First and Last Mile Connectivity for Bus Line

Sachin Jhanwar[1], Rena N. Shukla[2]

[1]P.G. Research Scholar, [2]Associate Professor

[1,2] L.D. College of Engineering, Ahmedabad, Gujarat, India

[1]sachin.jhawar003@gmail.com, [2]renashukla@ldce.ac.in

Abstract: *Demand for the public transport sector in Indian cities is increasing continuously. The Government of India has offered a number of transport systems such as Mass Rapid Transit System (MRTS), Bus Rapid Transit (BRT), and Light Rail Transit (LRT) in every transport city to mark these demands. However, the connectivity of the first and last mile point is not designed properly, so public transport riders lag behind. The purpose of this study is to identify the mode preference behavior of passengers for first and last-mile travel for Ahmedabad BRTS users and to propose feeder transit for first and last-mile connectivity. The travel option model for first- and last-mile travel is determined using a multinomial logit model and a home interview survey. It also examines disparities in selection behavior between youth and other age groups. The results of this study may enhance bus line ridership and improve the physical environment for first-to-last-mile connectivity through intermediate para transit (IPT) such as walking, auto-rickshaws, and e-rickshaws (battery operated). Intermediate Para Transit (IPT) is a part of a holistic transportation service provider for services to align transportation routes and regulations, and perfect for improving an enterprise infrastructure for safe and personal riding for pedestrians.*

Keywords: **first and last mile connectivity, multinomial logit model, BRTS, Intermediate para transit, feeder**

1. INTRODUCTION

The rapid growth of India's urban population has put enormous strains on urban transport systems. It is triggering to grow travel demand in urban cities especially in mega and metropolitan cities. In particular, the Public transport has been completely overwhelmed. Most buses and trains are overcrowded, unreliable, slow, inconvenient, uncoordinated and dangerous. Like in the present-day metro system, which is overcrowded in certain sections and unable, to get estimated ridership in many other sections (Tiwari and Advani, 2005). By 2051, the population of India is expected to be 1.7 billion. The number of cities with a population of more than 50 million people is expected to double. There will be 15 cities with populations in excess of 10 million each and 85 cities with populations between 1 and 10 million apiece. That is the challenge India is confronted with. A recent study by India's Ministry of Urban Development (MOUD) indicates that daily trips in the top 87 urban centres are anticipated to more than double from 228 to 482 million in 24 years (2007-2031). Hence, improving public transport is a critical component to bring efficiency in the performance of the city's transport system, improve quality of life for the city's growing population and building city's economic competitiveness.

The continuing urbanization of India is driven by urban sprawl transportation motorized vehicles and consistent growth in demand for travel, leading to congestion, high fuel consumption, and greater inequality in access to transport. The total number of registered automobiles increased from about 0.3 million in March 1951 to 253 million as on 31st March 2017 (MoRTH).

Nowadays, Bus Rapid System (BRTS), Metros, Commuter Rail, even subway Lines are various types of public transportation systems that define cost, power, and technology, and several other aspects may include stop size, right-of-way reach, operating regimes, and guide procedures.

In some cities such as Quito, Bogota, Jakarta and Beijing, the system has been successfully carried out. The past record of the BRT makes a convincing argument for other cities to make this another transportation priority if analyzed in relation to economic, social, and environmental benefits. That BRT system becomes highly desirable in several emerging countries in Asia pacific, like India.

First and last-mile connectivity services are the backbone for public transport enabling passengers to easily use public transport or to get to the point of origin and destination. So many steps are taken by the government of India and different individual states of India (such as the National Urban Transport Policy (NUTP), the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) bus project, etc.). In recent times, improving public transport (PT) patronage and the Intermediate Para-Transit (IPT) scenario in the aim of meeting growing demand, However, the position of last-mile connectivity (LMC) is crucial in order to reach the aims of attracting preferred riders to the main transit. Across many cases, due to the absence of suitable Last mile connectivity, the main transits are not really efficient.

Table 1. BRTS Network in Indian Cities

Cities	Passengers per Day	Length km
Ahmedabad	130,000	82 km
Amritsar	60,000	31 km
Bhopal	77,289	24 km
Hubballi-Dharwad	90,000	22 km
Indore	45,500	11 km
Jaipur	6,622	7 km
Pune - Primpi-Chinchwad	67,000	29 km
Rajkot	7,500	11 km
Surat	13,500	10 km

2. METHODOLOGY

The aim of this research to provide the solution for the first and last-mile connectivity problem in our country, this issue related to public transit like BRT and Metro. Based on that we select Ahemadabad as a study area, selected area is Mansi circle, sola Bhagvat, Naroda, where people like to use the BRTS transit in our country, and its developing metropolitan city in India. Ahmedabad BRTS ridership lagging behind due to first and last mile problem this problem is continuously increasing because peoples are shifting into own vehicle. So many researchers provide a solution to increase BRT ridership in the first and last mile. They suggest cycling as a feeder mode in the first and last mile and formulate a multinational logistics model based on socio-demographic data. But in our research work, we include e-rickshaws as feeder mode to bridge the gap between the first and last mile. Based on the literature review, we prepare a standard questionnaire form for the collection of primary data, we collect data by home interview survey and ask questions to the household and person around the selected study area. We have collected a total of 513 household and individual's data. After the collection of data, we did a preliminary analysis. based on the preliminary analysis we understand the household size, Income group, age, gender, travel distance, travel time, travel cost, it's the most important factor for the prediction of a new mode of travel. we prepare a Multinomial logistic Model it is a combination of predictor variables. in our research work willingness to use feeder mode is dependent variables and sociodemographic characteristics are independent variables. These data were collected by the home interview survey. The analysis was done

on SPSS software. Once the model was prepared, based on the coefficient value we decide the people which feeder more likely to use, Accordingly, we proposed a feeder route or transit model in the QGIS software.

3. STUDY AREA AND DATA COLLECTION

In Mansi circle have three BRTS stations up to 1km radius from the central residential area in a 1 km area there is no network coverage of BRTS. due to the high fare and less frequency of shuttle, Peoples do not like to use BRTS. Sola Bhagwat is a developing area, in that area only one BRTS there on the SG highway. which is not connected inside the area where the residential zone is there. Naroda is the oldest area and has the last terminal of the BRTS line. In that surrounding area have a large density of the residential area, inside of that area have no network coverage to reach BRTS station. Jashoda Nagar BRTS station connects a road where the industrial area is, but on this road, there is no network coverage of BRTS so labour can reach their own destination but they pay the high fare shuttle. We collect the data at peak hour. According to Indian Census, 5% margin of error and for 95% confidence level, the minimum sample size was found to be approximately 384 by Cochran formula.

