Drivers' willingness to shift towards electronic toll collection system in india

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ABSTRACT

Electronic toll collection (ETC), locally known as the FASTag system in India, has been made compulsory for payment of tolls on all National Highways (NHs) from January 2020. The users are thus adopting the newly developed FASTag system for toll payment, but the penetration rates are very low. The present research aims at studying the factors affecting road users' willingness or unwillingness to use the FASTag. The nationwide survey data are collected from the different vehicle users using an online survey and personal interview methods. Various trip-related parameters like vehicle type, trip purpose, etc.; attitudinal parameters like awareness of toll roads, and current toll rates; FASTag-related parameters like awareness of FASTag, and having or not having the FASTag, and socioeconomic and demographic parameters like age, gender, monthly income, etc., are considered in developing the questionnaire. Analysis of these survey data showed that drivers of big cars, Bus, multi axel vehicle (MAV) and Truck Trailers are more willing to use the FASTag facility to pay toll. A willingness to adopt the FASTag model is developed using the binary choice model. The results showed that trip-related attributes such as vehicle class, trip purpose and trip frequency significantly impact willingness to own FASTag. Further, awareness about FASTag is one of the important factors for shifting towards the FASTag system. Moreover, frequent users passing during peak hours are more likely to use FASTag. Also, the users who are in service, either Government or Private, have shown more willingness to adopt FASTag than those who are unemployed. Further, the stated preference analysis is also carried out for framing possible policy measures to increase the FASTag share. The outcome of the present study is expected to provide essential inputs to the policymakers for enhancing the adoption of FASTag among toll road users.

1. Introduction

Increasing population and urbanization increase the burden on the transportation system and infrastructure. The rapid economic and social development growth has led to the intense requirement for road networks in India. India is in the second position in the road networks, with more than 58.97 lakh km of road networks. India has approximately 4.87 km of roads per 1000 people (MoRTH 2019). The National Highway (NH) length has seen an annual growth rate of 7.3% during 2010–11 to 2015–16. The total registered vehicles in the country grew at a Compound Annual Growth Rate (CAGR) of 9.9% between 2006 and 2016 (Government Of India (GOI) 2015). Considering this extensive growth of vehicular ownership, the Indian Government has started a greatly expanded flagship program that is National Highways

Development Projects (NHDP), with an expected expenditure of rupees 6,000 billion (https://www.morth.in). Thus, government officials and private stakeholders are shifting towards using Intelligent Transportation Systems (ITS) applications to cater to this increasing demand. The ITS provides an integral connection between all the facilities, like intersections, highways, etc., used by the user, and surrounding infrastructure, enhancing safety and mobility.Table 1.

Toll collection all over the world started with the manual toll collection (MTC) system, which now shifts towards the electronic toll collection (ETC) (called FASTag system in India), an ITS-based system. The ETC allows users to pay the toll with the help of sensors and transponders. Initially, Radio Frequency Identification (RFID) tags are installed on the vehicles, and accordingly, the tag reader collects the information by scanning the RFID tag. Finally, it deducts the toll amount

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Table 1
Summary of literature review.

