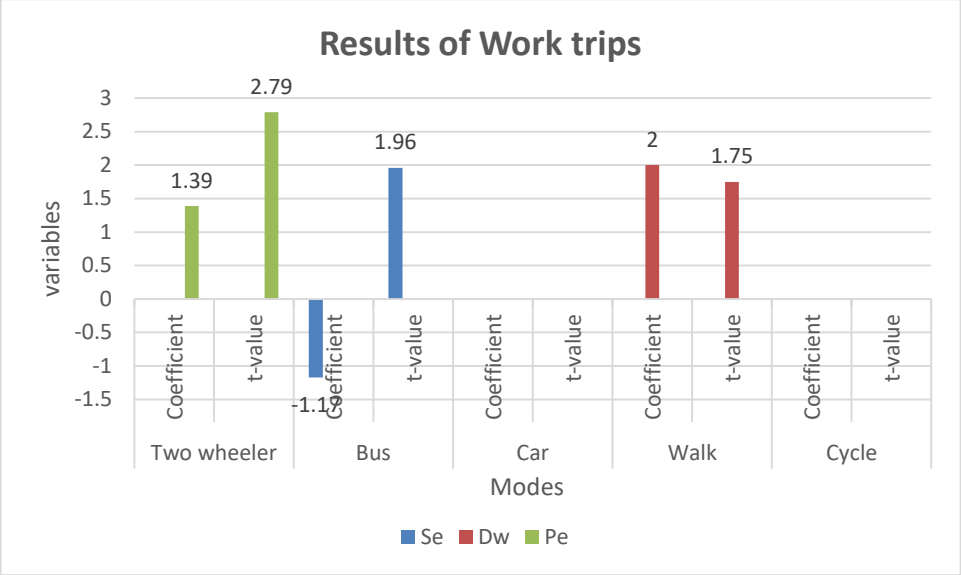

Figure 2: Results of Work trips

4.2 Modeling of Shopping Trips

Table 10 explains the outcomes of the multinomial logit modeling of shopping trips. Here walks mode is taken as the base for alternate specific constant. The choice set consists of two wheelers, bus, car, walk, auto and cycle [26]. The time taken for travel time and cost coefficients have a negative sign indicating that as time and cost increases, less preferred. Mutually the coefficients are statistically significant at 95% confidence interval. Number of automobiles has positive influence on two-wheeler mode and negative influence on walk mode. Government employees have a positive influence on two wheelers for shopping trips. While daily waged persons show more preference for walk mode. Presence of older people positively influences the utility of auto rickshaw mode. Low income groups showing positive utility for bus and walk mode and negative utility for car mode. Middle income groups showing more positive utility for bus and negative utility for car mode [27].

Table 10: Parameter estimates of shopping trips

Variables	TW	Bus	Car	Walk	Auto	Cycle

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	Coeff	t-value	Coeff	t-value	Coeff	t-value	Coeff	t-value	Coeff	t-value	Coeff	t-value
Constant	-1.86	-3.19	-2.76	-3.65	-3.99	-4.75			-3.37	-3.13	-4.08	3.08
Time	-0.11	-5.34	-0.11	-5.34	-0.11	-5.34	-0.11	-5.34	-0.11	-5.34	-0.11	-5.34
Cost	-0.02	-1.63	-0.02	-1.63	0.02	1.63	0.02	1.63	0.02	1.63	0.02	1.63
No of automobiles	2.94	1.87					-2.25	-1.73				
Govt.employee	2.80	1.97										
Daily waged							2.30	2.05				
Presence of older people							0.54	1.97				
Low income groups			1.60	1.88	-1.94	2.25	2.31	3.61				
Middle Income groups			1.33	1.58	-1.56	-2.53						
High Income groups			-1.49	-1.82			-1.79	-2.01				

The overall goodness of fit is tested by chi square test. Results are shown below. About 1/3rd data is kept for validation.

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Log likelihood of constants only model :-224.62

Log likelihood of model :-127.51

Chi-squared [48df] :194.21 >71.20 (at 99.9% confidence)

ρ^2 :0.54

% correctly predicted : 78%.

