



People's Preferences for Improvements in Public Transportation Systems: An Experience from India

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Abstract

This paper investigates the potential demand for improved bus service quality in India using the stated preference method. This paper evaluates the effect of passengers' socio-economic characteristics on their willingness-to-pay (WTP) for improved bus services by focusing on tradeoffs concerning the improvements to passengers' in-vehicle travel time and comfort level. The paper further compares more preferred improvements among the bus passengers between in-vehicle travel time and comfort level. The paper uses the ordered logit model to analyze decisive factors affecting the opinion of passengers' WTP for various improvement scenarios. Travel time, fare per trip, family monthly income, motor vehicle ownership, and age are found to be statistically significant to estimate the mean WTP. The results show that users consider the service quality of the public transportation system to be poor and are willing to pay for improved service qualities. As an exciting result, the collected data suggest that passengers are not willing to pay the same level towards improvements in travel time.

Keywords Willingness-to-pay · Stated preference · Improvement in bus service quality · Ordered logit model

Introduction

Efficient public transportation systems are essential for the sustenance and growth of urban centers. The role of public transportation has become even more significant in most developing and underdeveloped countries at present. The rapid growth of urban population countries has created a tremendous strain on all transportation systems, especially on roadways, with remarkable growth in vehicles over the last couple of decades. This growth, in turn, has contributed to increases in traffic congestion, air pollution, noise pollution, and other related issues [23, 26, 31]. The concern of

meeting the strained mobility demands with optimal utilization of existing facilities to provide better transport services and safeguarding the environment has thus imposed several challenges on the transport planners and environmentalists. The efficient public transportation system plays a massive role in shaping an active urban transportation system. Data from across the world, especially from developing countries, show that the share of public transportation among urban modes has been declining over the years, which is a cause of concern. Although the recent growth of personal vehicles can be a significant reason for this change, it would be worth investigating the role of service quality that the public transportation systems provide on the mode choice of its potential users. While the quality of service can have various definitions, travel comfort is of prime significance from a user's perspective. In low- and middle-income countries, most of the public transportation system provides poor travel comfort due to the challenges, including higher government subsidies and lower fares [22, 30]. In this paper, such a study is presented for Indian urban regions. The next section discusses the background and objective. It is followed by methodology, data analysis, results and discussion, and conclusions.

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Background

This section provides an overview of public transport in low- and middle-income countries and the challenges they have been facing over the years. People use a wide variety of travel modes in low- and middle-income countries. For example, in Indian cities, the modes include public and private buses, public and private-owned four-wheelers, three-wheelers, motorized two-wheelers, and bicycles. The share of public transport shows a declining trend with personal vehicles dominating the road transport in recent years. It is observed that from 1980 to 2004, the phenomenal growth of 20-fold was recorded for two-wheelers and eightfold for cars, while the increase was insignificant for busses. As a result, the share of buses in the vehicle population declined significantly [21]. Table 1 shows a continuous decline in the percentage of public transport between 1994 and 2007.

The rapidly increasing share of private vehicles has contributed to traffic congestion and other associated adverse effects. The primary reasons for this shift to private transport could be attributed to the liberalization of the automobile industry and improved users' economic status, which enables easier vehicle ownership. However, factors such as the inferior quality of service provided by public transport systems cannot be ignored [33]. These include lack of reliability, discomfort relating to space and seats inside the buses, and inadequate maintenance (Bhargab et al., 2014). In recent research, Sahu et al. [29] studied the impacts of various travel attributes such as waiting time, in-vehicle time, and crowding levels in suburban rail system on the user experience in Mumbai, India. Results show that a higher crowding level increases perceived in-vehicle travel time, which, in turn, will adversely affect the level of service offered by the system. The inability of public transport systems to meet the increasing demand concerning quantity and quality can be considered one of the primary reasons for the decline in this share of ridership.

A few studies have shown that users prioritize comfort over travel time (e.g., [3, 31]). The service attributes of

public transportation systems are expected to be compared with other modes, such as private vehicles. It is essential to make the system more efficient in operations and improve service levels to make public transportation systems attractive. However, this requires huge investments. Like in many other low-income countries, in India, public transportation systems are owned and operated predominantly by local governments. Even if private operators are allowed, fares are regulated by governments. Since most of the existing public transportation systems are already heavily subsidized, injecting more funds to improve its quality is challenging. It implies that the additional funding requirements have to be managed from efficient utilization of available resources, exploring alternate means of funding, and increasing fare. Elected officials consider the public transportation system as a political tool to please the voters. They do not take any bold steps such as increasing fare for improved quality of service, assuming it to be an unpopular measure. In the present context, when the users have more options available, it is essential to understand their requirements, so that the current share of public transportation can be maintained. As pointed out by Bhargav et al. [22], fare of the public bus service in India continues to remain a matter of concern with limited attention to improving the quality of service provision. It cannot be said with certainty that an increase in transit systems' capacity will arrest the shift of its current users to other modes of transport. In a study of TransJakarta Busway in Indonesia, Joewono et al. [14] showed that it is essential for the operators to provide standard service quality for its users to sustain long-term ridership.

