Exploring Travel Behavior of Passengers towards Loyalty to Delhi Metro Rail Transit

Phani Kumar PATNALA[a], Manoranajan Parida[b], Ravi Sekhar Chalumuri[c]

[a,b] *Center for Transportation Systems, Indian Institute of Technology Roorkee, Roorkee, India - 247667*
[a] *E-mail: pkumar@ct.iitr.ac.in*
[b] *E-mail: m.parida@ce.iitr.ac.in*
[c] *Transportation Planning and Environment Division, Central Road Research Institute-CSIR, New Delhi, India - 110025; E-mail: chalumuri.ravisekhar@gmail.com*

Abstract: Exploring passenger loyalty has gained significant attention in recent years, knowing its potential in increasing transit ridership values. Given the fact that metro rail transit (MRT) in Delhi, India is now striving for passenger retention, this paper explores the travel behavior and satisfaction of passenger groups through the use of multinomial logit (MNL) model and ordinal regression models, respectively. For this purpose, the study conducted passenger travel survey in 41 MRT stations. The study segmented 1048 transit passengers to four-passenger groups, namely loyal, chooser, captive, and non-loyal, based on their likelihood agreements. The MNL model on passenger groups illustrated that access characteristics of passengers play a significant role in deciding the passenger group to which they belong. Besides, ordinal regression models for each passenger group provide several insights into the service quality aspects of MRT that should be focused and enhanced to decrease the proportion of non-loyal and chooser passengers and to promote the use of MRT in India.

Keywords: Travel Behavior, Likelihoods, Passenger Groups, Loyalty, Access

1. INTRODUCTION

Metro rail transit (MRT) is traditionally a primary mode of transportation for cheap, reliable, timely, and long-distance travel within a city (Cho 2013; Rojas et al. 2019). In recent years, most of the Indian cities have started planning and investing huge funds on MRT systems to promote sustainability and to facilitate long-distance trips. Among them, Delhi Metro has proven its efficacy in attracting commuters of about 3.13 million passengers per day (DMRC 2018). Unlike the success of Delhi Metro, this transit facility still lacks proper accessibility and susceptible management of surplus private transport demand (Jain et al. 2014). According to a survey conducted by Central Road Research Institute (CRRI) on mode choice behavior of Delhites, MRT covers only 2.4 percent of overall trips (CSIR 2017; Minal and Ravi 2017). The main competitors for the Delhi Metro are the personal vehicle and the intercity bus (Goel and Tiwari 2016).

Recent statistics have shown a worrying decline in the Delhi Metro ridership. Figure 1 depicts that there is a sudden drop in the Metro ridership per total network length (in Kms) after the year 2016. The average ridership was around 2.76 million passengers per day for the year 2016, which was still far behind the expected ridership of 4 million passengers per day that art needs to break-even (CSE 2018). Delhi Metro is now striving for customer retention and reducing passenger migration towards private transport due to fare hike, network expansion, and recent community rivalries. However, community rivalries have a strong but

short-term influence on transit ridership. On the other hand, Metro authorities are investing huge funds on transit infrastructure (network expansion), keeping scant attention on access to transit stations (Bivina et al. 2019). In these cases, measures for improving the service quality and accessibility becomes necessary for retaining and enhancing Metro ridership in Delhi.

Existing studies suggest that retention of loyal passengers to transit will enhance transit ridership (Wang et al. 2016). Loyalty plays a vital role in deciding the mode choice of passengers (Rojas et al. 2019). The concept of loyalty to public transit is best explained in terms of passengers' attitudes and perceptions to continue using the service, followed by their overall satisfaction, most importantly the users' image on public transit (Van Lierop and El-Geneidy 2016). Recent studies have suggested three important dimensions of loyalty; firstly, the attitudes and perceptions of passengers to the transit service, secondly, the intention of passengers to continue using the service, and thirdly, the likelihood of recommending to others (Rojas et al. 2019; Zhao et al. 2014).

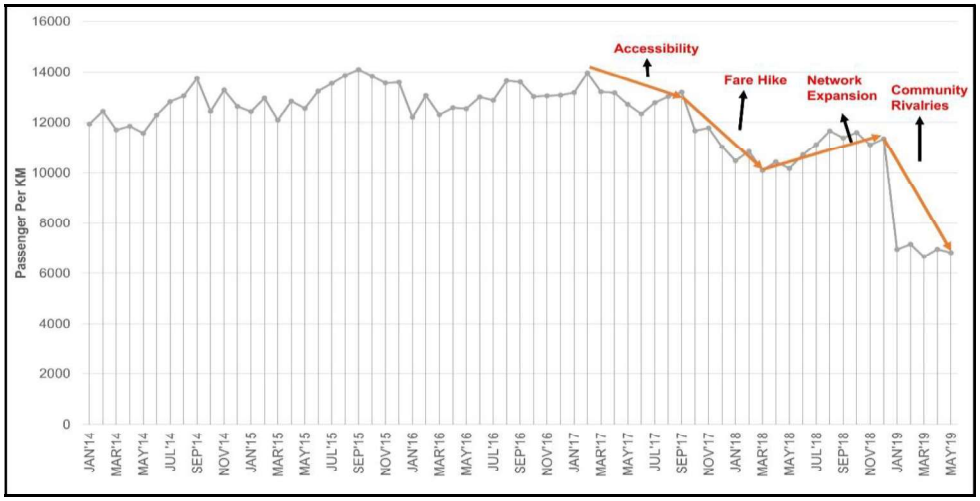

Figure 1. Delhi Metro Ridership per KM (Year wise) (Source: DMRC 2019)