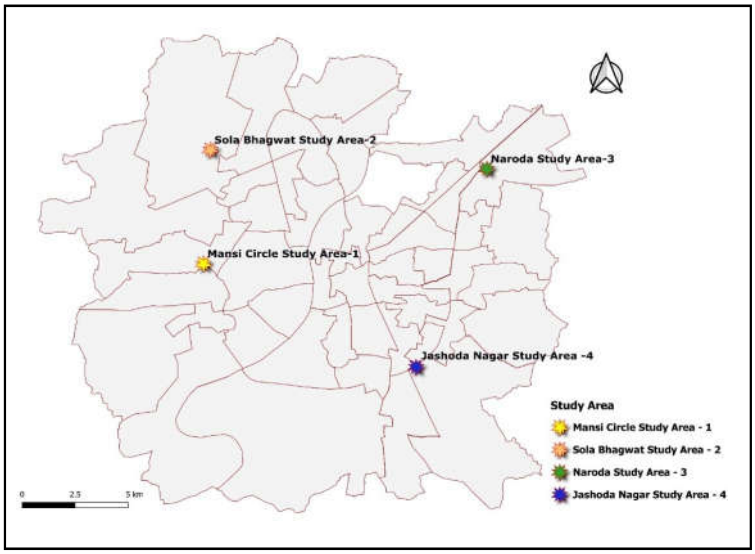

Figure 1. Study Area

4. PRELIMINARY DATA ANALYSIS

In the case study of BRTS Station in Ahmedabad district, a preliminary review of the coded data yielded a study of the deployment of E-Rickshaw as a feeder system of commuters. With respect to income distribution, age, vehicle ownership, and other factors, multiple inter graphs was developed. The following parts illustrate the findings of the study.

The questionnaire revealed data shown in the chart as shown below which is represent accordingly different study area.

Monthly income, car ownership, and household size are all important socioeconomic characteristics to consider. The data analysis revealed that the Economical Weaker

Section and Middle-Income group peoples are 23.2% and 39.2% respectively in Mansi circle which is a high percentage among all other study areas. The low-income group people are 50.4% and 41.6% respectively in Jashoda Nagar and sola Bhagavata. Nearly 38.4% of people have their LIG and MIG as per the analysis. The vehicle ownership result shows that 56.8 and 53.6% of people have 2W at Mansi circle and Jashoda Nagar respectively their own 2W which highest proportion of vehicle ownership. As per the survey, the household size observed as 76% households have >=5 members per household at Jahoda Nagar which is highest among the other study area while 32.8% have 4 members per household. Travel time analysis revealed that 36.8% of people are traveling daily up to 30-45 minutes at Mansi circle while 53.6% of respondents are daily traveling to 15-30 minutes at Sola Bhagwat. Travel distance-related questionnaire revealed that 53.6% and 48.8% of respondents have 6 to 10 km travel distance at sola Bhagavata and Mansi circle respectively. Willingness to use feeder related questionnaire revealed that 35.2 % of respondents use E-Rickshaw (up to 3 Rupees) at Mansi circle, 45.6% of respondents use E-rickshaw (up to 7 Rupees) at sola Bhagvat, 53.6% respondents to use E-rickshaw (up to 7 Rupees) which higher percentage among all other study areas. 40% of respondents use E-rickshaw (up to 7 Rupees) and 20.8%, respondents, use new BRTS relatively higher among the all-other study area.