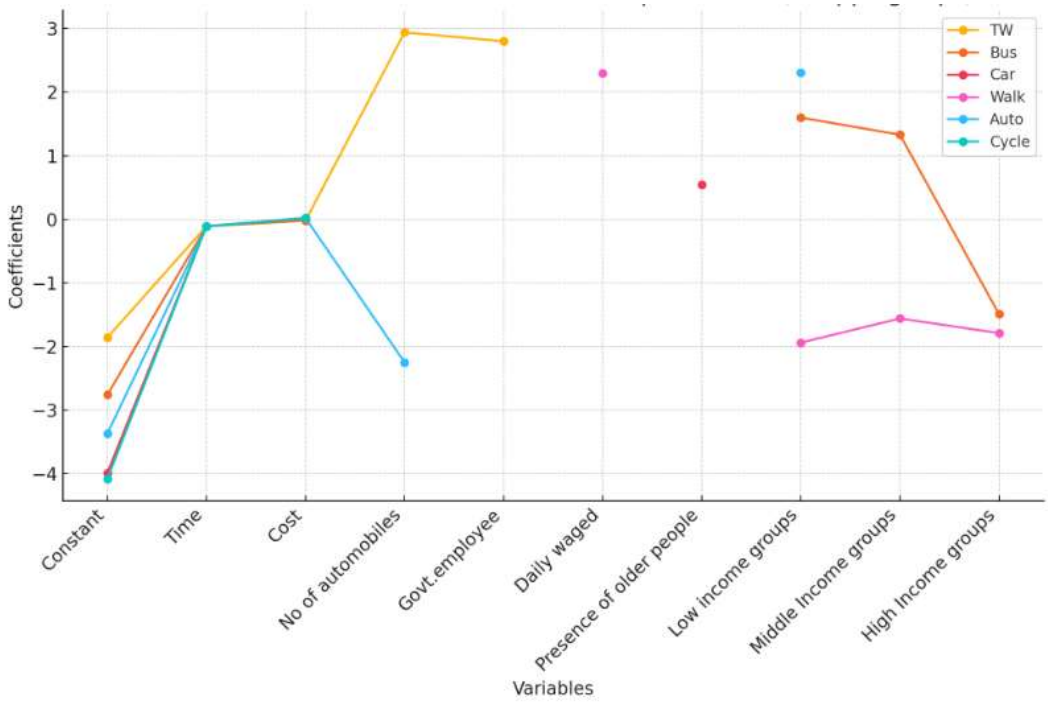

Figure 2a: Results of Shopping trips

Figure 2a provides insights into how various factors influence the choice of transportation modes for shopping trips.

- Time: The negative coefficients for time across all modes indicate that as travel time increases, the likelihood of choosing any transport mode decreases[38]. This reflects a general preference for quicker trips, which is consistent across all transportation options.
- Cost: The cost variable shows mixed effects. While it has a negative impact on choosing two-wheelers (TW) and buses, it surprisingly has a positive effect on cars, walking, autos, and cycling. This might suggest that people willing to pay higher costs for these modes see value in the convenience, comfort, or status associated with them.

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The results of shopping trip model fits in the overall goodness with chi-square value of 194.21 and the log likelihood model value as 127.51 in negative based on the input. The overall predicated shopping trips were 78% which is higher than the work trips. This analysis highlights that transportation choices for shopping trips are influenced by a combination of time, cost, income levels, and specific household characteristics. Affordability drives choices for lower-income groups, while comfort and convenience guide the preferences of higher-income groups and households with older members. Understanding these patterns is essential for tailoring urban transport policies to meet the diverse needs of different demographic groups.

4.3 Modeling of Educational Trips

Table 11 denotes the outcomes of the multinomial logit modeling of Educational trips. School bus taken as the base for alternative specific constant. The cost of travel and time are seeming to be negative. At 95% confidence level travel time is found to be significant, while travel cost is not significant[40]. This gives an indication that educational trips give more priority to travel time than travel cost. Students from low family income groups show a positive utility for walk mode. Students from a middle family income range show a negative utility for two-wheeler mode. Students from age group less than 10 shows a positive utility for Auto, School bus and two wheelers. Students from 10 to 13 age groups have a positive influence on school bus and auto. Students from age group greater than 18 show a positive utility for bus mode. For distances greater than 8 km bus mode is showing positive utility[41].

Table 11 Parameter estimates of Educational trips

Variables	**TW**		**Bus**		**Car**		**Walk**		**Auto**		**Cycle**		**Sb**		**Pv**	
	Coeff	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Constant	-0.74	-2.14	0.83	2.09	1.51	-2.05	2.52	3.77	-0.15	-1.35	0.38	0.64			-1.86	-2.48
Time	-0.09	-4.32	-0.09	-4.32	-0.09	-4.92	-0.09	-4.92	-0.09	-4.92	-0.09	-4.92	-0.09	-4.92	-0.09	-4.92

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Cost	-0.04	-1.75	-0.04	-1.75	-0.04	-1.75	-0.04	-1.75	-0.04	-1.75	-0.04	-1.75	-0.04	-1.75	-0.04	-1.75
Low income groups							2.52	1.75								
Middle income groups	-1.62	-1.72														
Age <10	2.29	2.05	-3.10	-2.47					3.40	2.82			3.32	3.03		
Age 10-13									3.43	2.38			3.08	2.29		
Age 14-17											2.25	1.99				
Age>18			2.18	2.83												
Distance >8km			2.93	2.31												

The overall goodness of fit is tested by chi square test. Results are shown below. About 1/3rd data is kept for validation.