In this line, the purpose and argument of this paper are to focus on non-loyal passengers of public transit, because converting non-loyal passengers to loyal is typically less costly than attracting new ones (Reichheld and Schefter 2000). Besides, customer retention leads to continue using the service, followed by the willingness to recommend it to others, which will enhance transit usage (Rojas et al. 2019). For this purpose, the study has identified passenger groups based on likelihood agreements of passengers on public transit. The segmentation of passenger groups can help prioritize future initiatives to focus on loyal group and determine the degree of success of past initiative (Van Lierop and El-Geneidy 2016; Beck and Rose 2016).

Secondly, investigating each passenger group to answer on what parameters the non-loyal passengers look while traveling on Metro. Exploring passenger groups as a function of socio-demographic and trip characteristics of passengers can help MRT and transit agencies to identify the aspects of service that should be focused and enhanced to increase the proportion of loyal passengers and to promote the use of MRT in India. At the same time, the findings of this study can also help government authorities and stakeholder groups to incorporate operational and marketing instruments that can maximize passenger retention. In particular, the findings of this study can be used to identify and target users who are more likely than others to shift to other modes of transportation.

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2. RESEARCH BACKGROUND

Understanding passenger loyalty is a prime determinant of transit service for its long-term performance (Lai and Chen 2011). Loyalty can be said to have occurred if people choose to use the same service from a long period, rather than other competitive services. Loyalty to public transit is a long-term likelihood of a user in choosing transit mode for present and future trips (TRB 1999). A passenger exhibit loyalty when he/she is consistently using the transit service over an extended period. Although definitions for loyalty exist in the transportation background, no study presents an established methodology for assessment (Van Lierop and El-Geneidy 2016). Exploring travel behavior of loyal passengers to public transit has gained significant attention in recent literature, given its potential to increase market shares, long term market management, efficient allocation of funds, yield cost savings, and increase ridership values (Rojas et al. 2019). Despite the absence of generalized and global factors for assessing loyalty, it is quite challenging to measure passenger loyalty for public transit systems (Skackauskiene et al. 2016).

Passenger loyalty carries two important aspects, namely, behavioral and attitudinal (TRB 1999; Zhao et al. 2014; Van Lierop and El-Geneidy 2016). Behavioral loyalty drives psychological decisions of passengers for long-term selection of transit facility over other modes. Attitudinal loyalty is passengers' emotional attachment or trust with the transit service. Three components provide a complete picture of these psychological and emotional attachments of a passenger to the transit service. Firstly, the intention of a passenger to continue transit usage. This component aims at measuring the willingness of passenger to use the same transit service in his/her future trips (Minser and Webb 2010). Lai and Chen (2011) have suggested that such willingness will act as a proxy to passenger loyalty. Secondly, the likelihood of passengers to recommend others that expel his/her emotional attachment to the transit service. According to Reichheld (2003), such a likelihood is common in loyal passengers. Thirdly, passenger satisfaction that displays the level of satisfaction with the transit service. Van Lierop and El-Geneidy (2016) claimed that a passenger would exhibit willingness and likelihood only if he/she are satisfied with transit service. Some studies have considered passenger satisfaction as the perfect proxy for measuring loyalty (Allen et al. 2019).

Existing studies have used a wide range of techniques such as quadrant analysis (Weinstein 2007; Figler et al. 2012), logit model (Kuo and Liang 2011; Habib et al. 2010), structural equation modeling (SEM) (Kuo and Tang 2013; Lai and Chen 2011; Carreira et al. 2014), Bayesian networks (Diez-Mesa et al. 2018), probit model (Rojas et al. 2019) etc. to investigate passenger loyalty. These studies have analyzed the relationships between willingness (Lai and Chen 2011), likelihoods (Minser and Webb 2010; Zhao et al. 2014), overall satisfaction (Figler et al. 2012; Van Lierop and El-Geneidy 2016), and behavioral intentions (Kuo and Tang 2011) for measuring passenger loyalty. But there is still an argument in the literature that these relationships itself cannot drive to a concrete picture of passenger loyalty (Zhao et al. 2014).

Besides, previous studies have considered transit users as a homogeneous group while investigating loyalty (Chou and Kim 2009; Figler et al. 2012; Carreira et al. 2014; Rojas et al. 2019). In reality, transit users are often heterogeneous in their travel, personal, perceptional, and attitudinal characteristics. This idea was pointed out by limited researchers and segmented passengers into two discrete groups, namely captive riders and choice riders (Beimborn et al. 2007; Minser and Webb 2010; Zhao et al. 2014). Captive riders are passengers who use transit by obliging. Choice riders are passengers who have a choice other than transit. A choice rider can switch from transit at any instance, which a captive rider cannot afford. Recently, another

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group, i.e., 'captive by choice' was come into the picture, who has no choice but affordable to switch (Van Lierop and El-Geneidy 2016). Understanding that different passenger groups exist, the present study tries to identify passenger groups based on their likelihoods on transit service.