The urban population is expected to double in the next 30 years [37], and with this, the travel demand will compound. Intracity travel demand in 1994 was 759 million person-km per day and is expected to grow to 2,511 million person-km per day by 2021 [28]. Table 2 shows the actual and projected per capita trip rate [35].

Influencing people to shift towards public transport is an essential strategy for sustainable urban growth as it provides various benefits compared to personal modes of travel. Thus, understanding people's opinions to endorse public transport and their willingness-to-pay (WTP) for improved service qualities is expected to provide interesting findings.

In the published literature, different WTP valuation methods have been proposed and used for various purposes. In the field of road transportation, WTP is used for carrying out research related to toll charges [27], traffic congestion [8, 25], road accidents [9], travel time [10, 12, 15], and qualitative service improvement [24]. Ahmed et al. [1] evaluated travel time-saving in Istanbul, Turkey. Li et al. [16] used WTP to estimate the value of reliability, scheduling costs, and reliability ratio for Australia. Li et al. [16] differentiated between objective and subjective measures of crowding in Sydney using WTP. In another similar study, Hensher et al.

Table 1 Share of public transportation in India

Class of city	Population (in millions)	RITES (1994)	WSA (2007)
1	<0.5	14.9–22.7	0.0–15.6
2	0.5–1.0	22.7–29.1	0.0–22.5
3	1.0–2.0	28.1–35.6	0.0–50.8
4	2.0–4.0	35.6–45.8	0.2–22.2
5	4.0–8.0	45.8–59.7	11.2–32.1
6	Above 8.0	59.7–78.7	35.2–54.0

Source: WSA Report [35]

Table 2 Per capita trip rate for all modes

Class of city	Population (in millions)	RITES	WSA	Projected (as per WSA Report)		
		1994	2007	2011	2021	2031
1	<0.5	0.77–0.89	0.76	0.8	0.9	1.0
2	0.5–1.0	0.57–1.00	0.81–1.02	1.0	1.1	1.2
3	1.0–2.0	0.89–1.10	0.98–1.25	1.2	1.3	1.4
4	2.0–4.0	1.10–1.20	1.20–1.29	1.3	1.4	1.6
5	4.0–8.0	1.20–1.35	1.30–1.50	1.5	1.6	1.8
6	Above 8.0	1.25–1.40	1.41–1.67	1.6	1.8	2.0

[11] presented a mode-specific WTP study for Sydney, Australia. The authors studied various public transit attributes, such as travel time, service frequency, and crowding. Chaturabong et al. [5] used WTP to evaluate the loss of life due to motorcycle accidents in Thailand. Luigi dell' Olio et al. [19] used WTP for providing information on waiting time, service quality in the multimodal area in the city of Santander. A few recent studies (example: [13, 16, 32] showed that passengers were willing to pay up for public bus trips if they offered superior interiors suited their needs, such as comfortable seating place and working place.

There are a few papers that employ the WTP method for various road transportation-related studies in India. Maitra et al. [20] used a WTP method in the context of rural buses. They observed higher willingness-to-pay for travel time for commuter trips and higher WTP for qualitative attributes for non-commuter trips. Basu et al. [2] highlighted the importance of WTP for addressing policy issues in reducing in-vehicle crowding levels, valuing qualitative and quantitative travel attributes influencing the attractiveness of suburban train service in Mumbai city. Maitra et al. [22] established that for captive riders, WTP is less than that for choice riders for bus service attributes in India. Chhotu et al. [6] studied improving safety standards on the state highway roads in the state of Bihar.

In summary, although there are quite a few studies conducted in WTP and public transportation systems, not much work has been carried out in low-income countries. One of the interesting problems from a low-income country's perspective is understanding whether people are willing to pay to improve in qualities such as travel comfort and reduced travel time. This paper's objective is to study the passengers' WTP for improvement in service quality of urban transit buses and determine factors influencing these decisions in India, a developing country.

Methodology

In this paper, the willingness-to-pay (WTP) by passengers is analyzed to understand their opinions on improving the service quality of public transit buses in India using data from

three metropolitan cities Chennai, Delhi, and Hyderabad. The public transport systems in these cities offer representative service qualities of those in most of the other major cities. The ordered logit model is used to analyze the passengers' preferences.