Reference	Study Area	Modelling Framework	Number of Samples	Respondents	Survey Method	Main Aim of the study	Factors considered
Odeck and Svein, (1997)	Oslo	Logit Model	1100	Residents	Telephonic Survey (Random Sampling)	Public perception for the implementation of toll roads	Respondents socioeconomic, demographic and trip characteristics and the year of the survey
Yelds and Burris (2000)	Lee Country, Florida	Descriptive statistics	400	Residents using the facility at least three times a week	Telephonic Survey (Random Sampling)	To find the factors affecting participation for the Variable Toll Pricing Program	Socioeconomic factors such as gender, age, monthly income, household type, education, employment type. Trip-related characteristics as trip purpose, last trip length
Schade and Schlag, (2003)	European cities	Stepwise Multiple Regression	952	Motorists	Telephonic Survey (Quota Sampling)	Factors affecting the acceptability of public pricing policies	Respondents socioeconomic, demographic and trip characteristics and stated preference for different schemes consisting of variable charges and revenues
Jaensirisak et al., (2005)	Leeds and London	Logit Model	830	Car, Bus and other mode users	Not mentioned	Factors affecting the acceptability of public pricing schemes	Respondents socioeconomic, demographic, and trip characteristics and stated preference for different schemes
Podgorski and Kockelman (2006)	Texas, United States of America	Ordered probit and binomial and multinomial logit models	2111	Random Households	Telephonic Survey (Random Sampling)	To know the public perception about the toll roads	Demographic variables, trip-related characteristics and perception and willingness variables (called as dependent variables in the study)
Jou and Yeh, (2013)	Taiwan	Mixed Logit Model and Elasticity analysis	2339	Passenger Car users	Telephonic survey	Effect of toll rates on drivers' choice behavior	Drivers background information, Travel characteristics, and different combinations for price and travel time saving
Jou et al., (2013)	Taiwan	Spike Model	1077	Small Passenger Vehicles users	Not mentioned (Random Sampling)	Factors affecting drivers' willingness to shift to Onboard Unit for ETC system	Drivers background information, Travel characteristics, willingness to use OBU, and scenario for different discounts and OBU price.
Gomez et al., (2017)	Spain	Tobit Model	3204	Random (Current and potential toll road users)	Telephonic survey and Face to face interview	Willingness to pay for inter-urban toll roads	Socioeconomic and demographic characteristics, trip related and region of residence
Heras-Molina et al. (2017)	Spain	Binary Logit Model	3043	Random (Current and potential toll road users)	Telephonic survey and Face to face interview	Willingness to shift to ETC system and drivers' attitude towards ETC	Socioeconomic and demographic characteristics, trip related, attitudinal variables
Sugiarto et al., (2018)	Jakarta, Indonesia	Bivariate Response Model	1998	Car users	Direct interview method	Factors affecting Road pricing scheme and alternative pricing scheme that is Parking Deposit System (PDS)	Socioeconomic and demographic characteristics, trip related, and specific choice attributes
Belgiawan et al., (2019)	Jakarta, Indonesia	Random Regret Minimization Model	507	Car and Motorcycle users	Online survey	Effect on the Mode choice due to different pricing	Socioeconomic and demographic characteristics, travel time and cost factors
Sunitiyoso et al., (2020)	Jakarta, Indonesia	Binary Logit Model	356	Private vehicle users	Online survey	Factors affecting the use of Electronic Road Pricing (ERP) system	Sociodemographic condition, traffic management strategies perception, and road pricing revenue allocation perception
Swami et al., (2021)	India	Descriptive and Elasticity analysis	770	Small Car, Big Car and Light Commercial Vehicles	Online survey	Main factors promoting the use of distance-based tolling in India	Socioeconomic and demographic characteristics, trip related, attitudinal variables
Glavić et al., (2021)	European countries	Structural Equation Modelling (SEM)	284	Passenger Car users	Paper-based questionnaire survey	Factors affecting the choice of distance based and time-based pricing schemes	Socioeconomic and demographic characteristics, trip related, ETC experience, technical characteristics
Adurthi et al., (2022)	India	Multinomial Logit Model	550	Car, Bus, Light Commercial Vehicles, Heavy Commercial Vehicles	Face-to-face survey and online survey	Factors affecting different pricing schemes for Indian conditions	Socioeconomic and demographic characteristics, trip related, attitudinal variables

from the patron's account. In this system, the drivers need not stop to pay the toll; hence, they can move at cruising speed, thus decreasing the transaction time and increasing the toll plaza throughput (Jun-long, 2015; Mahdi et al., 2019; Zarrillo and Radwan, 2009).

India, a developing nation, started projects under a public–private partnership (PPP) basis for the development of highways. Till December 2019, MTC prevailed for toll tax collection (Bari et al., 2019; Navandar et al., 2017). Though the ETC system was started from 2014 in India but

Table 2
Vehicle type considered Source: (Y. V. Navandar et al., 2019a).

Sr. No.	Vehicle Class	Vehicle Included	Average Length (m)	Figure	Toll rate ($/km)
1	Small Car (SC)	Car (All Hatchback and Sedan with engine capacity < 1400 cc)	3.72		0.0086
2	Big Car (BC)	Big Utility Vehicle (All SUV and XUV having engine capacity > 1400 cc)	4.58		0.0086
3	Light Commercial Vehicle (LCV)	Light Motor Vehicle	5.00		0.0139
4	Bus	Standard Bus	10.30		0.0291
5	Heavy Commercial Vehicle (HCV)	2 to 3 Axle Truck	7.20		0.0318
6	Multi-Axle Vehicle (MAV)	4 to 6 Axle Truck	11.70		0.0457
7	Trailer	More than 7 Axle Truck	15.60		0.0556

*1 Dollar ($) = ₹75.43 (as on April 22, 2021, https://www.xe.com/currencyconverter/convert/?Amount=1&From=USD&To=INR)

not made compulsory for toll payments. However, from January 2020, the ETC system, commonly known as FASTag, became mandatory for paying tolls on National Highways (NH's) for the vehicles equipped with FASTag, such as Cars, buses, trucks, etc. (TOI, 2020). They have to pay with FASTag compulsorily and hence don't have the choice to use the MTC lane. At each toll plaza, only one lane to each traffic direction is kept as an MTC lane for exempted vehicles such as agricultural tractors, motorized two-wheelers, etc., and for the discounted local vehicles that use the MTC system (Ministry of Shipping Road Transport and Highways, 2008). The MTC lane is generally kept as the extreme last lane, so the MTC users might shift to the extreme lane at the start of the flare area. As the ETC system is new in the Indian market, the study has been undertaken to investigate the adoption of the FASTag by users. Many studies focused on user's perception about toll roads (Gomez et al., 2017; Heras-Molina et al., 2017), but mere research is done on the willingness to shift towards an ETC system considering the different factors. Hence, the willingness to own a tag depending upon various parameters is thoroughly investigated in the present study, and a binary choice model is proposed.