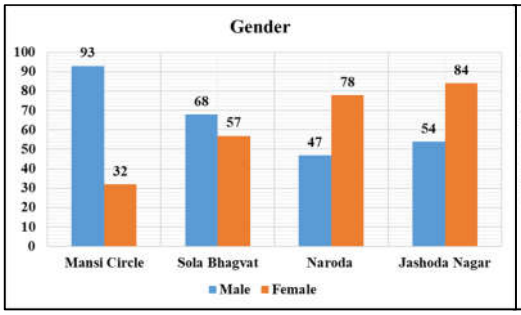

Figure 2. Trips Generation as per Gender

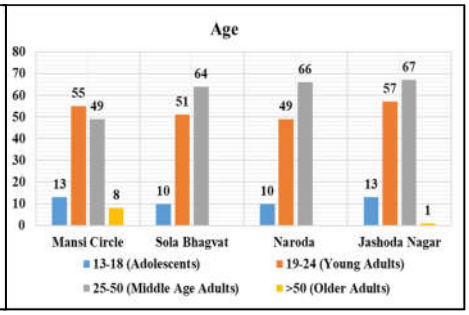

Figure 3. Age

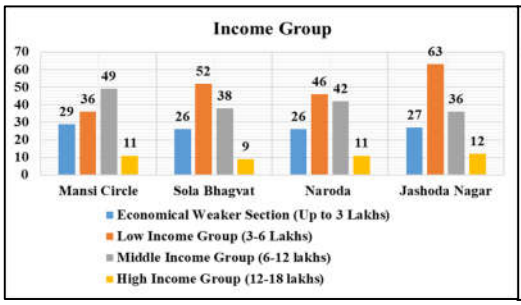

Figure 4. Income Group

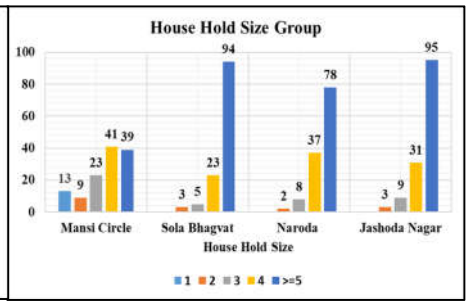

Figure 5. House Hold Size Group

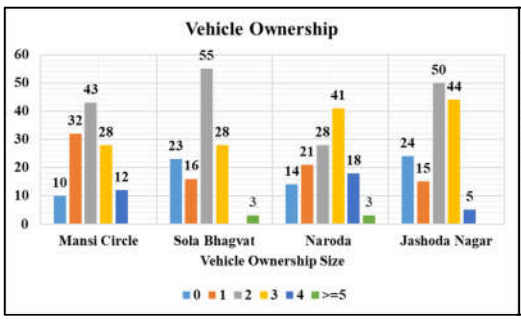

Figure 6. Vehicle Ownership

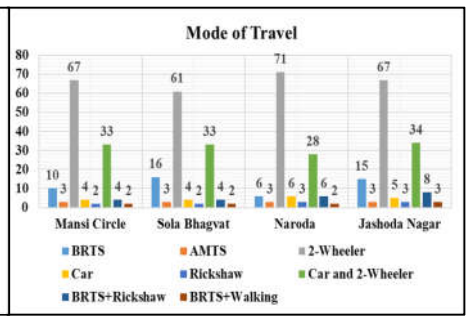

Figure 7. Mode of Travel

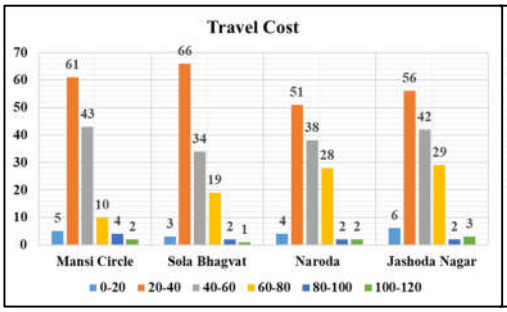

Figure 8. Travel Cost

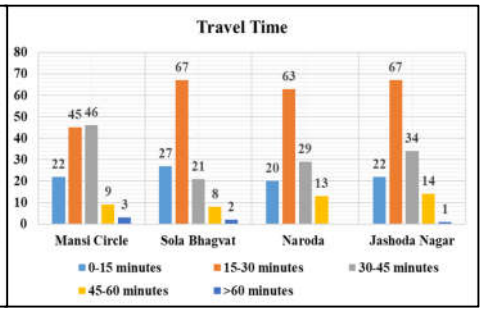

Figure 9. Travel Time

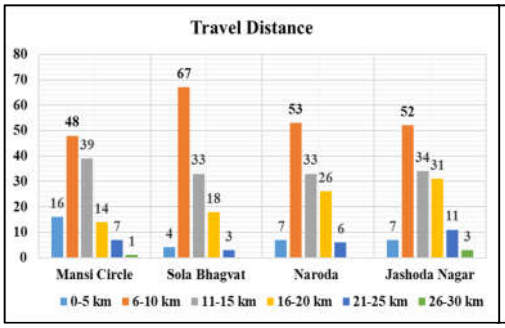

Figure 10. Travel Distance

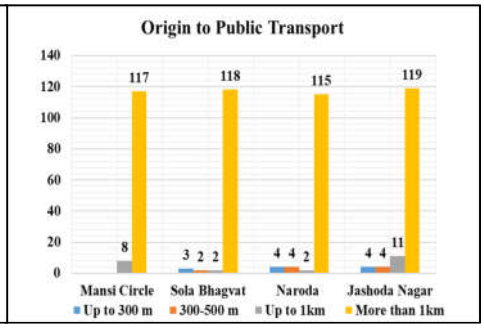

Figure 11. Origin to Public Transport

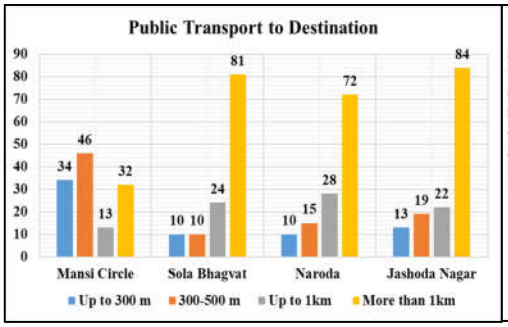

Figure 12. Public Transport to Destination

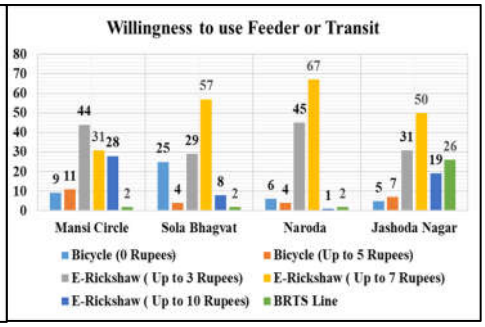

Figure 13. Willingness to use Feeder or Transit

5. MODEL DEVELOPMENT

5.1. Model Defining

Because of its simple mathematical formulation, easy analysis, and interpretation, for both urban and intercity mode option models, the Multinomial Logit (MNL) model was widely used to model the respondents' attributes and preferences through their defined preference choices. When users have more than two modes of transportation to choose from, the model estimates a utility function that decides outcome probabilities. The MNL model is used in this analysis to explore the relationships between socioeconomic factors such as household income, vehicle ownership, travel time, and travel cost, as well as the integration of feeder and transit service for the first and last mile in Ahmedabad's Mansi circle, Sola Bhagwat, Naroda, and Jashoda Nagar study areas. We collected a total of 513 data, based on questionnaires for all study areas. for analysis of MNL, we divide the data into equal percentages after that we prepare MNL for all individual study areas. We prepare four model groups and analyze each group. The groups are shown below in table 2, in this model group we have a dependent variable which is a willingness to use feeder

Mode. Choose the independent variable by doing the different trails. After choosing eight independent variables we get a good higher value of pseudo R^2 which is showing the good relation between dependent and independent variables. It means the model is a good fit for dependent and independent variables. the model estimates a utility function that decides outcome probabilities of willingness to use feeder mode.

Table 2. Model Group

Model Group	Mansi Circle	Sola Bhagvat	Naroda	Jashoda Nagar
Data	125	125	125	138

5.2. Model Fitting Information

Table 3 explains the model fitting information. The Chi-Square analysis for the likelihood test shows the observed relationship with respect to the expected relationship. The value of regression coefficients of predictors of the model not equal to zero. The Likelihood ratio chi-square test statistic formula used by (−2×L of Null Model) – (−2×L of fitted Model). The L of the null model is equal to the intercept only and L of the fitted model is equal to the final iteration parameters of response variables as shown in Table 3 The model formulations are shown below.

$$LRCT\,(Mansi) : -378.096 - 255.004 = 123.092$$

$$LRCST(Sola) : - 325.683 - 258.357 = 67.326$$

$$LRCST(Naroda) : - 261.527 - 159.592 = 101.935$$

$$LRCST(Jashoda\ Nagar) : - 417.640 - 320.918 = 96.722$$

In multiple regressions, this technique is similar to the F-test, it represents the model statically significant or not. In this model chi-square values of 123.092, 67.326,101.935 and 96.722 of mansi circle, sola Bhagvat, Naroda and Jashoda Nagar respectively and have a significance of 0.000, 0.004, 0.000 and 0.000 is less than 0.05. It shows a significant relationship between the dependent variable is Feeder and the set of independent variables like IG, HHS, VO, TD, Gender, Age, TT, and TC.

Table 3. Model Fitting Information

Model	Mansi Circle				Sola Bhagwat				Naroda				Jashoda Nagar			
	Model Fitting Criteria	Likelihood Ratio Tests			Model Fitting Criteria	Likelihood Ratio Tests			Model Fitting Criteria	Likelihood Ratio Tests			Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.	-2 Log Likelihood	Chi-Square	df	Sig.	-2 Log Likelihood	Chi-Square	df	Sig.	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	378.096				325.683				261.527				417.64			
Final	255.004	123.092	40	0	258.357	67.326	40	0.004	159.592	101.935	40	0	320.918	96.722	40	0

5.3. Goodness of fit

The goodness of fit test is a statistical hypothesis test to see how well the samples fit the data. As the significance value was greater than 0.005 (P> 0.005), the results in Table 4 clearly show that the variable was definitely practicable and offered a good fit to the data.

Table 4. Goodness of Fit

	Mansi Circle			Sola Bhagvat			Naroda			Jashoda Nagar		
	Chi-Square	df	Sig.	Chi-Square	df	Sig.	Chi-Square	df	Sig.	Chi-Square	df	Sig.
Pearson	483.837	515	0.834	393.953	420	0.815	286.781	490	1	475.152	560	0.996
Deviance	253.618	515	1	243.552	420	1	153.898	490	1	305.093	560	1