Log likelihood of constants only model :-175.93 log
likelihood of model :-122.12
Chi-squared [44df] :107.62>68.71 (at 99.9% confidence)

ρ^2 :0.38

% correctly predicted : 67%

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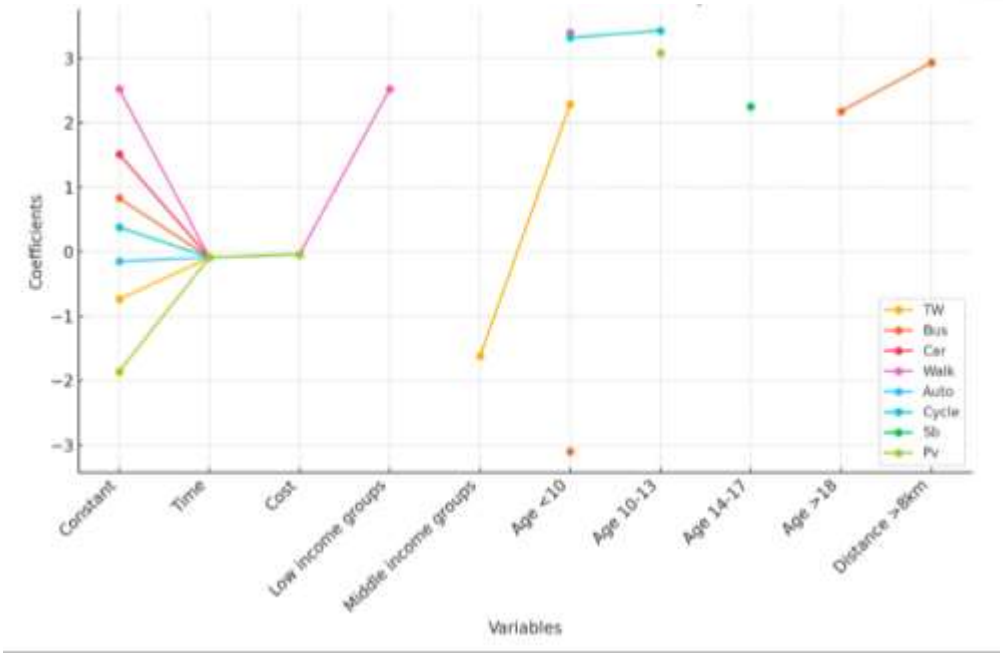

Figure 2b: Results of Educational trips

Figure 2b showing the coefficients of different variables for various transport modes. The lines represent the relationship between each variable and the corresponding transportation mode, with markers indicating the coefficient values[33]. The x-axis lists the variables, while the y-axis shows the coefficient values. The graph helps in understanding how different demographic and travel-related factors influence the choice of transport modes in an urban setting. For example, cost and time negatively affect all modes, but certain groups, like younger passengers or those from lower-income groups, have specific preferences that can inform transportation planning and policy-making.

As the model predicts that the result of educational trip in the city were 67% with the chi-square value of 107.62. Based on the results of these trips, educational trips are less when compared with shopping and works trips.

4.4 Mode Distribution of Trips

From the figure 3 the mode distribution of trips shows that 39% of trips were made by two-wheeler, 15% of the trips were made by bus, 23% of the trips were made by walk, 5% of the trips were made by auto rickshaw, and 11%, 3%, 3% of the trips were made by car, cycle and school bus respectively [28].