2. Literature review

Various studies are carried out using users' perceptions to model the dynamic payment, accident prediction, level of service, tollbooth operator's behavior, willingness to own tag, etc. Some of the studies are discussed below.

Yelds and Burris (2000) carried out a telephonic revealed preference survey about variations in travel patterns due to the variable pricing scheme. Authors found that significant differences exist between employment type and household size among the users participating in the variable pricing scheme. A study done by Podgorski and Kockelman (2006) in Texas focused on understanding public opinion about toll roads. The results showed that the users continue to use the same toll road when the tolls were abolished from existing roads, accepting higher

toll charges from trucks and without congestion charging for rush hours. Binary logit and multinomial logit models were developed to check the effect of demographic factors on perception. Results revealed that the more educated people supported toll roads but retried, and males opposed the toll projects. Xie and Olszewski (2011) studied the effects of variable pricing schemes on traffic using Electronic Road Pricing (ERP) system data. The authors developed vehicle class-wise logit models to predict the difference in users' travel behavior. Jou and Yeh, (2013) researched the willingness to pay for distance-based tolls in Taiwan. The result showed that the trip purpose, toll rates, time of freeway use, etc., are the significant factors for adopting the distance-based policy. Jou et al., (2013) studied the willingness to pay for the onboard unit (OBU) for freeway drivers. They concluded that the government prices were too high than the users willingness and hence, the suggestion of giving discounts, bonus points, etc. were given. Holguín-Veras et al. (2016) used discrete choice models to study the effectiveness of time-of-day pricing with the data from stated preference survey in United States (US). The results showed that the drivers' decision to use the ETC system or cash payment is highly correlated with the time of travel of users. Jou and Huang, (2014) studied the willingness to pay for tolls and on-board unit for short distances. They found that the less frequent travelers have less affinity towards paying tolls. Cheng et al. (2016) used a binary choice model to study the effect on mode choice by different socio-demographic parameters for low-income groups. Heras-Molina et al. (2017) studied drivers' attitudes to own the tag for the ETC system in Spain using the binary choice logit model. Authors found that trip-related factors mainly affect drivers' choices rather than socioeconomic factors. Further, the author suggested that if tag were sold for free, the percentage of ETC use would be higher. Gomez et al., (2017) analyzed the users' attitude towards willingness to pay (WTP) toll due to the disproportionate distribution of toll roads in the region. Authors used the binary logit model and censored regression (tobit) model to find drivers' perception and WTP in Spain. Authors found that the drivers' experience with toll roads, regional differences and the quality
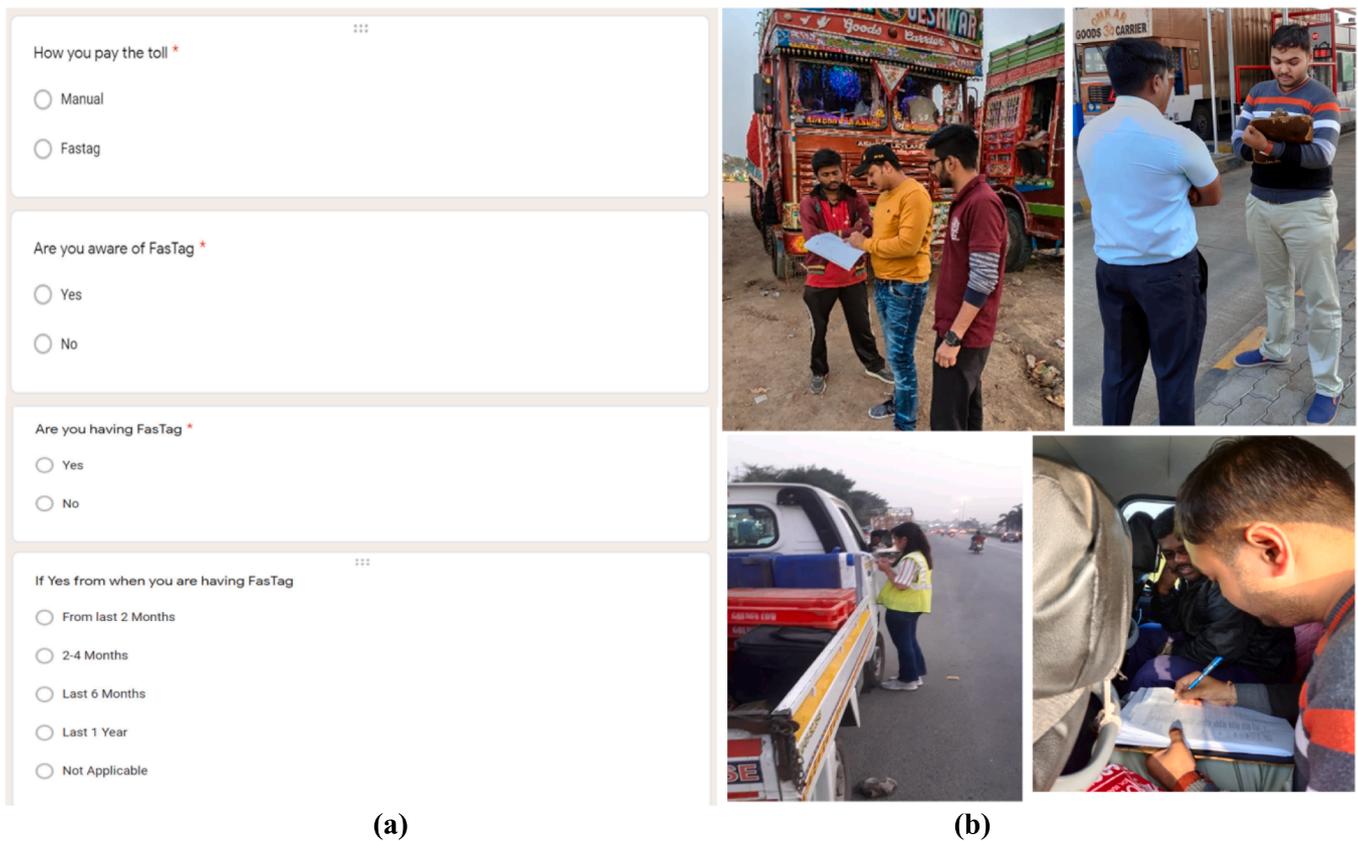
Fig. 1. (a) Online survey form (b) Field personal interview.