5.4. Mansi Model

Table 5. Parameters Estimate of Mansi Circle

Parameter Estimates								
		B	Std. Error	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Bicycle (0 Rupees)	**Intercept**	-1095.659	2235.303	1	0.624			
	HHS	0.722	1.742	1	0.678	2.059	0.068	62.534
	IG	-2.813	3.808	1	0.460	0.060	3.442E-05	104.582
	GENDER	4.429	6.380	1	0.488	83.847	0.000	22605861.333
	AGE	-11.220	4.822	1	0.020	1.340E-05	1.054E-09	0.170
	TC	1.893	3.361	1	0.573	6.638	0.009	4818.154
	TD	4.590	1.459	1	0.002	98.542	5.646	1719.944
	VO	2.336	3.698	1	0.528	10.344	0.007	14531.892
	TT	-4.619	3.135	1	0.141	0.010	2.117E-05	4.592
Bicycle (Up to 5 Rupees)	**Intercept**	-1837.322	2087.230	1	0.379			
	HHS	-0.661	1.623	1	0.684	0.516	0.021	12.422
	IG	-1.327	3.760	1	0.724	0.265	0.000	420.577
	GENDER	4.191	6.283	1	0.505	66.069	0.000	14736097.136
	AGE	-7.726	4.611	1	0.094	0.000	5.244E-08	3.711
	TC	2.664	3.149	1	0.398	14.358	0.030	6881.017
	TD	6.027	0.502	1	0.000	414.382	155.051	1107.455
	VO	1.771	3.667	1	0.629	5.878	0.004	7780.635
	TT	-7.133	2.931	1	0.015	0.001	2.555E-06	0.250
E-Rickshaw (Up to 3 Rupees)	**Intercept**	-1205.477	2069.809	1	0.560			
	HHS	-0.093	1.604	1	0.954	0.911	0.039	21.117
	IG	-2.802	3.735	1	0.453	0.061	4.019E-05	91.652
	GENDER	4.852	6.249	1	0.437	128.001	0.001	26680711.229
	AGE	-6.408	4.583	1	0.162	0.002	2.069E-07	13.130
	TC	2.433	3.137	1	0.438	11.388	0.024	5324.287
	TD	5.410	0.417	1	0.000	223.680	98.832	506.242
	VO	2.006	3.657	1	0.583	7.434	0.006	9635.198
	TT	-6.590	2.904	1	0.023	0.001	4.638E-06	0.408
E-Rickshaw (Up to 7 Rupees)	**Intercept**	-2543.936	2062.445	1	0.217			
	HHS	-0.075	1.608	1	0.963	0.928	0.040	21.671
	IG	-1.624	3.737	1	0.664	0.197	0.000	298.781
	GENDER	5.058	6.254	1	0.419	157.300	0.001	33112293.380
	AGE	-6.129	4.584	1	0.181	0.002	2.734E-07	17.371
	TC	2.622	3.131	1	0.402	13.759	0.030	6358.695
	TD	6.390	0.332	1	0.000	595.645	310.953	1140.986
	VO	1.764	3.657	1	0.630	5.837	0.004	7576.033
	TT	-6.819	2.896	1	0.019	0.001	3.747E-06	0.319
E-Rickshaw (Up to 10 Rupees)	**Intercept**	-2257.262	2059.943	1	0.273			
	HHS	0.006	1.613	1	0.997	1.006	0.043	23.761
	IG	-1.338	3.741	1	0.721	0.262	0.000	401.225
	GENDER	6.137	6.274	1	0.328	462.753	0.002	101354726.857
	AGE	-6.268	4.587	1	0.172	0.002	2.361E-07	15.233
	TC	2.423	3.131	1	0.439	11.282	0.024	5219.070
	TD	6.358	0.000	1		576.895	576.895	576.895
	VO	2.085	3.657	1	0.569	8.046	0.006	10438.619
	TT	-7.333	2.893	1	0.011	0.001	2.252E-06	0.190
a. The refere nce category is: BRTS Lin e.								

$$P(Bicycle\ (0\ Rupees)) = -1095.659 + 0.722(HHS) - 2.813(IG) + 4.429(GENDER) - 11.220(AGE) + 1.893(TC) + 4.590(TD) + 2.336(VO) - 4.619(TT)$$

$$P(Bicycle\ (Up\ to\ 5\ Rupees)) = -1837.322 - 0.661(HHS) - 1.327(IG) + 4.191(GENDER) - 7.726(AGE) + 2.664(TC) + 6.027(TD) + 1.771(VO) - 7.133(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 3\ Rupees)) = -1205.477 - 0.093(HHS) - 2.802(IG) + 4.852(GENDER) - 6.408(AGE) + 2.433(TC) + 5.410(TD) + 2.006(VO) - 6.590(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 7\ Rupees)) = -2543.936 - 0.075(HHS) - 1.624(IG) + 5.058(GENDER) - 6.129(AGE) + 2.622(TC) + 6.390(TD) + 1.764(VO) - 6.819(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 10\ Rupees)) = -2257.262 - 0.006(HHS) - 1.338(IG) + 6.137(GENDER) - 6.268(AGE) + 2.423(TC) + 6.358(TD) + 2.085(VO) - 7.333(TT)$$

Based on the coefficient value in Table 5 we analyze the impact of the independent variable on the dependent variable. When comparing respondents' monthly incomes, it

was discovered that those with a higher monthly income were more likely to use E-rickshaw (Up to 7 rupees) and E-rickshaw (up to 10 rupees) over BRTS for their regular commutes. According to the age distribution, young people are more likely to choose all categories of feeder service over BRTS service. As a result, it can be inferred that as one reaches adulthood, the choice of Bicycle (Up to 0 Rupees) and Bicycle (Up to 5 Rupees) of over BRTS and Reduce the use of E-Rickshaws in favor of BRTS. Female groups have a higher preference for All categories of feeder service than male groups, according to gender distribution. The analysis of travel time revealed that it has a major impact on bicycle feeder and E-rickshaw feeder services, while travel distance has a minor impact on bicycle and E-rickshaw feeder service selection. With the rise in travel time, people preferred the BRTS service over all other feeder services. If the distance traveled increases, so will the choice E-rickshaw (up to 10 Rupees) and E- rickshaw (up to 7 Rupees) by commuters. to encourage more commuters to use the BRTS, policymakers must significantly reduce time and distance. The observation of Household significantly less impact. Increasing travel cost respondents are more likely to use BRTS service instead of feeder service. Increasing vehicle ownership respondents are not like to use feeder mode for a short distance.