3. STUDY AREA AND SURVEY STATISTICS

3.1 Study Area

The introduction of MRT in Delhi (2002) have shown significant changes in the travel behavior of Delhites. Within ten years of service, Delhi Metro received the world's first metro in achieving carbon credits for reducing CO2 emissions (DMRC 2018). It is currently operational with eight corridors connecting 231 station areas by 317 km of network length. Delhi metro stands 16th in metro ridership and 7th in the network length worldwide. Figure 2 represents the spatial distribution of Metro corridors and transit stations in the study area. Out of 8 existing MRT corridors, the present study has selected two corridors, namely blue line and yellow line, due to three major reasons. Firstly, both the transit lines serve as longest (47.4 km and 49 km, respectively) and highest in ridership (0.99 million and 0.93 million passengers per day, respectively) compared to other corridors. Secondly, the two corridors spatially cover Delhi in all directions. The blue corridor extends from Dwarka sector 21 in the West to Noida city center and Vaishali in the East directions connecting 44 metro stations. The yellow corridor extends from Samaypuri Badli in the North to Huda city center in the South directions connecting 37 metro stations. Thirdly, both the corridors are noticeably diverse. Most of the station areas hold social, political, heritage, commercial, administrative and historical importance to the Delhi city. Among 81 transit stations of the two corridors, 41 (21 in yellow and 20 in blue corridors) were selected based on the block population density (Census 2011) and the separation of at least 2000m distance between them to eliminate overlapping of survey samples.

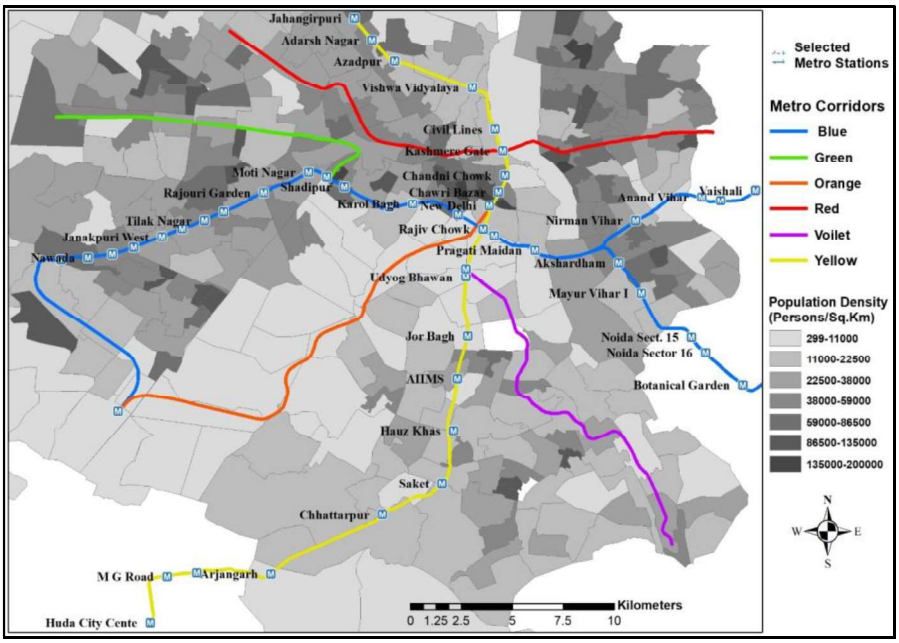

Figure 2. Spatial Distribution of Delhi Metro Corridors and Selected Transit Stations

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3.2 Survey Design

Passenger travel survey was conducted at 41 selected metro stations from January to April 2018, during peak hours, i.e., 8 am to 10 am and 4 pm to 7 pm. Passenger responses were collected at entry and exit gates within transit stations to capture both access and egress trips, respectively. Each Passenger was solicited to answer a two-page questionnaire which includes four sections. The first section contains information about socio-demographic characteristics of the passenger such as age, income, household size, type of dwelling unit, employment status, years of riding metro, etc. The second section collects ongoing trip characteristics at each leg namely origin/destination address, access/egress mode, access/egress distance, access/egress time, total travel time/distance, alternative mode choice for the main haul, origin/destination metro station, number of transfers, transfer time, etc. The third section includes attitudinal questions on the likelihood of passengers to use MRT for the future years. The fourth section solicited to answer a set of perceptional questions on transit service quality.

This study implemented a stratified random sampling strategy. The sample size was estimated using the equation (1) by Krejcie and Morgan (1970) as

$$S = \frac{\chi^2 NP(1-P)}{d^2(N-1)+N^2P(1-P)} \quad (1)$$

where S is the required sample size, χ^2 is the table value for Chi-square, N is the population size, P is the proportion of the population, and d is the degree of accuracy. With metro ridership of 2.76 million passengers per day (N), marginal error of 5% (d), chi-squared value of 3.841, and 50% proportion of population (P), the study has obtained a total of 600 samples from the Krejcie and Morgan (1970) equation as the required sample size. In total, the survey has collected 1440 responses with a response rate of 82%. During the survey, some of the passengers were found to make metro trips from outside Delhi (i.e., from its satellite cities). Excluding incomplete and invalid responses, outside residents, and 5% of outliers, the survey responses were filtered to 1048 complete and clean samples.