The ordered logit model is based on an unobserved latent variable, which, in this case, is the willingness-to-pay. The latent variable is modeled as a linear function of explanatory variables, and an error term. The essential explanatory variables in this paper are travel time improvement, cleanliness, and travel comfort. Also, this study uses family income, vehicle ownership, age, and education, among many other control variables. The error terms are assumed to be independently and identically distributed (i.i.d.)

The latent variable is not observable. In this paper, an individual ranking that has discrete values is observed.

Survey Design

A survey using a questionnaire was conducted to gather peoples' opinions on the quality of bus services at present and their WTP towards improving travel time and comfort. The survey also collected information on travel behavior, socio-economic, and demographic data. Trained graduate students administered the data collection on computer tablets running on the Android platform. The questions were straightforward and hence are not described here. However, the intricate part of the questionnaire is elaborated in the subsection. The survey used for this study is provided as part of supporting documents along with this manuscript.

Description of the Willingness-to-Pay Questions

Several published studies have identified travel time and travel conditions such as comfort and convenience as important factors for the users of public transport (e.g., [7, 17]). The existing levels of service are considered as the benchmark for this study. Therefore, the questions for WTP for improving travel time and comfort in the design of the questionnaire survey are assumed dependent on the travel time, and comfort level passengers presently experience in their travel along with the money spent on that trip. The survey

design provided options for three levels of improvement on travel time, four levels of improvement on comfort, and six choice options of WTP.

In the questionnaire, the value of fare was increased up to twice the prevailing fare, with an increment of 0.2 to analyze responders' WTP. The estimated values obtained were rounded off to the nearest integer value to make the questions realistic. In the remaining part of this paper, these increments in values are referred to as WTP0, WTP1, WTP2, WTP3, WTP4, and WTP5. These represent increments of 1.0, 1.2, 1.4, 1.6, 1.8, and 2.0 times the prevailing fares, respectively.

The value for travel time was scaled to 0.833, 0.667, and 0.500 times the travel time they experience at the time of survey rounded off to the nearest multiple of five. It may look not easy to achieve a 50% reduction in travel time in most parts of the world. However, this might not be impossible to attain in urban areas in several developing countries, including India, since the travel time typically experienced by passengers is exceptionally high. These proposed that travel time reductions can be achieved by providing dedicated lanes, limited-stop buses, signal preemption, and introducing systems such as Bus Rapid Transit. The idea to round off to the nearest multiple of five is because people perceive time in multiples of five. In the remaining part of this paper, the scaled values of travel time will be referred to as X1, X2, and X3, where X_i represents an i th level reduction in travel time ($i = 1, 2, 3$).

The level of comfort is described into four categories as follows.

- Level 1: Fully overcrowded, with passengers pressed to each other (non-air conditioned).
- Level 2: All the available seats are occupied, and a few passengers stand. There are a sufficient number of hand-rails for the standing passengers to hold (non-air conditioned).
- Level 3: All the passengers are seated (non-air conditioned).
- Level 4: Same as level 3, but on an air-conditioned bus.

Level 4 was introduced as there are a few air-conditioned buses introduced in urban regions under a new initiative. Pictorial representations of these scenarios were

used to explain these levels to survey participants. The numerical division of time and levels of comfort was intuitive and finalized based on a pilot survey. Table 3 shows an example of the table for a passenger who spends ₹20 for a 30-min trip. The passenger is asked whether he/she is willing to pay from the choice set for each improvement per trip. Depending on the respondent's answer, the question is repeated by increasing or decreasing the bid until the maximum willingness-to-pay for each travel time level is obtained. A similar procedure was used to collect the options of WTP for travel comfort level.

As the data were collected on computer tablets, these options were generated based on the initial user inputs. The user responses were directly imported to the workbook format for further analysis. Statistical software program STATA was used for data analysis.

Data Collection and Database Development

Primary data collection involved face-to-face interviews of passengers at major bus stations. As discussed previously, the survey questionnaire was developed on an Android platform and administered using computer tablets. The surveyors were given formal training, and a pilot survey was conducted to check responders' understanding of the questionnaire and to test the functionality of the Android application. After several changes to improve the questionnaire, the final surveys were administered in three cities, namely, Chennai, Delhi, and Hyderabad, in the months of January and February 2015. A total of 937 responses were obtained and were used in further analysis. The response rate was around 97 percent. The prime objective of the survey was to gather responses on WTP for each scenario, along with each respondent's socio-economic and travel characteristics.

The database composition of passengers' gender, age, monthly income, level of education, travel time for each trip, fare per trip, and scenarios for improvement travel time are presented in Table 4. The qualitative attributes were coded according to the levels, and quantitative characteristics such as fare and travel time were entered in the cardinal form.