5.5. Sola Bhagvat Model

Table 6. Parameters Estimate of Sola Bhagvat

Parameter Estimates								
		B	Std. Error	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Bicycle (0 Rupees)	Intercept	759.339	1242.991	1	0.541			
	HHS	0.127	1.533	1	0.934	1.135	0.056	22.914
	IG	-0.349	1.197	1	0.771	0.705	6.754E-02	7.366
	GENDER	1.823	1.919	1	0.342	6.191	0.144	266.387
	AGE	0.778	1.381	1	0.573	2.177E+00	1.454E-01	32.603
	TC	0.273	1.487	1	0.854	1.315	0.071	24.259
	TD	-2.859	2.650	1	0.281	0.057	0.000	10.330
	VO	-0.405	0.513	1	0.430	0.667	0.244	1.823
	TT	2.884	2.535	1	0.255	17.878	1.244E-01	2569.357
Bicycle (Up to 5 Rupees)	Intercept	-3445.039	2009.537	1	0.086			
	HHS	3.619	3.439	1	0.293	37.287	0.044	31552.434
	IG	-2.720	2.541	1	0.285	0.066	0.000	9.597
	GENDER	1.925	2.990	1	0.520	6.854	0.020	2404.957
	AGE	16.498	0.000	1		14628201.783	1.463E+07	14628201.783
	TC	0.934	1.941	1	0.631	2.544	0.057	114.249
	TD	-2.740	3.192	1	0.391	0.065	0.000	33.651
	VO	-0.466	0.753	1	0.536	0.627	0.143	2.744
	TT	6.059	3.243	1	0.062	427.985	7.427E-01	246638.286
E-Rickshaw (Up to 3 Rupees)	Intercept	766.538	1240.751	1	0.537			
	HHS	-0.333	1.525	1	0.827	0.717	0.036	14.243
	IG	-0.757	1.201	1	0.528	0.469	4.451E-02	4.940
	GENDER	2.318	1.927	1	0.229	10.155	0.233	443.274
	AGE	0.750	1.383	1	0.588	2.117	1.408E-01	31.843
	TC	-0.169	1.489	1	0.910	0.845	0.046	15.628
	TD	-2.424	2.652	1	0.361	0.089	0.000	16.008
	VO	-0.248	0.511	1	0.627	0.780	0.287	2.123
	TT	3.193	2.535	1	0.208	24.353	1.693E-01	3502.745
E-Rickshaw (Up to 7 Rupees)	Intercept	569.247	1231.485	1	0.644			
	HHS	0.486	1.532	1	0.751	1.625	0.081	32.747
	IG	0.010	1.188	1	0.993	1.010	0.098	10.362
	GENDER	0.689	1.898	1	0.716	1.992	0.048	82.155
	AGE	1.041	1.371	1	0.448	2.833	1.929E-01	41.590
	TC	0.301	1.474	1	0.838	1.351	0.075	24.270
	TD	-3.121	2.635	1	0.236	0.044	0.000	7.721
	VO	-0.428	0.509	1	0.401	0.652	0.240	1.768
	TT	3.104	2.518	1	0.218	22.276	1.602E-01	3097.487
E-Rickshaw (Up to 10 Rupees)	Intercept	176.262	1325.272	1	0.894			
	HHS	1.079	1.822	1	0.554	2.943	0.083	104.561
	IG	-0.541	1.287	1	0.674	0.582	0.047	7.254
	GENDER	2.484	2.081	1	0.233	11.986	0.203	707.457
	AGE	1.066	1.520	1	0.483	2.902	1.477E-01	57.055
	TC	-0.247	1.552	1	0.874	0.781	0.037	16.357
	TD	-2.464	2.711	1	0.364	0.085	0.000	17.301
	VO	-0.324	0.557	1	0.561	0.723	0.243	2.156
	TT	3.433	2.595	1	0.186	30.974	1.914E-01	5012.381

a. The reference category is: BRTS Line.

$$P(Bicycle\ (0\ Rupees)) = 759.339 + 0.127(HHS) - 0.349(IG) + 1.823(GENDER) + 0.778(AGE) + 0.273(TC) - 2.859(TD) - 0.405(VO) + 2.884(TT)$$

$$P(Bicycle\ (Up\ to\ 5\ Rupees)) = -3445.039 - 3.619(HHS) - 2.720(IG) + 1.925(GENDER) + 16.498(AGE) + 0.934(TC) - 2.740(TD) - 0.466(VO) + 6.059(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 3\ Rupees)) = 766.538 - 0.333(HHS) - 0.757(IG) + 2.318(GENDER) + 0.750(AGE) - 0.169(TC) - 2.424(TD) - 0.248(VO) - 3.193(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 7\ Rupees)) = 569.247 - 0.486(HHS) - 0.010(IG) + 0.689(GENDER) + 1.041(AGE) + 0.301(TC) - 3.121(TD) - 0.428(VO) + 3.104(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 10\ Rupees)) = 176.262 - 1.079(HHS) - 0.541(IG) + 2.484(GENDER) + 1.066(AGE) - 0.247(TC) - 2.464(TD) - 0.324(VO) + 3.433(TT)$$

Based on the coefficient value in Table 6 we analyze the impact of the independent variable on the dependent variable. When comparing respondents' monthly incomes, it was discovered that those with a higher monthly income were more likely to use bicycle (5 rupees), E-rickshaw (Up to 7 rupees) and E-rickshaw (up to 7 rupees) over BRTS for their regular commutes. According to the age distribution, middle age people are more likely to choose all categories of feeder service over BRTS service. As a result, it can be inferred that as one reaches Middle age, the choice of Bicycle (Up to 5 Rupees) and E-rickshaw (Up to 10 Rupees) of over BRTS. Female groups have a higher preference for All categories of feeder service than male groups, according to gender distribution. The

analysis of travel time revealed that it has a major impact on bicycle (up to 5 Rupees), while travel distance has a minor impact on bicycle (Up to 5 Rupees) and E-rickshaw (Up to 3 Rupees) feeder service selection. With the rise in travel time, people preferred the feeder service over BRTS service. If the distance travelled increases, so will the choice E-rickshaw (up to 7 Rupees) and Bicycle (up to 0 Rupees) by commuters. to encourage more commuters to use the BRTS, policymakers must significantly reduce time and distance. The observation of Household significantly less impact. Increasing travel cost respondents are more likely to use BRTS service instead of feeder service. Increasing vehicle ownership respondents are not like to use feeder mode for a short distance.

5.6. Naroda Model

Based on the coefficient value in Table 7 we analyze the impact of the independent variable on the dependent variable. When comparing respondents' monthly incomes, it was discovered that those with a higher monthly income were more likely to use E-rickshaw (Up to 7 rupees) and E-rickshaw (up to 10 rupees) over BRTS for their regular commutes. According to the age distribution, young people are more likely to choose all categories of feeder service over BRTS service. As a result, it can be inferred that as one reaches adulthood, the choice of Bicycle (Up to 0 Rupees) and Bicycle (Up to 5 Rupees) of over BRTS and Reduce the use of E-Rickshaws in favor of BRTS. Female groups have a higher preference for All categories of feeder service than male groups, according to gender distribution. The analysis of travel time revealed that it has a major impact on bicycle (up to 5 Rupees), while travel distance has a minor impact on bicycle (Up to 5 Rupees) feeder service selection. With the rise in travel time, people preferred the feeder service over BRTS service. If the distance travelled increases, so will the choice E-rickshaw (up to 7 Rupees) and E-rickshaw (up to 10 Rupees) by commuters. to encourage more commuters to use the BRTS, policymakers must significantly reduce time and distance. The observation of Household significantly impacts on it, increasing household size respondent are likely to use feeder service over the BRTS. Increasing travel cost respondents are more likely to use BRTS service instead of feeder service. Increasing vehicle ownership respondents are not like to use feeder mode for a short distance.

$$P(Bicycle\ (0\ Rupees)) = 27452.097 - 42.017HHS) - 18.858(IG) + 42.561(GENDER) - 4.311(AGE) - 8.173(TC) - 22.952(TD) - 17.513(VO) + 13.701(TT)$$

$$P(Bicycle\ (Up\ to\ 5\ Rupees)) = 27988.579 - 43.969(HHS) - 19.137(IG) + 52.261(GENDER) - 5.793(AGE) - 9.726(TC) - 21.683(TD) - 17.237(VO) - 13.667(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 3\ Rupees)) = 27862.955 - 43.246(HHS) - 18.261(IG) + 46.201(GENDER) - 4.637(AGE) - 8.533(TC) - 23.012(TD) - 17.555(VO) - 14.621(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 7\ Rupees)) = 27806.595 - 42.256(HHS) - 19.038(IG) + 44.662(GENDER) - 4.241(AGE) - 8.281(TC) - 23.318(TD) - 18.137(VO) + 13.991(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 10\ Rupees)) = 25780.495 - 24.948(HHS) - 15.562(IG) + 35.526(GENDER) - 0.391(AGE) - 3.123(TC) - 30.047(TD) - 30.463(VO) + 18.437(TT)$$