3.3 Socio-Demographics of Passengers

Figure 3 presents the socio-demographic characteristics of survey respondents. As the figure shows, the majority of respondents are male (67.36%) as compared to female (32.64%). This proportion is similar to previous studies that investigated the trip characteristics of metro passengers in Delhi (Ranjan et al. 2015; Bivina et al. 2019). One in ten respondents owned no vehicle (10.78%). More than half of respondents are employed (56.97%) in various public and private firms, while 21.56% were self-employed, 14.98% were students, 3.15% were unemployed, and 3.34% were retired. The majority of respondents were between 25-40 years old (53.15%), followed by 40-65 years old (19.27%). The average household size was 4.39, where about 88.36% of respondents belong to large households (≥4). This household size is nearer to 4.53, which was reported in existing studies on Delhi metro passengers (Bivina et al. 2019; Census 2011). At least two persons in a household are workers, with an average of 1.92.

3.4 Trip Characteristics of Passengers

Figure 4 depicts the mode choice of passengers in their access, egress, and alternate trips. About 68.03% of respondents choose the bus as their second choice other than the metro, while the car been only 1.34%. It is an interesting finding that people who are using MRT choose other public modes as alternatives giving less priority to private modes. Respondents

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mostly preferred walking for their access (38.55%) and egress (53.63%) trips, implying that transit usage enhances the walking behavior of residents who live near station areas (Rastogi and Rao 2003). However, the Delhi Metro (38.55%) passengers walk less than Mumbai Metro (49%) passengers (Rastogi 2010) and Nanjing Metro (59%) passengers (Zhao et al. 2018), but higher than Netherlands railway (20.1%) passengers (Givoni and Rietveld 2007) for access trips.

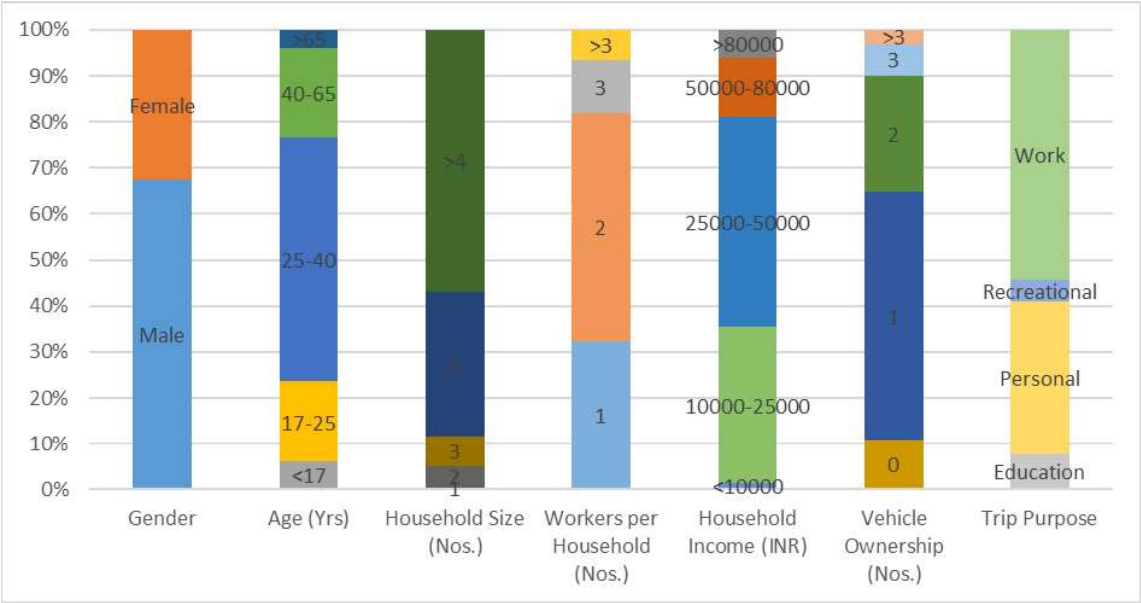

Figure 3. Socio-demographic Characteristics of Survey Respondents

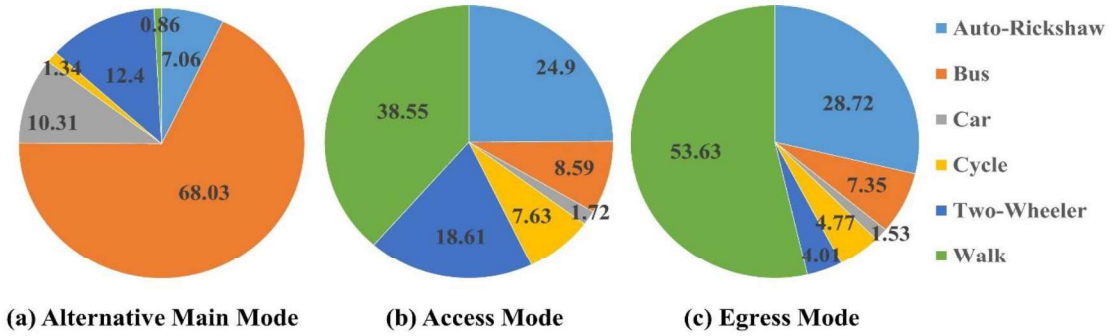

Figure 4. Mode Choice (%) of Survey Respondents in Access and Egress Trips

Table 1 illustrates two major differences between access and egress trips. Firstly, as expected, passengers are making longer access journey (in terms of distance and time) compared to egress journey. Secondly, passengers use different modes to complete both access and egress trips. In general, the same mode could not available at both ends. It also depends on the survey duration, whether the passenger is making a home trip or activity trip. For instance, a male passenger might be going back to his home at the time of the survey. He might have walked to the nearest metro station and might take auto-rickshaw to reach his home from the destination metro station. This trip will reciprocate when he returns to the activity end. Thus, we can treat egress to the home end station and access from it almost the same. Following from that, whether the trip is to home end or activity end or whether the