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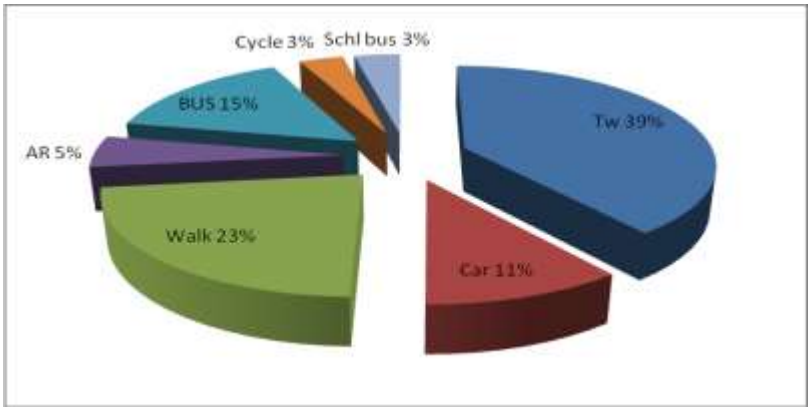

Figure 3: Mode wise Distribution of Trips

4.5 Mode Distribution of Work trips

Mode share of work trips is shown in figure 4[32]. It shows that mostly of work trips were made by two wheelers (49%) and Bus (23%). Proportion of trips made by walk, cycle, car, and auto rickshaw were 12%, 4%, 10% and 2% respectively [29].

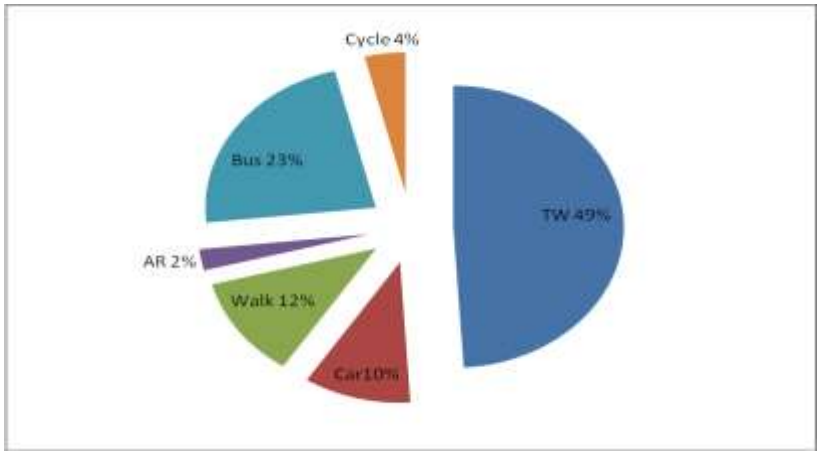

Figure 4: Mode Distribution of Work Trips

4.6 Mode Distribution of Educational Trips

Major mode share of educational trips in the selected study area is equally shared by school- bus (25%) and bus (25%) [30]. Other mode shares are two wheelers (21%), auto rickshaw (8%), cycle (8%) and walk (9%) as shown in figure 5.

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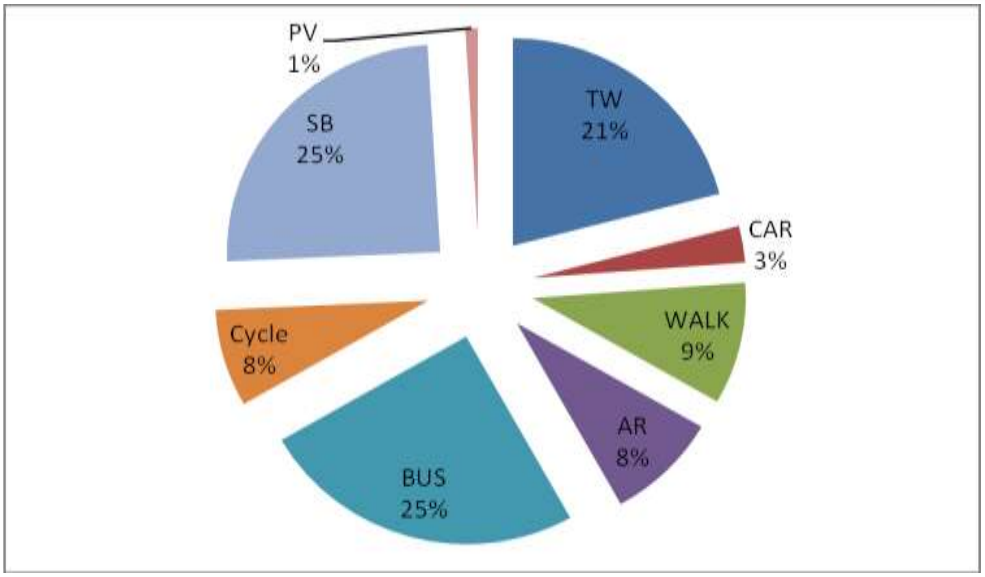

Figure 5: Mode wise distribution of Educational Trips

4.7 Mode Distribution of Medical Trips

Two Wheeler is the major mode share of Medical trips were shown in figure 6, other mode shares are walk (20%), auto (18%), car (16%), bus (7%), cycle (1%).