Table 3 Question design for improvement in travel time

Select options in fare if travel time is reduced by						
Fare*	₹20	₹24	₹28	₹32	₹36	₹40
5 min						
10 min						
15 min						

*₹ is Indian Rupees. US\$ 1 ~ ₹ 75 as of June (2020)

Table 4 Demographic summary of respondents

Variables		Values
Observations		937
Gender	Male	86%
	Female	14%
Age (years)	15–20	9%
	21–35	62%
	36–50	25%
	51–65	4%
	above 65	0%
Education	10th and below	5%
	12th	19%
	Graduation	65%
	Post-Graduation	10%
	Doctoral	1%
Occupation	Job	56%
	Student	23%
	Business	19%
	Others	2%
Family monthly income (Rs/month)	Less than 5000	6%
	5000–25,000	36%
	25,000–50,000	42%
	50,000–75,000	14%
	Greater than 75,000	3%
Two-vehicle ownership	None	34%
	One	61%
	More than one	5%
Travel time (min)	44 (mean)	22 (std. dev.)
Average fare per trip (Rs.)	16 (mean)	10 (std. dev.)

Perception of passengers' present comfort level: Level 1: 22%; Level 2: 53%; Level 3: 16%; and Level 4: 9%

Model Development

Choosing a particular price alternative explained previously is a problem where the decision-maker (passengers) wants one option from a defined set of price alternatives. It is important to note that for a particular improvement in service quality, the decision-maker (the respondent of the survey) can choose only one price from a set of alternatives given in the survey. Hence, to model the choice behavior of each decision-maker, the theory of discrete choice was used in this study. As the different willingness-to-pay alternatives are ordered, the ordered logit model was used to analyze the data collected.

Probability of passenger i 's willingness-to-pay for one of the J set of alternatives is

$$\Pr(W_i = j - 1) = F(\lambda_j - X'_i\beta) - F(\lambda_{j-1} - X'_i\beta),$$

where $F(\bullet)$ is the cumulative density function measuring the probability of willingness-to-pay being less than the threshold level

$$X'_i = X_{ij} - X_{ik};$$

λ_j are the category threshold parameter that is estimated.

Assuming $F(\bullet)$ to be logistic function, the resultant probability model is ordered logit model. Ordered logit model is used in this study.

To interpret the coefficients of parameter estimates from the model, the sign of the coefficient only makes sense as the coefficients differ by scale factor. Therefore, we also calculate the marginal effects of regressor. The marginal effect of increase in regressor X_n on the probability of selecting alternative j is given by

$$\frac{\partial p_{ij}}{\partial x_{ni}} = [F'(\lambda_j - x'_i\beta) - F'(\lambda_{j-1} - x'_i\beta)]\beta_n.$$

Descriptive Data Analysis

This section presents the summary of responses by passengers towards improvement in travel time and comfort. This section also discusses their rating of preferred improvement options among travel time, comfort, cleanliness, and fare of bus services in the selected urban areas. Collected data showed that 68% of passengers were not satisfied with their travel time at the time of this survey. Figure 1 shows the summary of responses related to willingness-to-pay for various levels of improvements in travel time. This figure shows that 68% of the responders were not willing to pay any additional fare (WTP0) if the travel time decreased only by 17% from their current travel time. This percentage of responders who were unwilling to pay any additional fare fell drastically to 30% if the percentage reduction in travel time increased to 33%. The percentage of passengers willing to pay 20% extra from the present fare (WTP1) increased to 42% from 24% if the travel time was improved by 33 percent. However, if the travel time was reduced to half, 31% of passengers would pay 20% over the prevailing rate, and 34% of passengers were willing to pay 40% (WPT2) over their current fare. This response clearly indicates that passengers are willing to pay higher for improved public transport facilities. The willingness-to-pay over 40% of the prevailing fare was very less.

Perceptions of passengers' willingness-to-pay for improvement in comfort levels of buses are shown in Fig. 2. This figure shows that about 63% of passengers were willing to pay an additional 20% or more (WTP1, WTP2, WTP3, WTP4, and WTP5) for any level of improvement in travel comfort. Percent of passengers who were willing to pay 20%

more in their current fare was 26% for level 2 (from level 1) to 34% for level 3 (from level 2) and 29% for level 4 (from level 3). This is an exciting finding. This result indicates that a higher proportion of people were willing to pay for air-conditioned buses than from level 1 to 2. Overall, these data show that passengers are willing to pay for improved travel comfort levels.

The above discussion showed that passengers were willing to pay for improvement in both travel time and comfort. Figure 3 shows that passengers ranked travel comfort over

and above all service quality improvements, though they were willing to pay for both travel comfort and travel time improvement options individually.