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passenger is choosing any feeder mode to access/egress, the access distance to transit itself include egress distance from transit. Such differences would serve as a useful implication for the planning of transit stations and demand management at both ends.

Table 1. Summary of Trip Characteristics (Mean Values)

Description	Trip Distance (km)	Trip Time (min)	Trip Cost (INR)
Access Trip	1.92 (1.78)	14.64 (7.20)	14.13 (9.30)
Egress Trip	1.36 (1.28)	11.27 (6.52)	14.54 (8.74)
Total Trip	19.15 (9.78)	47.51 (23.68)	42.71 (14.49)

*Value in the parenthesis is the standard deviation

3.5 Likelihoods of Passengers

Respondents were solicited to express their likelihood in 'Yes/No' agreements that capture attitudinal loyalty of passengers. Figure 5 illustrates the questions asked to passengers which include their likelihoods of continuing metro usage in the future, shift due to fare hike, recommending metro to others, and limit driving. Besides, a question was asked to express their single most reason for riding Metro. About 68.22% of respondents likely to recommend metro to others and continue metro usage for their future years of travel. The question 'I like to shift due to the fare hike' was asked given 100% fare hike in the last year. Surprisingly, only 30% of respondents are willing to shift due to fare hike. Therefore, it can be evident that fare hike is not the only reason behind ridership decline. Furthermore, the majority of passengers agreed that metro saves time (65.94%) and frees from road congestion (20.13%) for their trips.

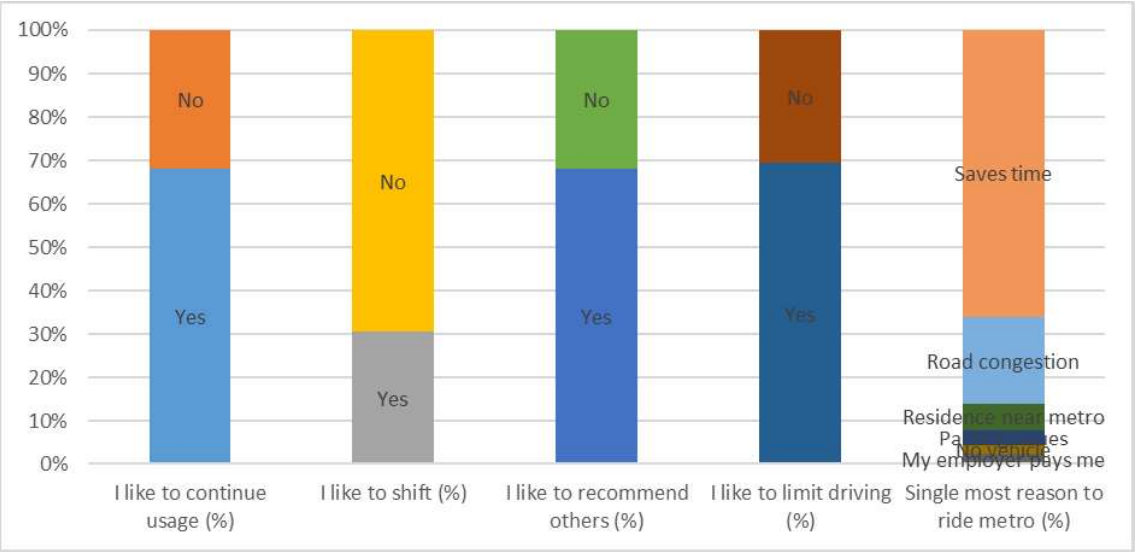

Figure 5. Likelihoods of Survey Respondents

3.6 Perceptions of Passengers

Finally, respondents were asked to provide their satisfaction on ten service quality attributes namely train cleanliness, personal safety, travel comfort, over-crowding, time reliability, security onboard, dynamic information, travel satisfaction, parking facilities, accessibility, and proximity on a scale of 1 to 5, where '1' is poor and '5' means excellent. The choice of service quality attributes is based on the deOna et al., (2020) study to assess service quality of

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public transit in Madrid, Spain. Passengers also rated their 'overall satisfaction' for transit service on same scale. It was observed from satisfaction data that respondents were highly satisfied to reliability (4.38) and less satisfied to personal safety (1.95) within transit service. It is attributed to the fact that Delhi metro has achieved 99%-time punctuality since 2013 (DMRC, 2019), but ranked 4th dangerous public transport among 15 largest capitals in the world due to overcrowding (UITP, 2016).