of alternative roads are essential for WTP decisions. Moreover, the results show that different policies in different regions in the same nation causes negativity in the drivers' mind about toll. Swami et al., (2021) studied the users' willingness for dynamic toll pricing in India. The results showed that most of the users were willing to shift for morning peak at a maximum discount of 25% in toll fares.

From the extensive literature review, it is found that users' perception is a necessary parameter for the acceptability and implementation of any policies related to road pricing. Further, the studies were mostly focused on the user's perception towards the implementation of different road pricing policies or congestion charging. Many of them are from developed countries. As observed from the literature, willingness to shift for an ETC system and the factors affecting the shift are important aspects that need to be studied before implementation. Considering India as a developing nation, no specific study was devoted to study drivers' perception for the ETC system, and hence, the present study is undertaken to analyze the factors affecting the drivers' willingness to own FASTag. Further, the reasons for not using FASTag and possible policies to increase the share have also been studied.

3. Data collection

In line with the objectives of the present study, the data is collected through a nationwide preference survey of the users. The survey was carried out in two ways for the present work. Firstly, with the help of google form (online survey) and other by means of personal interviews of the drivers. Personal interview was carried out within the vicinity of toll plaza areas, hotels and petrol pumps receding nearby the toll plazas. The survey was carried out from 15th February to 29th February 2020. The data is intentionally collected for this period, as the FASTag is made mandatory from 15th January 2020 in India and the selected period is the high time when users have to be habituated for the adoption of the new system. The data for the personal interview is collected from

different classes of vehicles at different toll plazas covering the peak and off-peak hours to get the variability in the dataset. The target population for the present survey is the driver/user who uses the toll roads for travelling with or without FASTag.

For any users' perception-based surveys, the most vital thing is the design of the questionnaire (Gomez et al., 2017; Petrik et al., 2016). The questionnaire should cover all the factors related to the objectives of the study. For the present study, the questionnaire is designed to reveal the present use of FASTag in India, and the factors affecting to own the FASTag. The questionnaire is designed in four different blocks (i) trip-related information (ii) attitudinal variables (iii) FASTag-related attributes (iv) socioeconomic and demographic factors. The trip-related variables include vehicle type, frequency of road users and trip purpose of the user (Gomez et al., 2017; Heras-Molina et al., 2017; Odeck and Svein, 1997). For vehicle type data, the seven classes of vehicles are considered, as noted in Table 2, depending on the length of the vehicle (Navandar et al., 2019a). Toll rates for each vehicle class are also given in Table 2 (MoRTH, 2011). The different categories of vehicle are taken to consider the drivers' behavior regarding the service time, delay and payment method. Five types of trip purposes, i.e., work, educational, commercial, social and others, are considered for the present study. The work trip purpose consists of the users going for the job, i.e., employment purpose while those in educational trips consist of trip for educational institutes. The commercial trip in the present study is the trip related to commercial activities such as freight pickup and delivery and that having long distance travel (Campbell et al., 2018). The social trips consist of the trips for the social purpose such as meeting with the family, friends, etc. The class others consist of all the remaining trips such as recreational, shopping, etc.