Table 7. Parameters Estimate of Naroda

Parameter Estimates								
		B	Std. Error	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Bicycle (0 Rupees)	Intercept	27452.097	12012.815	1	0.022			
	HHS	-42.017	1.221	1	0.000	5.655E-19	5.166E-20	6.192E-18
	IG	18.858	10.697	1	0.078	1.548E+08	1.213E-01	1.974E+17
	GENDER	42.561	19.533	1	0.029	3.047E+18	7.198E+01	1.290E+35
	AGE	-4.311	19.185	1	0.822	1.342E-02	6.277E-19	2.869E+14
	VO	-17.513	12.024	1	0.145	2.479E-08	1.444E-18	4.256E+02
	TC	-8.173	4.630	1	0.078	2.823E-04	3.230E-08	2.467E+00
	TD	-22.952	9.842	1	0.020	1.077E-10	4.516E-19	2.569E-02
	TT	13.701	6.318	1	0.030	8.922E+05	3.734E+00	2.132E+11
Bicycle (Up to 5 Rupees)	Intercept	27988.579	12020.793	1	0.020			
	HHS	-43.969	0.918	1	0.000	8.028E-20	1.329E-20	4.850E-19
	IG	19.137	10.679	1	0.073	2.046E+08	1.664E-01	2.516E+17
	GENDER	52.261	28.653	1	0.068	4.972E+22	2.027E-02	1.220E+47
	AGE	-5.793	19.232	1	0.763	3.048E-03	1.298E-19	7.154E+13
	VO	-17.237	12.013	1	0.151	3.267E-08	1.944E-18	5.491E+02
	TC	-9.726	4.703	1	0.039	5.968E-05	5.924E-09	6.013E-01
	TD	-21.683	9.853	1	0.028	3.828E-10	1.570E-18	9.337E-02
	TT	13.667	6.352	1	0.031	8.623E+05	3.378E+00	2.201E+11
E-Rickshaw (Up to 3 Rupees)	Intercept	27862.955	11997.018	1	0.020			
	HHS	-43.246	0.381	1	0.000	1.655E-19	7.837E-20	3.493E-19
	IG	18.261	10.661	1	0.087	8.524E+07	7.178E-02	1.012E+17
	GENDER	46.201	19.509	1	0.018	1.161E+20	2.876E+03	4.684E+36
	AGE	-4.637	19.192	1	0.809	9.690E-03	4.471E-19	2.100E+14
	VO	-17.555	12.005	1	0.144	2.376E-08	1.435E-18	3.934E+02
	TC	-8.533	4.629	1	0.065	1.969E-04	2.258E-08	1.717E+00
	TD	-23.012	9.822	1	0.019	1.014E-10	4.418E-19	2.326E-02
	TT	14.621	6.311	1	0.021	2.237E+06	9.496E+00	5.270E+11
E-Rickshaw (Up to 7 Rupees)	Intercept	27806.595	11997.629	1	0.020			
	HHS	-42.256	0.000	1		4.450E-19	4.450E-19	4.450E-19
	IG	19.038	10.666	1	0.074	1.854E+08	1.545E-01	2.225E+17
	GENDER	44.662	19.494	1	0.022	2.491E+19	6.356E+02	9.760E+35
	AGE	-4.241	19.181	1	0.825	1.440E-02	6.787E-19	3.053E+14
	VO	-18.137	12.011	1	0.131	1.328E-08	7.938E-19	2.223E+02
	TC	-8.281	4.610	1	0.072	2.532E-04	3.016E-08	2.125E+00
	TD	-23.318	9.828	1	0.018	7.466E-11	3.217E-19	1.733E-02
	TT	13.991	6.293	1	0.026	1.192E+06	5.239E+00	2.711E+11
E-Rickshaw (Up to 10 Rupees)	Intercept	25780.495	20702.635	1	0.213			
	HHS	-24.948	31.367	1	0.426	1.463E-11	2.921E-38	7.330E+15
	IG	15.562	17.921	1	0.385	5.736E+06	3.193E-09	1.030E+22
	GENDER	35.526	34.183	1	0.299	2.684E+15	2.151E-14	3.351E+44
	AGE	-0.391	23.911	1	0.987	6.761E-01	2.997E-21	1.525E+20
	VO	-30.463	21.188	1	0.151	5.890E-14	5.432E-32	6.387E+04
	TC	-3.123	20.739	1	0.88	4.402E-02	9.782E-20	1.981E+16
	TD	-30.047	30.095	1	0.318	8.927E-14	2.155E-39	3.698E+12
	TT	18.437	15.192	1	0.225	1.016E+08	1.190E-05	8.674E+20
a. The reference category is: BRTS Line.								

5.7. Jashoda Nagar Model

Based on the coefficient value in Table 8 we analyse the impact of the independent variable on the dependent variable, in this model, we choose a reference category is Bicycle (0 Rupees) we compare all other categories with Bicycle (0 rupees). When comparing respondents' monthly incomes, it was discovered that those with a higher monthly income were more likely to use E-rickshaw (Up to 7 rupees) and BRTS over Bicycle for their regular commutes. According to the age distribution, middle age people are more likely to choose all categories of feeder service over BRTS service. As a result, it can be inferred that as one reaches Middle age, the choice of E-rickshaw (Up to 3 rupees)) and BRTS of over Bicycle. Female groups have a higher preference for E-rickshaw (Up to 3 rupees), E-rickshaw (Up to 10 rupees) and BRTS service than male groups, male groups have a higher preference for E-ickshaw (Up to 7 rupees) and Bicycle (5 rupees) service than female groups according to gender distribution. The analysis of travel time revealed that it has a major impact on Bicycle (Up to 5 Rupees) and E-Rickshaw (Up to 3 Rupees) feeder services, while travel distance has a minor impact on E-rickshaw and BRTS service selection. With the rise in travel time, people preferred the BRTS service over all other feeder services. If the distance travelled increases, so will the

choice E-rickshaw (up to 3 Rupees) and E- rickshaw (up to 10 Rupees) by commuters. to encourage more commuters to use the BRTS, policymakers must significantly reduce time and distance. The observation of Household significantly major impact on Bicycle (Up to 5 rupees). Increasing travel cost respondents are more likely to use BRTS service instead of feeder service. Increasing vehicle ownership respondents are not like to use feeder mode for a short distance.