Results and Discussion

This section presents the finding of the survey data using econometric analysis. Models were developed to find the relative influence of explanatory variables on WTP choice

Fig. 1 Willingness-to-pay for improving travel time

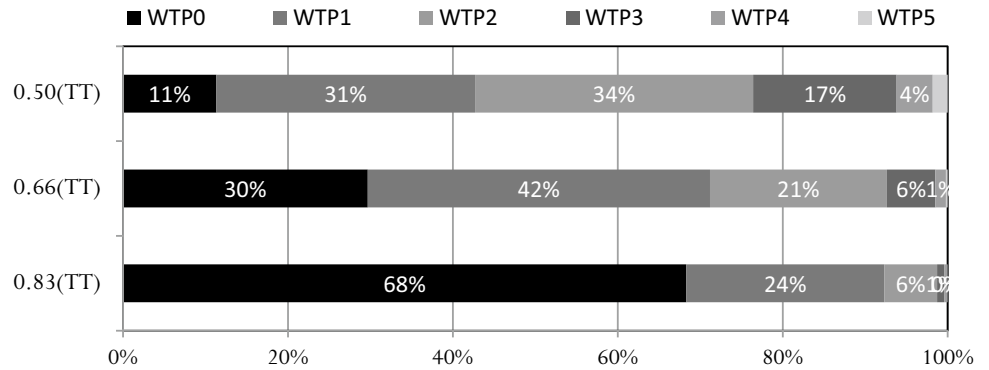


Fig. 2 Willingness-to-pay for improving comfort level

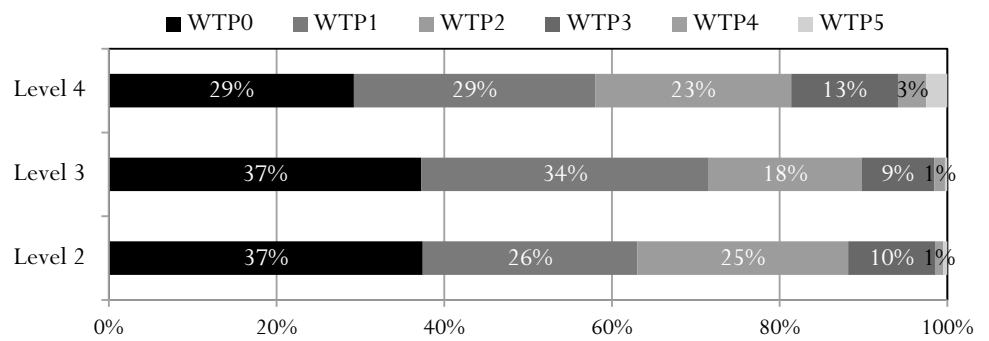
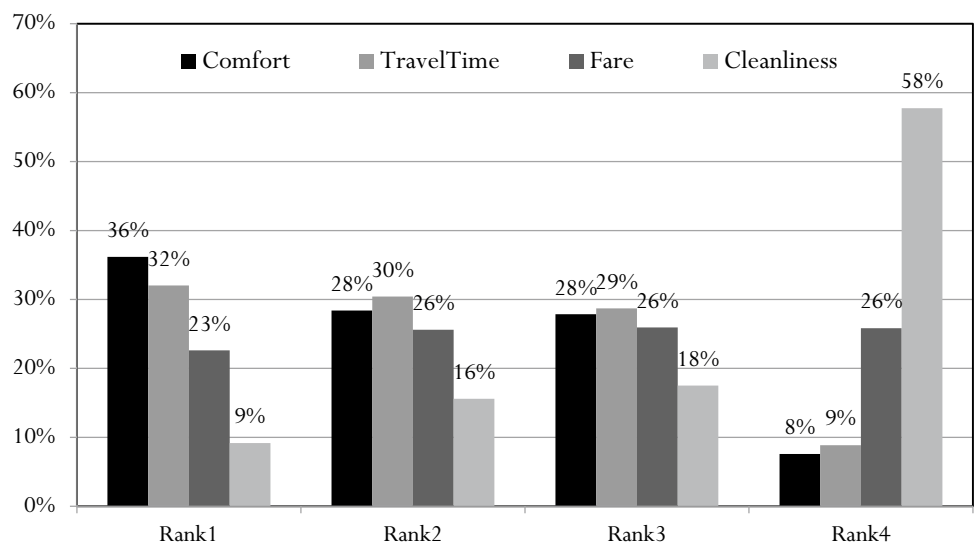


Fig. 3 Ranking of travel attributes



categories. Significant results are discussed in the following subsections.