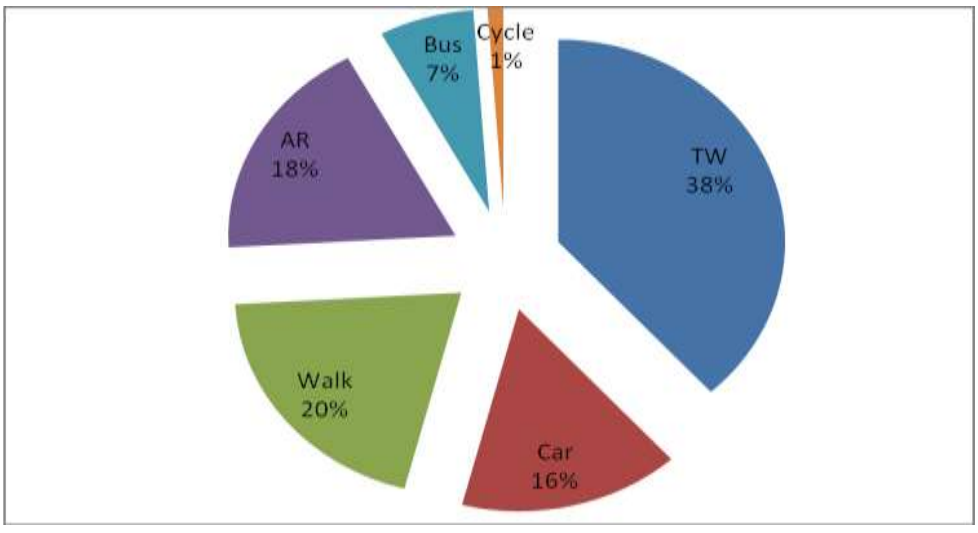

Figure 6: Mode wise Distribution of Medical Trips

5 SUMMARY AND CONCLUSION

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To identify the mode choice behavior of passenger for local trips and intercity trips of Tiruchirappalli city, the data were collected at different locations such as bus terminals, Railway terminals and in household areas. Data analysis was conducted to study the socio demographic attributes of the study area. Mode choice models for various categories of people were developed using Multinomial Logit Modeling. The main mode of work trips are two wheelers. Private employees showed more positive utility to two wheelers are compared to other modes. Among daily waged persons walk mode showed more positive utility [31]. Number of automobiles in the household has an adverse utility on public transport i.e bus and walk mode. For work trips of distances greater than 30 km, bus has shown more positive utility compared to other modes. Age group (21-30) has shown a positive utility on Two-Wheeler, (31-40) group shown positive utility on car mode and (41-50) age group shows negative utility for two wheelers and positive utility for bus mode. Walk and two wheelers are the major modes of shopping trips. Government employees show more positive utility to two-wheeler for shopping trips. While daily waged persons show more positive utility for walk mode. Presence of older people shows a positive utility for auto rickshaw

Low income groups show a positive utility for walk mode and negative utility for cars. Middle income group shows a positive utility for bus and negative utility for car. While high income group showing negative utility for both bus and walk mode. Major modes of educational trips are school bus, bus and two-wheeler. Monthly family income, distance, age are the influencing variables for educational trips. For Students having age less than 13, school bus and auto are their major mode. Major modes of religious trips are walk and two-wheeler. As we move from middle income to high income groups, people tend to rely more on cars for religious trips. But in the case of walk, mode share gradually decreases from lower to higher income groups. Major mode of medical trips is two-wheeler. Medical trips mainly consist of shared rides.

Tiruchirappalli city major mode share constitute of two-wheeler and walk mode. As distances increases bus mode becomes predominant compared to other modes. The reason for high modal share of walk is better accessibility to facilities. Type of Employment is the key factor in determining the mode for work trips. Mode choice of shopping trips are influenced by type of employment, number of automobiles, presence of older people and also the financial status of the family. For students having age less than 13, school bus and auto are the major modes. This may be because parents give more priority to comfort, convenience and safety than travel cost. Family income, distance, age group these are the key factors influencing mode choice for educational trips. The distance between home and school is found to strongly and negatively impact the choice of walking to and from school, with the impact being stronger for walking to school. Low income family students also shown a tendency to use walk as major mode compared to other modes. From the analysis of Nlogit, the predicted trips for shopping have higher 78% when compared with work and educational trips

For intercity travel the mode considered for study are bus and train. Among the modes, the passenger choices based on the educational level, trip frequency, purpose of journey were analyzed and identified that buses are most used modes for long distance from Trichy.

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