4. TRAVEL BEHAVIOR OF PASSENGER GROUPS

4.1 Identification of Passenger Groups

The passenger groups were identified based on the 'Yes/No' agreements of survey responses to attitudinal questions. The four likelihood agreements (Figure 5) has resulted in 16 combinations, out of which only four combinations were found reasonable and valid. For example, a combination is invalid if his/her likelihood is 'Yes' to continue using and 'Yes' to shift or 'Yes' to shift and 'No' to driving or 'Yes' to shift and 'Yes' to recommend others. Table 2 illustrates the four-passenger groups based on likelihoods to transit namely, (i) loyal (who are likely to continue the metro usage in the future, recommend others and limit driving and not likely to shift due to fare hike), (ii) chooser (who are likely to recommend others but shift due to fare hike and not likely to limit driving), (iii) captive (who are likely to continue using but not likely to shift and recommend others), and (iv) non-loyal (who are the rest). The study findings indicated that 48% (503) of survey respondents are loyal to Delhi Metro.

Table 2. Likelihood Combinations to Identify Passenger Groups

Passenger Groups	Likelihoods of Passengers				Sample Size (N)
	Continue usage	Shift	Recommend others	Limit driving	
Loyal	Yes	No	Yes	Yes	503
Chooser	No	Yes	Yes	No	225
Captive	Yes	No	No	Yes	212
Non-Loyal	No	Yes	No	No	108
Total					1048

4.2 Validation of Passenger Groups

This study conducts ANOVA tests on demographic and travel behavior variables to verify and validate passenger groups. Table 3 presents the description of variables within each passenger group. The demographic variables considered were age, household income, and vehicle ownership, whereas, travel behavior variables were years of riding Metro, total trip distance, trip time, access distance, access time, and acceptable walking distance to transit facilities. From the Table 3, it is evident that there exist significant differences (with 90% confidence, except age, and access time parameters) among passenger groups. It indicates that the segmentation of passenger groups based on their likelihoods (Yes/No) seems valid. Passenger groups who use transit by obliging due to lower income levels and longer trip distances are captive riders. Due to higher vehicle ownership (1.29), a choice rider can possibly switch from transit at any instance. Loyals have higher income levels, lower vehicle ownership, and access transit from longer distances, and use transit for longer distances. The travel behavior of loyal passengers is similar to "captives by choice" group of Van Lierop and El-Geneidy (2016) study, who are affordable to switch but choose transit for their daily trip. The rest of passengers belong to non-loyal group who like to walk less (570m) to reach transit facilities.

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Table 3. ANOVA Test Results on Passenger Groups

Dependent Variable	Passenger Groups				Overall Mean	Test Results	
	Loyals	Choosers	Captives	Non-Loyals		F	Sig.
Age	33.15	33.05	32.90	32.06	32.96	0.361	0.781
Vehicle Ownership	1.24	1.29	1.27	1.31	1.29	0.365	0.078
Household Income (INR.)	39295.23	36600.00	32737.96	36891.51	37554.58	3.379	0.018
Years of riding metro	6.10	5.75	5.95	5.10	5.77	2.699	0.045
Trip Distance (m)	19334.00	18492.89	19401.18	19160.19	19149.09	0.444	0.072
Trip Time (min.)	47.67	46.18	48.55	47.53	47.51	0.380	0.076
Access Distance (m)	1927.46	1730.89	2151.89	1699.44	1907.16	2.725	0.043
Access Time (min.)	13.36	13.60	14.58	13.15	13.64	1.617	0.184
Acceptable Walking Distance (m)	610.60	577.31	626.98	570.74	603.27	3.216	0.022
Acceptable Walking Time (min.)	7.66	7.43	7.91	7.34	7.64	1.512	0.021

These findings are interesting and emerging in two important inferences. Firstly, loyal and captive riders like to walk more or access from long distances to transit facilities, whereas, choosers and non-loyals does not appreciate it. On the other hand, captives are more reliable on transit facilities than loyal groups. These findings are consistent and add evidence to the existing studies that low-income groups living far from transit facilities force them to be captives (Zhao et al., 2014). Thus, transit facilities must focus to fulfil access needs of captive passengers. Secondly, there is a clear distinction between captive and loyal groups in terms of their demographics and trip characteristics. It also adds evidence to the previous findings that high-income group passengers become loyal if they are satisfied with transit usage (Minser and Webb, 2010; Van Lierop and El-Geneidy, 2016).

4.3 Travel Behavior of Passenger Groups

Multinomial logit (MNL) model was developed to investigate the differences in the travel behavior of passenger groups. MNL models are a flexible and most convenient form of analyzing a categorical dependent variable (Schwanen and Mokhtarian 2004; Kumar et al. 2018). Passenger group parameter as the dependent variable in the model controlled by socio-demographic and travel characteristics of passengers. Table 4 presents the variables that are statistically significant in any of the groups in the MNL model. Nagelkerke pseudo-R-square value shows that the model explained 63.1% of the total variance in the data, confirming the good fit of the model. The model has classified the passenger groups with 73.7% accuracy. MNL models compute odds ratio (OR) which indicates the effect of a parameter in one group over the reference group, controlling for all other parameters in the model. A parameter having OR value greater than one indicates that a one-unit increase in that variable will multiply the relative increase in the outcome group over the reference group and with OR less than 1, it is contrary.