Attributes Tested in the Models

The decision of passengers' willingness-to-pay over the reduction in travel time and improvement in comfort is expected to depend on their socio-economic, demographic, and travel characteristics. Therefore, models are generated to establish a relationship between their socio-economic, demographic, and travel characteristics. The variables are coded as required for the ordered logistic model using the maximum-likelihood estimator, as Long and Freese [18] described. The estimates of each model are presented in Tables 5 and 6.

The structure of these tables is as follows. Tables 5 and 6 show the variables tested in the model and their estimates along with respective z values. These tables also show estimates of marginal effects of explanatory variables for each choice category, assuming all other explanatory variables taking their average values for all the scenarios of improvements in travel time and comfort, respectively. It also shows the average predicted probabilities for each category of the regressor. The second part of the tables shows the value of the log-likelihood function, $L(0)$ when all the coefficients are assumed to be zero, and $L(\beta)$ for the fitted model.

Discussion on the Model for Improvement in Travel Time

Models have been estimated for three scenarios of improvement in travel time for the urban Indian bus service. Parameter estimates, marginal effects, and predicted probability for each scenario are tabulated in Table 5. As the ordered logit model is non-linear, marginal effects have been estimated and discussed. Results suggest that the null hypothesis that the estimated coefficients are jointly equal to zero is rejected at a one% level of significance for all the three improvement scenarios in travel time. Parameter estimates having a positive/negative sign indicates WTP increases/decreases with the regressor. Results from all the three scenarios of improvement in travel time suggest that, as expected, passengers with higher family monthly income are more likely to pay higher for improving their travel time. Passengers who own a motor vehicle yet use public transport will pay a higher fare for reduced travel time. This observation could be because these passengers choose public transit to avoid exposure to harmful driving factors, such as exposure to pollution and traffic congestion. For these groups of passengers, a reduction in travel time could be substantial, possibly one of the main factors that made them initially attracted to personal vehicles.

While looking at the variable fare per trip, as expected, the passengers are reluctant to pay higher fares for improvement in travel time as the fare per trip of passengers increases. Passengers who are higher on the fare per trip scale have a lower probability of being in the higher category of WTP for improvement in travel time. As the ages of the passengers increase, they are willing to pay higher to use the improved bus service. This result could be attributed to the rise in the value of time as one gets older and the chances of having a higher income as the age increases. The predicted probability estimated in the table for improvement in travel time evaluated at sample mean shows a substantial likelihood of passengers' WTP for improved bus service in terms of travel time. Overall, the willingness of passengers to pay higher for improved travel time is a good sign. This result means that the operators can afford to increase the fare to improve the quality of public transit services.

Predicted probabilities cannot assess the impact of change in explanatory variables. Therefore, the marginal effect for each explanatory variable has been evaluated and is presented in Table 5. The marginal effect shows the change in the predicted probability of WTP for each explanatory variable assuming all the other variable take their respective average value. The marginal effect of family monthly income is negative for the first WTP category for all the scenarios of improvement in travel time but positive for all other willingness-to-pay categories, except for the third level of improvement in travel time (X3), which shows a negative marginal effect for WTP0 and WTP1. This result indicates that passengers are willing to pay amounts higher than their present fares if their travel time is improved. Also, as the travel time scenario improves, the peak of the U-shaped marginal effect shifts towards a higher WTP category for better improvement in travel time. Parameter estimate of fare spent per trip for all the travel time improvement scenarios is negative, and the weight of marginal effect on fare per trip is minimal but worth discussing.

As the fare for the trip increases, the users are reluctant to accept a higher increase in tariff. This result shows that as the base fare increases, passengers are not willing to pay the same percentage increase in fare compared to passengers with lower base fares per trip. This response is understandable as for the same% value, and the higher base fare would mean that the passengers with higher fare will have to pay the more considerable difference in fare (from their respective base fare). Although 'travel time per trip' is not significant for travel time's first level of improvement (X1), the sign of the explanatory variable is consistent for all three levels of reduction in travel time. 'Travel time per trip' attribute is seen to be significant at 1% for X2 and X3. This result shows that as passengers' travel times increase, they are more likely to pay higher for reducing travel time. Marginal effects for WTP0 category are negative, indicating that passengers are