Similarly, the attitudinal variables, which are based on individual users' experience, such as prior awareness of toll roads, perception about the current toll rates, and using any other route to reach a destination other than toll road, etc. are considered (Heras-Molina et al.,
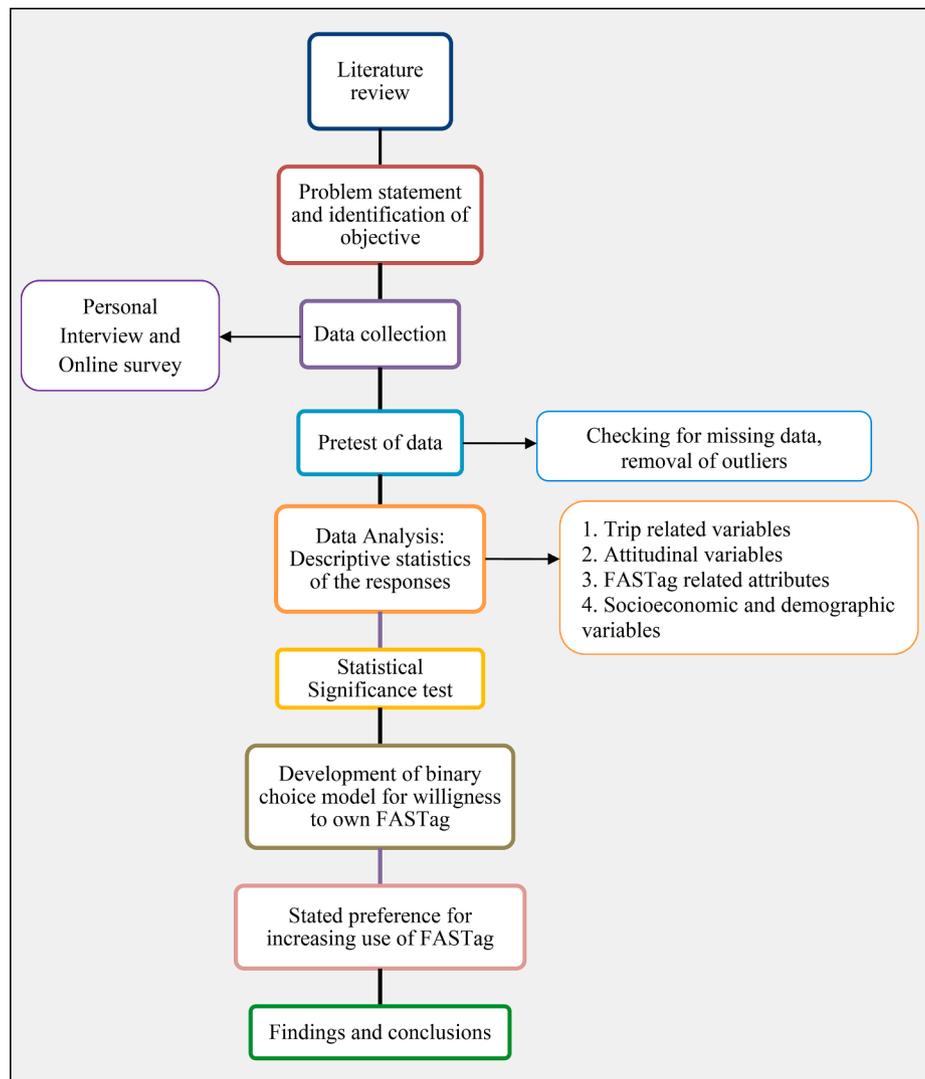
Fig. 2. Methodology of the present study.

The trip-related data set is collected to know the user's trip aim and features. However, the attitudinal variables help us to understand the different attitudes and perceptions of the users residing in various parts of the country. These different perceptions and awareness may affect the driver's shift towards the ETC system. Further, the FASTag-related attributes give insights into the current situation regarding the penetration of the FASTag in India and also lighten the possible reasons for the willingness to own FASTag. Last but not least, demographic and socioeconomic parameters help us to correlate the different possible factors affecting to the users for owning the FASTag.

The sample questionnaire for the online survey is shown in Fig. 1 (a), and the data collection by personal interview is illustrated in Fig. 1 (b).

4. Methodology of the present study

The main objective of the study is to find out the possible variables that affect the driver's perception about owning the ETC system in India. The possible variables are examined from the available literature. To meet the prescribed objectives, the data is collected using a questionnaire survey through personal interviews and an online google form survey. First, the pilot study was carried out, and the insignificant factors were removed. Some suggestions were given by the respondents while the pilot survey was incorporated into the final survey. The final collected responses were then checked for missing data, and outliers were removed with the help of the Mahalanobis D^2 equation (Finch, 2012; Penny, 1996).

Hypothesis testing is used to determine whether significant differences exist between the two categories of respondents, one having FASTag and the other not having FASTag. For that purpose, two hypotheses are modulated, one being the null hypothesis assumes that the means of both the samples are the same, and the alternate hypothesis states that there exists a significant difference between the two categories of respondents.

The chi-square test is carried out to check whether a statistically significant difference is present between observed and predicted values (Hecke, 2012; McDonald, 2014; Yelds and Burris, 2000). The test is carried out at a 95 % confidence interval. If the p-value is less than 0.05, then there exists a significant difference between the two categories of respondents.