Table 8. Parameters Estimate of Jashoda Nagar

Parameter Estimates								
		B	Std. Error	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Bicycle (Up to 5 Rupees)	Intercept	-648.660	990.906	1	0.513			
	HHS	8.275	0.000	1		3.926E+03	3.926E+03	3.926E+03
	IG	-3.329	1.660	1	0.045	3.582E-02	1.385E-03	9.264E-01
	GENDER	-0.055	1.378	1	0.968	9.461E-01	6.348E-02	1.410E+01
	AGE	1.321	1.790	1	0.461	3.746E+00	1.121E-01	1.252E+02
	TC	0.593	0.923	1	0.520	1.810E+00	2.964E-01	1.105E+01
	TD	0.567	0.664	1	0.394	1.763E+00	4.794E-01	6.481E+00
	VO	-0.897	0.542	1	0.097	4.076E-01	1.410E-01	1.178E+00
	TT	-2.357	1.281	1	0.066	9.473E-02	7.692E-03	1.167E+00
E-Rickshaw (Up to 3 Rupees)	Intercept	923.695	711.259	1	0.194			
	HHS	-0.982	0.941	1	0.297	3.745E-01	5.923E-02	2.368E+00
	IG	-0.120	0.779	1	0.878	8.871E-01	1.928E-01	4.082E+00
	GENDER	0.756	1.097	1	0.491	2.129E+00	2.478E-01	1.829E+01
	AGE	-2.090	1.144	1	0.068	1.237E-01	1.315E-02	1.163E+00
	TC	-0.617	0.662	1	0.351	5.394E-01	1.474E-01	1.973E+00
	TD	-0.221	0.444	1	0.619	8.019E-01	3.359E-01	1.914E+00
	VO	0.024	0.358	1	0.946	1.025E+00	5.082E-01	2.066E+00
	TT	0.444	0.773	1	0.565	1.559E+00	3.429E-01	7.090E+00
E-Rickshaw (Up to 7 Rupees)	Intercept	620.249	705.090	1	0.379			
	HHS	0.393	0.969	1	0.685	1.482E+00	2.218E-01	9.899E+00
	IG	0.553	0.760	1	0.467	1.738E+00	3.922E-01	7.704E+00
	GENDER	-0.609	1.042	1	0.559	5.438E-01	7.061E-02	4.189E+00
	AGE	-1.454	1.122	1	0.195	2.337E-01	2.591E-02	2.108E+00
	TC	-0.629	0.651	1	0.334	5.332E-01	1.490E-01	1.909E+00
	TD	-0.442	0.427	1	0.301	6.430E-01	2.787E-01	1.484E+00
	VO	-0.345	0.358	1	0.336	7.085E-01	3.510E-01	1.430E+00
	TT	0.166	0.746	1	0.824	1.181E+00	2.735E-01	5.099E+00
E-Rickshaw (Up to 10 Rupees)	Intercept	908.566	720.744	1	0.207			
	HHS	-0.865	0.949	1	0.362	4.209E-01	6.557E-02	2.702E+00
	IG	0.062	0.792	1	0.938	1.064E+00	2.252E-01	5.023E+00
	GENDER	1.365	1.195	1	0.253	3.917E+00	3.765E-01	4.074E+01
	AGE	-1.677	1.158	1	0.148	1.869E-01	1.932E-02	1.808E+00
	TC	-0.623	0.679	1	0.359	5.364E-01	1.417E-01	2.030E+00
	TD	-0.400	0.478	1	0.402	6.702E-01	2.628E-01	1.709E+00
	VO	-0.516	0.382	1	0.177	5.972E-01	2.823E-01	1.263E+00
	TT	0.675	0.789	1	0.392	1.964E+00	4.180E-01	9.230E+00
BRTS Line	Intercept	580.773	712.458	1	0.415			
	HHS	-0.245	0.952	1	0.797	7.830E-01	1.212E-01	5.057E+00
	IG	0.804	0.769	1	0.296	2.234E+00	4.947E-01	1.009E+01
	GENDER	0.017	1.081	1	0.988	1.017E+00	1.222E-01	8.465E+00
	AGE	-0.838	1.153	1	0.467	4.325E-01	4.514E-02	4.144E+00
	TC	-0.351	0.658	1	0.593	7.037E-01	1.939E-01	2.554E+00
	TD	-0.799	0.462	1	0.083	4.498E-01	1.820E-01	1.112E+00
	VO	-0.288	0.372	1	0.439	7.499E-01	3.619E-01	1.554E+00
	TT	0.473	0.774	1	0.541	1.605E+00	3.519E-01	7.325E+00
a. The reference category is: Bicycle (0 Rupees).								

$$P(Bicycle\ (Up\ to\ 5\ Rupees)) = -648.660 + 8.275(HHS) - 3.329(IG) - 0.055(GENDER) + 1.321(AGE) + 0.593(TC) + 0.567(TD) - 0.897(VO) - 2.357(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 3\ Rupees)) = 923.695 - 0.982(HHS) - 0.120(IG) + 0.756(GENDER) - 2.090(AGE) - 0.617(TC) - 0.221(TD) + 0.024(VO) - 0.444(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 7\ Rupees)) = 620.249 + 0.393(HHS) + 0.553(IG) - 0.609(GENDER) - 1.454(AGE) - 0.629(TC) - 0.442(TD) - 0.345(VO) + 0.166(TT)$$

$$P(E-Rickshaw\ (Up\ to\ 10\ Rupees)) = 908.566 - 0.865(HHS) - 0.062(IG) + 1.365(GENDER) - 1.677(AGE) - 0.623(TC) - 0.400(TD) - 0.516(VO) + 0.675(TT)$$

$$P(BRTS\ Line) = 580.773 - 0.245(HHS) + 0.804(IG) + 0.017(GENDER) - 0.838(AGE) - 0.351(TC) - 0.799(TD) - 0.288(VO) + 0.473(TT)$$

6. FEEDER ROUTE PROPOSAL

6.1. Feeder Route Map Proposal at Mansi Circle

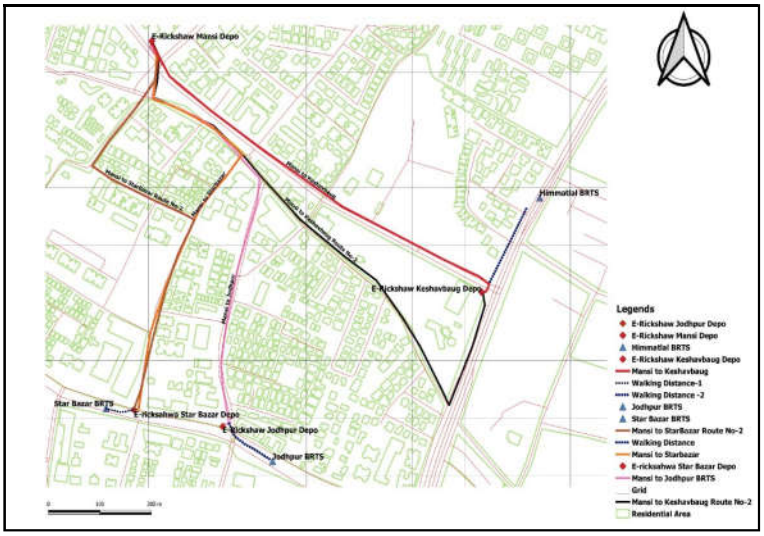

Figure 14. Proposed Feeder Route at Mansi circle

Table 9. Feeder Route Length at Mansi Circle

E-Rickshaw Depo		Route Name	Route length	Nearest BRTS
Mansi Depo	Keshavbaug Route No-1	Mansi to Kshavbaug	840 m	Himmatlal park
	Keshavbaug Route No-2		1.18 km	
	Jodhpur Depo	Mansi to Jodhpur	860 m	Jodhpur BRTS
	Star Bazar depo	Mansi to Star Bazar	890 m	Star Bazar BRTS