Table 5 Results for improvement in travel time

Variables	First-level improvement in travel time					Second-level improvement in travel time					Third-level improvement in travel time								
	Parameter estimates	Z value	Marginal effect (WTPi)			Parameter estimates	Z value	Marginal effect (WTPi)			Parameter estimates	Z value	Marginal effect (WTPi)						
			0	1	2			3	4	5			0	1	2	3	4	5	
Travel time per trip	0.006	1.51	-1	1	0	0	3.27	-2	0	1	1	0.010***	3.24	-1	-2	1	1	0	0
Fare per trip	-0.019**	-2.12	4	-3	-1	0	-0.015**	3	0	-2	-1	0	-0.006	-0.85	1	1	0	-1	0
Vehicle ownership	0.447***	2.79	-95	66	24	3	0.226*	1.72	-46	1	31	11	0.248*	1.89	-23	-37	18	30	9
Monthly income	0.400***	4.76	-85	59	22	3	0.402***	5.61	-82	1	56	20	0.448***	6.3	-42	-68	32	54	16
Age	0.065	0.65	-14	10	4	0	0.149*	1.72	-30	0	21	7	0.13	1.51	-12	-20	9	16	5
Average predicted probabilities, %			68	24	6	1			30	42	22	6			11	32	34	17	4
Log-Likelihood with all zero coefficients L(0)																			-1396.78
Log-likelihood of the model L(β)																			-1360.02
Number of observations																			937
Chi2 (5)																			73.52***
ρ2																			0.026

*Significance at 0.10 level

**Significance at 0.05 level

***Significance at 0.01 level

Table 6 Results for improvement in comfort level

Variables	Improvement from comfort level 2					Improvement from comfort level 3					Improvement from comfort level 4																								
	Parameter estimates	Z value	Marginal effect (WTPi)					Parameter Estimates	Z value	Marginal effect (WTPi)					Parameter Estimates	Z value	Marginal effect (WTPi)																		
			0	1	2	3	4			5	0	1	2	3			4	5	0	1	2	3	4	5											
Travel time per trip	0.004	0.46	-1	0	1	0	0	0	0.008**	1.83	-2	0	1	0	0	0	0	0.001	0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fare per trip	-0.043**	-1.96	10	0	-6	-3	0	0	-0.038***	-3.8	8	-1	-5	-2	0	0	0	-0.014**	-2.01	2	1	-1	-2	-1	0	0	0	0	0	0	0	0	0	0	
Vehicle ownership	-0.137	-0.49	32	0	-18	-11	-1	-1	-0.049	-0.32	11	-1	-6	-3	0	0	0	0.011	0.09	-2	-1	1	1	0	0	0	0	0	0	0	0	0	0	0	
Monthly Income	0.412***	2.85	-96	0	55	33	4	4	0.461***	5.39	-100	11	57	28	4	1	1	0.241***	3.32	-42	-18	19	26	9	7	0	0	0	0	0	0	0	0	0	0
Age	-0.065	-0.33	15	0	-9	-5	-1	-1	0.1420	1.33	-31	3	17	9	1	0	0	0.101	1.07	-18	-8	8	11	4	3	0	0	0	0	0	0	0	0	0	0
Level of comfort	-	-	-	-	-	-	-	-	-1.662***	-10.02	361	-39	-204	-101	-14	-3	-3	-0.696***	-6.97	122	52	-54	-74	-25	-20	0	0	0	0	0	0	0	0	0	
Average predicted probabilities, %																																			
Log-likelihood with all zero coefficients L(0)																																			
Log-likelihood of the Model L(β)																																			
Number of observations																																			
Chi2 (5)																																			
ρ2																																			

*Significance at 0.10 level
 **Significance at 0.05 level
 ***Significance at 0.01 level

willing to pay an amount higher than their current fare to decrease travel time. Also, passengers who experience travel time above the mean travel time are willing to pay higher as they would save a considerable amount of time compared to passengers who experience lower travel time. The marginal effect of motor vehicle ownership has a negative effect on the first category of WTP for all travel time improvement scenarios, but is positive for other WTP categories. This result indicates that these passengers are willing to pay a higher fare for improved bus service if the travel time is improved.

Discussion on Models for Improving the Comfort Levels

In this section, the results of models estimated for improvement in the level of comfort are discussed. The results are tabulated in Table 6.

Three models were generated for each level of improvement in comfort. The survey structure produces data only for the next higher improvement in the level of comfort from the present level of comfort passengers' experience. From chi-square statistics, one can see that the null hypothesis that the estimated coefficients were jointly equal to zero for the model on improving comfort to level 2 was rejected at a 5% level of significance. The null hypotheses for improving comfort levels to 3 and 4 were rejected at a 1% level of significance. 'Fare per trip' and 'monthly income' were the parameters showing the significance for improving the comfort to level 2. Along with the fare per trip and monthly income, the prevailing level of comfort they experienced was significant for improving comfort to level 3 and 4.