The results based on socio-demographic characteristics indicate that the female respondent has a significant and negative correlation with loyal groups. This finding indicates that male passengers are more susceptible to be loyal, whereas females are more likely to be non-loyal. Age parameter is found to be the most significant factor for captive and loyal riders. This finding confirms the evidence from the previous studies (Rojas et al. 2018). Elders are more likely to be captives (85 times) than being loyal (21 times). These findings would assist transit providers to focus on female passengers to make them shift to loyal groups in the

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future years. Household income is another important parameter in segmenting passenger groups. High-income group passengers are more likely to be choosers and non-loyal. Employment status is not a significant parameter for loyal passengers. However, employed riders are mostly captive. As expected, vehicle ownership has a negative influence on captive groups, implicating that the unavailability of a private vehicle can be one reason for being a captive rider.

Table 4. Multinomial Logit Model for Passenger Groups (Ref: Non-Loyal)

Explanatory Variables	Loyal		Captive		Chooser	
	B	OR	B	OR	B	OR
Intercept	3.661		2.856		2.777	
Age (Yrs.)	3.057*	21.267	4.450*	85.601	0.355	1.426
Female (Ref: Male)	-0.666*	0.514	-0.760*	0.468	-0.412	0.662
Household Income (INR)	-0.295*	1.344	-0.776*	2.172	0.389*	1.475
Vehicle Ownership (Nos.)	-0.247*	0.782	-0.455*	0.635	-0.128	0.880
Employment Status (Ref: Student)						
Employed	0.423	0.655	1.536*	0.215	-1.997*	0.136
Retired	0.895	0.409	-2.323*	0.098	-0.885	0.413
Years of Riding Metro (Yrs.)	0.178*	1.195	-0.158	0.854	-0.183	0.833
Access Mode (Ref: Walk)						
Auto-Rickshaw	-0.943*	2.566	1.416*	4.120	0.743*	2.103
Bus	0.230	0.794	0.785	2.193	-0.230	0.794
Car	-1.309	0.270	-2.410*	0.090	-1.558	0.211
Two-wheeler	0.251	1.285	0.215	1.240	-0.329	0.719
Cycle	0.037	1.038	-0.174	0.841	-0.176	0.838
Access Distance (m)	0.317*	1.373	0.125	1.133	0.340*	1.405
Access Time (mins)	-0.165	0.847	-0.461*	0.631	-0.154	0.858
Access Cost (INR)	0.085	1.089	0.352*	1.422	0.045	1.046
-2 Log Likelihood						1654.221
Chi-Square (Likelihood Ratio)						899.649
Pseudo R-Square (Nagelkerke)						0.631
Sample Size (N)						1048

*indicates statistical significance at 95% confidence interval

Years of riding a transit service play a significant role in deciding the loyalty of passenger to that transit service. A passenger's years of riding metro explains 'from how many years the passenger is using the metro service rather than other competitive modes.' In our model, years of riding parameter is significant and positive for the loyal group, reflecting that higher the years of riding higher the probability of being a loyal passenger. Among all trip characteristics, only access characteristics were found significant in the model. Passengers use different access modes such as auto-rickshaw or e-rickshaw, bus, car, two-wheeler, cycle and walk to transit stations. Auto-rickshaw is a significant access mode for all passenger groups. However, loyal passengers prefer walking than using auto-rickshaw as access mode. Non-loyal group mostly and captive group least prefer a car. As expected, loyal passengers accept high access distances compared to all other groups, whereas, all passengers are less likely to spend their journey time at access ends. Captive riders are 42.2% more likely to spend in their access trips due to lack of choice. These findings indicate that the access

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characteristics of passengers provide a clear picture of the passenger group to which they belong.

5. IDENTIFYING PRIORITY SERVICE QUALITY ASPECTS

The present study employed ordinal regression models to identify priority service quality aspects for each passenger group. Table 5 provides the results of ordinal logistic regression models for each passenger group, where dependent variable is perceptions of 'overall satisfaction' and perceptions of ten service quality attributes as independent variables. The pseudo R-squared (Nagelkerke) values range from 0.308 to 0.431, indicating a good fit for service quality models (deOna et al., 2020). Overcrowding is found to be insignificant attribute for all passenger groups. For loyal group, cleanliness has the highest effect, followed by reliability and proximity on overall satisfaction. For choosers, safety on-board is found to be highly effective on overall satisfaction. Captives and non-loyals consider accessibility as most essential service quality attribute. As expected, fare has negative and significant effect on transit service quality (except for chooser group). Other attributes such as ease of information, security, and proximity also play significant role in influencing overall service quality of at least three groups.