Further, the binary logit model is used for the development of a model aimed at drivers' willingness to own FASTag. Choice models are mostly used to analyze the drivers' perception to opt for any system or

facility using stated preference survey data (Polydoropoulou and Ben-Akiva, 2001; Twaddle, 2016).

Choice models are econometric models based on the assumption of utility maximization, which means the person made a choice that offers greater personal utility to that individual (TRB, 2012; Twaddle, 2016). Consumer and psychological theories of microeconomics are incorporated into binary choice models. Binary choice models are used in situations having only two choice sets. The binary choice model depends upon the utility theory, and the user can choose the alternative having the maximum utility. In the present case, the willingness to shift to FASTag is taken as 'Yes' and 'No'; hence, the binary logit model is used. Utility (U) is the value which captures the users' (or decision maker) preference for an alternative (Ben-Akiva and Bierlaire, 1999). Utility is not a fixed entity, but it varies with the individual. Utility is basically the effect of different factors in a common unit for different alternatives.

The basic mathematical form of utility function is given in equation (1).

$$U_{ik} = V_{ik} + \varepsilon_{ik} \tag{1}$$

Where,

U_{ik} = the utility derived for person k by selecting alternative i
V_{ik} = systematically derived element of ith alternative for person k (observed term)
ε_{ik} = random part of the utility function specific to an individual user. It is assumed to follow the Gumbel distribution (Ben-Akiva and Bierlaire, 1999)
k = person
i = alternative

The 'V_{ik}' in the above equation is quantified as the linear additive function depending upon the factors considered along with the priority weights as shown in equation (2)

$$V_{ik} = \sum_{a=1}^{a} \beta_{ik} X_{ika} \tag{2}$$

Where,

β_{ik} = Alternate Specific Constant
X_{ika} = independent parameter
a = parameter associated with alternative i

Logit is used to link the Bernoulli distribution to independent variables. Odds is defined as the ratio of the probability of occurrence to the probability of non-occurrence, and the natural log of odds is called a logit. Inverse of logit is used to find the probability of the dependent variable. Hence, the probability of moving towards the use of FASTag is given by equation (3)

$$P_{shift} = \frac{e^{V_{ik}}}{1 + e^{V_{ik}}} \tag{3}$$

Where,

P_{shift} = probability to adopt FASTag instead of cash

Logit model depends upon the different independent parameters for estimation. Hence, in the present study, the different parameters considered for the development of the utility function are trip-related attributes (T), attitudinal variables (A), FASTag-related attributes (F), and socioeconomic and demographic parameters (S).

All such considerable factors are analysed in the present study to meet out the study objectives and summarized in the methodology chart as given in Fig. 2.

Finally, model validation is carried out and then the policy measures to increase the use of FASTag are evaluated using the stated preference

Table 3
Description of responses.

Dependent Variables	Question Addressed	Provided Options	Respondent's Answers (%)
Trip Related Attributes	Vehicle Type	SC	54.79
		BC	24.05
		LCV	6.69
		Bus	3.80
		HCV	3.44
		MAV	5.79
		Trailer	1.45
	Travel on toll roads	More than 4 times a week	28.03
		At least once in a week	31.10
		At least once a month	27.12
		At least once a year	11.57
		Less than once in a year	2.17
	Trip Purpose	Work	42.31
		Educational	10.31
		Commercial	18.26
		Social	19.17
		Other	9.95
Attitudinal variables	Aware of toll roads	Yes	96.20
		No	3.80
	Do you use any other route to reach destination other than toll road	Yes	32.19
		No	67.81
	Does using toll roads helps to reach faster	Yes	78.30
		No	21.70
	Current Toll Rates	Economic	47.74
		Expensive	52.26
	When you often pass toll plaza	Peak Hours	64.56
		Off-Peak Hours	35.44
FASTag Related Attributes	How you pay the toll	Manual	50.09
		FASTag	49.91
	Are you aware of FASTag	Yes	88.43
		No	11.57
	Are you having FASTag	Yes	54.79
		No	45.21
	If Yes from when you are having FASTag	From Last Two Months	26.76
		From last 2 to 4 months	13.20
		From last 6 months	5.97
		From Last one year	8.86
		Not Applicable	45.21
Socioeconomic Variables	Gender	Female	7.96
		Male	92.04
	Age	18—20 years	2.17
		20——30 years	71.25
		30——40 years	16.64
		40——50 years	6.15
		50——60 years	3.25
		>60 years	0.54
	Educational Level	Uneducated	0.18
		Upto high school	13.20
		High school diploma	9.04
		Graduate	42.13
		Post-Graduate	33.63
		Others/ Doctorate	1.81
	Household Size	1——2	7.78
		2——4	51.90
		4——6	31.83
		> 6	8.50
	Employment Status	Full-time employed	68.72

Table 3 (*continued*)

Dependent Variables	Question Addressed	Provided Options	Respondent's Answers (%)
		Part-time employed	5.61
		Unemployed	25.68
	Family Monthly Income	< ₹15,000 (<$199)	13.74
		₹15,000 - ₹30,000 ($199 - $398)	10.85
		₹30,000 - ₹50,000 ($398 - $663)	28.03
		₹50,000 - ₹80,000 ($663 – $1060)	18.08
		₹80,000 - ₹1,00,000 ($1060-$1326)	9.22
		> ₹1,00,000 (> $1326)	20.07

*1 Dollar ($) = ₹75.43 (as on April 22, 2021, https://www.xe.com/currencyconverter/convert/?Amount = 1&From = USD&To = INR)

survey. The questions such as decreasing waiting time, rewards, getting prior information, etc., are asked as policy measures.