6.2. Feeder Route Map Proposal at Sola Bhagvat

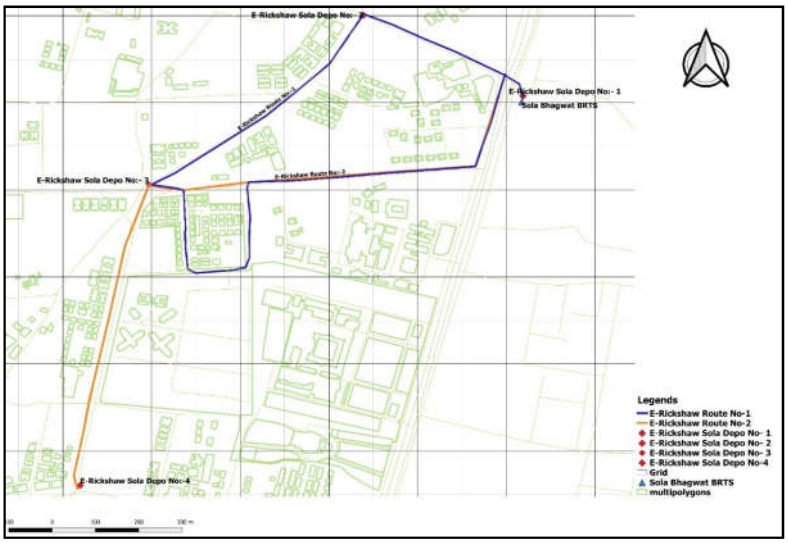

Figure 15. Proposed Feeder Route at Sola Bhagvat

Table 10. Feeder Route Length at Sola Bhagvat

E-Rickshaw Depo		Route Name	Route length	Nearest BRTS
Sola Deop-1	Sola Depo-2	Route-1(Blue Line)	500 m	Sola Bhagwat
Sola Depo-2	Sola Depo-3		670 m	
Sola Depo-3	Sola Depo-4	Route-2 (Orange Line)	790 m	
	Sola Depo-1		1 km	
	Sola Depo-1	Route-1 (Blue Line)	1.38 km	

6.3. Feeder Route Map Proposal at Naroda

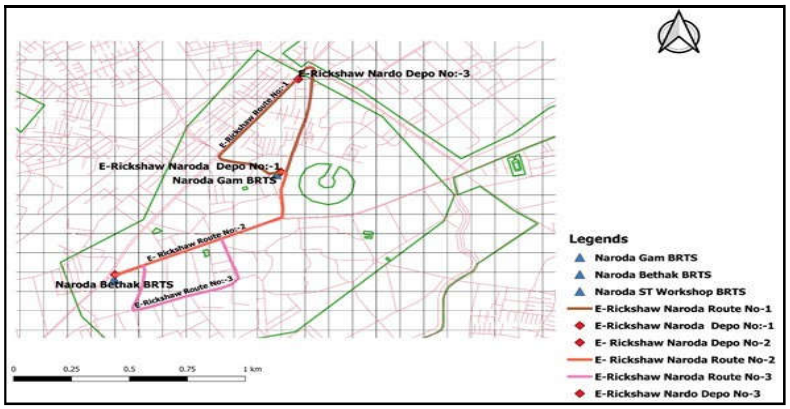

Figure 16. Proposed Feeder Route at Naroda

Table 11. Feeder Route Length at Naroda

E-Rickshaw Depo		Route Name	Route length	Nearest BRTS
Naroda Deop-1	Naroda Depo-2	Route-2(Orange Line)	1.1 km	Naroda Gam
Naroda Depo-1	Naroda Depo-3	Route-1 (Brown Line)	710 m	
Naroda Depo-3	Naroda Depo-1	Route-1 (Brown Line)	830 m	Naroda Bethak
	Sola Depo-1		1 km	
	Sola Depo-1	Route-1 (Blue Line)	1.38 km	
Route-3(Magenta line) is By pass route of Route no 2(Orange Line)			1km	

6.4. Feeder Route Map Proposal at Jashoda Nagar

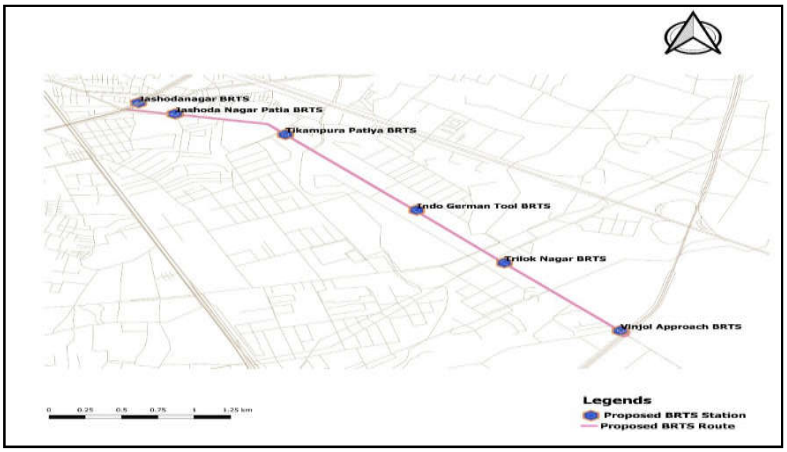

Figure 17. Proposed BRTS Route at Jashoda Nagar

Table 12. BRTS Route Length at Jashoda Nagar

Proposed BRTS Station		Route Length	Total Route Length
1.	Jashoda Nagar (Already Exist)	0 m	4.57 km
2.	Jashoda Nagar Patia	325 m	
3.	Tikampura Patiya	829 m	
4.	Indo German tool	1317 m	
5.	Trilok Nagar	900 m	
6.	Vinjol Approach	1172 m	

7. RESULT AND DISCUSSION

The basic objective of this research paper is to develop the models for proposed E-Ricksahw feeder mode service in Mansi Circle, Sola Bhagwat, Naroda and Jashoda Nagar of Ahmedabad city using Multinomial Logit (MNL) Model. According to table 13, the model's pseudo R^2 value. The Cox and Snell R^2 value for Mansi Circle, Sola Bhagwat, Naroda and Jashoda Nagar are 0.626, 0.416, 0.558 and 0.501 respectively. This means that the model accounts for 62.6%, 41.6 %, 55.8%, and 50.1 % of the difference in the dependent variables, respectively. The result measurements of Nagelkerke were used to determine the intensity of the relationship between variables. The Nagelkerke R^2 value for Mansi Circle, Sola Bhagwat, Naroda and Jashoda Nagar are 0.658, 0.445, 0.633 and 0.524 respectively, which suggests that the model explains roughly 65.6%, 44.5%, 63.3% and 52.4% of the variation in the outcome. While, the McFadden R^2 value for Mansi Circle, Sola Bhagwat, Naroda and Jashoda Nagar are 0.324, 0.196, 0.384 and 0.222 respectively which state 32.4.0%, 19.6%, 38.4% and 22.2% variation in the outcome. So, finally the R2 value indicates that the model explains nearly 32-65% of the variance Mansi circle, 38-63.3% at Naroda and 22-52% variation in the study that is considered statistically significant result. R^2 value is 19-41% at Sola Bhagvat, variation in the R^2 value at sola bhagvat that is not considered statistically significant result.

Table 13. Pseudo R^2 Value

Pseudo R^2	Mansi Circle	Sola Bhagvat	Naroda	Jashoda Nagar
Cox and Snell	0.626	0.416	0.558	0.501
Nagelkerke	0.658	0.445	0.633	0.524
McFadden	0.324	0.196	0.384	0.222

Based on preliminary results and multinational logistic models, it can be concluded that e-rickshaws are also a good public transport mode for first and last-mile connectivity. It also reduces CO_2 emissions. It is a good public transport mode for those who are away from public transport. Easily attract them to connect.

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