Table 5. Ordinal Logistic Regression Model Results for each Passenger Group

Service Attribute	Loyals	Choosers	Captives	Non-Loyals
Cleanliness	0.639*	0.217*	0.072	0.337*
Safety on board	0.031	0.486*	0.045	0.065
Comfort	0.035	0.314*	0.076	0.254*
Reliability	0.575*	-0.01	0.015	-0.083
Over crowding	-0.036	-0.02	0.011	-0.041
Accessibility	0.224*	0.096	0.539*	0.504*
Security	0.005	0.263*	0.332*	0.129*
Fare	-0.404*	0.005	-0.459*	-0.259*
Ease of Information	0.317*	0.065	0.265*	0.297*
Proximity	0.543*	0.197*	0.223*	0.06
N	503	225	212	108
Psuedo-R2 (Nagelkerke)	0.431	0.316	0.411	0.308

*indicates statistical significance at 95% confidence interval

Table 5 allows us to identify following priority aspects for each passenger group:

- Loyals: cleanliness and reliability are most important attributes for this segment. It hints transit agencies to continue its performance in both these aspects. However, fare and proximity are other important service aspects that needs attention. It indicates that further increase in Fare could reduce satisfaction and thus loyal passengers to Delhi Metro.
- Choosers: safety, security, comfort, and cleanliness are priority aspects for this group. It implies that these passengers expect similar aspects of service with Metro, as they feel while using personal vehicles. Besides, choosers are more concerned towards proximity to transit facilities. Thus, providing transit facilities more closely to residential neighborhoods may transfer choosers to loyals.
- Captives: passengers of this group are more vulnerable to accessibility, and fare. This is as expected, and alarms Metro authorities to provide accessible, secure, ease, and

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proximate transit services to withstand captive riders. In any case, these passengers may jump to chooser or non-loyal group, owing to the presence of personal vehicle. In addition, a further increase in fare will have large effect on overall satisfaction, thereby, the possibility of migration.

- Non-Loyals: this group found unsatisfactory with cleanliness and fare of Metro services. In addition, these passengers look for comfort, accessibility, and ease of information as primary service aspects. Thus, to attract non-loyals, transit agencies must improve accessibility, cleanliness, and ease of information.

If chooser or non-loyal passengers are to be attracted to Metro usage, transit agencies must look at the service aspects that has greatest impact on their overall satisfaction. Such a comprehensive understanding about their perception of service quality will generate new ideas for retaining existing users, enticing new ones and increasing ridership.

6. CONCLUSIONS

The present study conducted a passenger travel survey that includes 1048 cleaned responses from 41 stations of two corridors (blue and yellow lines) of Delhi metro. This survey has informed all respondents regarding the purpose, motivation, and potential use of data before participating, to ensure the issues of confidentiality. Survey data includes socio-demographics, trip characteristics, likelihoods, and perceptions of passengers. Based on the broad literature review, four attitudinal statements on the likelihoods of the passenger were framed in the survey to capture the attitudinal loyalty of passengers. The 'Yes/No' agreements on these four statements have resulted in 16 combinations between them. Out of 16 combinations, only four combinations were found feasible and further grouped them as (i) loyal (503 individuals), (ii) captive (212), (iii) chooser (225), and (iv) non-loyal (108). The study identified about 48% of passengers belong to loyal group. Further, socio-demographic and trip characteristics were used to explore the travel behavior of passenger groups.

Transit agencies need to recognize that different passenger groups have different travel characteristics. Each passenger group should be treated separately to enhance transit ridership. Based on a comparison of results between different passenger groups, the study findings indicate following policy implications:

- Female passengers are volatile users and are more susceptible to be non-loyal and choosers. Such a finding is no surprise because only 9% of women feel safe in Delhi metro and rely mostly on other modes of transport due to distrust (UITP, 2016).
- Elderly passengers are more susceptible to be captives (85%) than being loyal (21%).
- Passengers from higher-income households are choice riders, since high-income passengers have affordability to switch to personal modes.
- Loyal passengers are riding Metro from longer years than any other groups.
- Access characteristics play a major role in differentiating passenger groups.
- Walking is most preferred access mode by loyal passengers, whereas, non-loyals prefer car.
- Loyal passengers accept high access distances, whereas all other groups are reluctant. The interesting finding is that captive riders are spending more time in their access trips due to lack of choice because the captive users in Delhi live farther from metro due to low housing costs (Van Lierop and El-Geneidy, 2016), and therefore, maybe more dependent on access modes.
- Each passenger group have diverse perceptions on service aspects. However, these groups converge in considering accessibility and fare as significant contributors of transit service quality.

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- Choosers and non-loyals are most vulnerable groups. These groups seek comfort, ease and security while using Metro services. Thus, transit agencies require much needed attention on these service aspects to attract new ones and increase transit ridership.

From the study findings it is evident that transit providers should provide seamless access opportunities to enhance travel experience in access journey. Planning strategies should be developed to assess how transit users are satisfied with access modes in detail. Although for captive and choice riders, the household income and vehicle ownership vary, they rely on auto-rickshaw at their access ends. For chooser, if he is satisfied at such ends to have the complete probability of switching to loyal group. Hence focusing on the captive group is a viable option for transit providers to enhance ridership. The major concern of the captive users is that they are mostly retired, elder and spend most their travel out of vehicle. Given this, transit providers must develop policy standards for elder and disabled users to increase loyalty among captives.

The findings from this study add a significant contribution to the loyalty literature from the Indian perspective. However, there are few areas that need to be focused on informing specific policy implications. Firstly, the study results have shown travel comfort, overcrowding, and reliability as poor indicators for measuring overall satisfaction. Therefore, the results are fairly general, and future research should attempt to assess these and other possible satisfaction attributes to further develop the understanding of the relationships between satisfaction and loyalty. Secondly, the study collected no information about how the service value and problem experience will influence passenger loyalty and satisfaction. Future research should focus on how the perceptions differ within each passenger group using SEM models. Also, studies on these relationships in a longitudinal approach demand more research.

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