5. Data analysis

Prior to the data analysis, the quality of the obtained responses from the questionnaire survey forms is to be verified. This prior verification of the data is necessary to get reliable results (Navandar et al., 2019c). Hence, the data is checked for missing values and for inaccuracy. A total of 820 responses were collected through personal interviews and online forms, and no missing data was found. The samples collected from the online questionnaire consist of 73.34%, while 26.66% data is from face-to-face interviews. The presence of outliers can result in the wrong model; hence, outliers were detected using the Mahalanobis D^2 equation and 10 outliers were removed from further analysis (Navandar et al., 2019b). Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity values are carried out to check sampling adequacy and multivariate normality. The value of KMO greater than 0.5 shows the adequacy of the sample size for further analysis. The result shows that the KMO test value of 0.66 which is more than 0.5. Further, Bartlett's sphericity test was evaluated to check the significant correlation between the items. Here, Bartlett's test of sphericity p-value was found to be 0.000, showing items being closely related. This value shows sampling adequacy and multivariate normality. The variation of responses in the percentage is shown in Table 3.

The remaining 810 responses are used for further analysis. The results showed that most of the respondents were car users (SC and BC combined share of 78.84%) and the trailer respondents were found to be 1.45%. As the responses from Trailers were lower, the class Trailer was combined with class MAV for further analysis. Further, it was found that most of the users (31.10%) traveled at least once a week through the toll plaza. Daily commuter's percentage was 28.03%, followed by the users' travelling at least once a month. Considering the trip purpose, it is found that most of the trips are made for work purpose (42.31%), while for commercial and social purposes, it constitutes 18.26% and 19.17%, respectively.

Fig. 3 indicates the trip purpose-wise variation in trip frequency for different classes. Out of the total trips by SC, 9.95% of trips are carried out more than four times a week, whereas 14.65% of trips are carried at least once a week. Out of those trips which are carried more than four times a week, 6.69% of trips are for work purpose and the remaining are

for educational purpose. On the other hand, the BC users were found to travel on toll roads more frequently than the SC users. The respondent data revealed that out of total BC users, 5.24% of users travel more frequently on toll roads and 8.86% of users were found to travel at least once on toll roads. The trip purpose of BC users is mostly found to be work. The car users (SC and BC both) used their vehicles for social and other purposes less frequently, at least once a month or a year.

Moreover, the results showed that the Bus drivers are daily commuters, frequently passing the toll plazas having trip purpose as work. Similarly, for LCV's, 4.34% of total LCVs trips are carried out for more than four times a week for work and commercial purposes. The other categories of vehicles, like HCV and MAV, are the users who at least negotiate the toll plazas once a week.

Further, the attitudinal variables were questioned to capture the attitude and perception of the respondent. The results showed that 96.20% of the users are aware of toll roads and the purpose of toll roads. 67.81% of the total users are found to use the toll roads to reach faster. Also, the perception about the current toll rates of their category of vehicles was asked, and it was found that most of the users found the toll rates to be expensive (52.26%). Also, the question was put forward about the time of passing from the toll plaza. The results revealed that 64.56% of users pass at the toll plaza during peak hours.

As the study objective is about willingness to own FASTag, the FASTag-related questions were enquired. It is found that 88.43% of the users are aware of the FASTag program and its use. While still, the penetration of FASTag is only 54.79 percent. Considering the payment preference method, users have still adhered to the traditional cash transaction method; hence, the cash transaction percentage is about 50.09% of the total transactions. Moreover, it is found that 4.88% of the users have FASTag but still prefer payment by cash. Fig. 4 (a) shows the respondents according to their payment method.

Moreover, the respondents, still paying through cash, are queried about the possible reasons for not using the FASTag. Fig. 4 (b) shows the graphical representation of perceived reasons for not using FASTag. The results revealed that 33.22% of the users avoid using FASTag because they don't frequently travel on toll roads. It can be seen from the trip frequency that the users using toll roads less frequently are about 40.96% (Table 3). Out of total cash users, 28.42% of respondents avoid FASTag as they don't like automatic deductions of the amount from their account and therefore, they like control over cash flow. Other reasons, such as not having enough knowledge about FASTag, privacy, local driver, etc., are specified by the users for still using the cash payment method for tolls.