The interpretations of parameter estimates are very much similar to that for improvement in travel time. As the family monthly income increased, passengers were likely to pay more to improve comfort, but as the fare per trip increased, they were less likely to pay more for improvement in the comfort level. 'Level of comfort' was significant for the parameter for improvement to level 3 and level 4. Data showed that the passengers in the lower comfort category were willing to pay a higher fare for improving their comfort. This result is logical as these passengers are affected the most by the bus services' poor comfort levels and would welcome a change in the system and are willing to pay for that. This result is a very positive finding for operators, indicating that services with inferior service quality need to be upgraded even if it means higher cost transfer to passengers, as passengers are willing to accept that change in fare. Since political decisions profoundly influence changes in fares in public transportation systems, this result is expected to be a positive finding. The results of marginal effects also show a similar effect as that described in travel time. For families with higher monthly income, the probability of selecting

WTP2 is the highest for improvement to level 2. As the levels of comfort improve, their WTP also increases. Thus, it can be interpreted that, in general, passengers are willing to pay higher for better improvements in the level of comfort.

Mean Willingness-to-Pay Value

The mean WTP is calculated using the equation proposed by Dissanayake et al. [9]. The mean WTP is estimated using the following formula:

$$W = \sum_{n=1}^N \frac{[\sum w_i P_n(i)w(i)]}{N},$$

where W = Mean WTP in terms of the ratio of maximum fare. $P_n(i)$ = Probability that individual n chooses alternative i . $w(i)$ = WTP choice option i expressed as the ratio of choice in fare to their present fare. N = Total number of individuals. The mean willingness-to-pay values for improvement in travel time and comfort are as shown in Table 7.

The mean WTP value for each scenario of improvement in travel time and comfort is evaluated in Table 7. This table shows that passengers were willing to pay about a 9% increase in fare for about 16% saving in their travel time. Also, passengers on an average were willing to accept a 35% raise in fare for a 50% reduction in travel time. Similarly, the mean WTP for level 2 type of comfort is about 20% higher than base fare, while WTP for other levels is comparable with that for travel time. Although it is difficult to compare the information of two separate qualitative data (although they are from the same survey), the willingness-to-pay analysis is expected to take care of it to an extent. Table 7 shows that passengers were willing to pay more for travel comfort than travel time, complementing the preliminary analysis shown in Fig. 3, and that passengers rank improvement in comfort level higher over travel time.

Conclusions

The pace of expansion or improvement of public transportation in India is languid compared to the growth of its demand. In most cities, public transportation facilities' performances in terms of either travel time or comfort are way below acceptable standards. Along with the increase in

Table 7 Mean Willingness-to-Pay value

Travel time	X1	X2	X3
WTP	9%	23%	35%
Comfort	Level 2	Level 3	Level 4
WTP	21%	23%	32%

the country's GDP, people's purchasing power has also improved. The affordability of purchasing personal vehicles has led to people shifting towards private cars for the daily commute. Providing better public transportation services is challenging as it requires significant investment and planning by the authorities. The strategy to increase the share of public transport (with reference to public buses) can only be achieved if the service quality of the public bus system is improved, especially when passengers have several options. The results presented an overall view of passengers' inclination towards the willingness-to-pay for improved public bus service. The data collected for this study showed that the factors affecting the willingness-to-pay for passengers included family monthly income, motor vehicle ownership, travel time, fare, age, and present crowding level. Marginal effects for each of the factors are evaluated to understand the relative importance of each of the variables.

This study made some interesting findings. These observations are relevant from a policy perspective. It is observed that, as passengers' monthly incomes increase, passengers are more likely to pay for improvement in service quality. The results also show that a passenger who owns at least one motor vehicle is willing to shift to the improved bus service. This result implies that passengers are willing to shift from private to public transport, provided that the service qualities are improved. The ranked preference and mean WTP calculated show that Indian urban bus passengers prefer improvements in travel comfort to improved travel time. This result is fascinating. At the same time, this result is understandable as the passengers in urban areas of India might have incorporated daily travel time into their schedule and would prefer to travel comfortably during their travel time. It could also be due to these services' abysmal comfort level, especially during peak demand hours. The critical conclusion of passengers willing to pay more for improved bus service should assure the operators of the public transit facilities that, in general, people are not against paying more for improved services. The findings from this study are expected to be of great value to the operators and administrators from other developing economies who face similar challenges [4, 34, 36, 38].

One of the major limitations of this study is that due to the limited resources, the responses were collected only from three metropolitan areas. While there are valid reasons for selecting these cities, data from some Tier II or Tier III cities need to be collected and analyzed to have a comprehensive understanding of people's preferences. After understanding the people's opinion on improving service quality, analysis needs to be carried out to evaluate the financial viability for improving such service quality, especially for a middle-income country like India. Further study can be carried out to analyze using a random coefficient heteroscedastic ordered response logit model.

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