Additionally, to check the awareness about FASTag, an inquiry was carried out about when the user starts to use FASTag. It is found that 26.76% of the users started using FASTag from the last two months, i.e., from November 2019. This may occur due to compulsion and awareness programme done by the Government of India (GOI) in the last two-month period.

Finally, the demographic and socioeconomic characteristics are analyzed. The study shows that 92.04% are male drivers. According to the age, 71.25% of the drivers are 20–30 years old. 68.72% of the users are found to be full-time employed, while 25.68% are unemployed. The sample size of the age group of 18–20 years and more than greater than 60 years was observed to be less and hence, they are clubbed for further analysis as one class of 18–30 years and another class of greater than 50 years. Thus, a total of four classes of age are considered for further analysis. Further, it can be seen that the percentage of responses for uneducated people is too low. But, as it cannot be clubbed with other categories, the uneducated people are kept separately for further analysis. Fig. 5 shows the variation in socioeconomic and demographic characteristics according to different vehicle classes. It is seen that females are driving only SC and BCs and no other vehicle class. Further, it can be seen that SC and BC users are highly educated with higher monthly incomes than the users driving other vehicles.
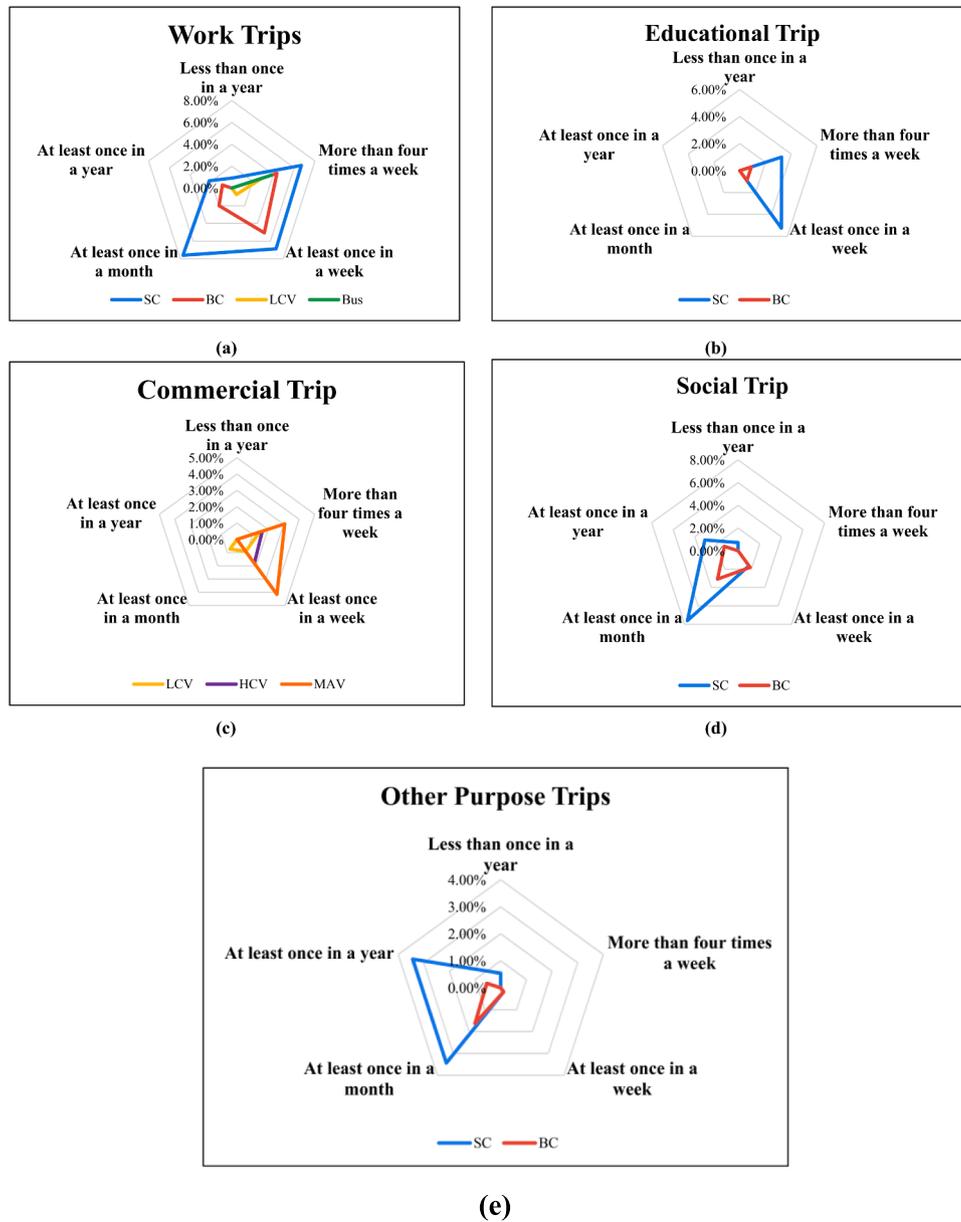
Fig. 3. Trip purpose-wise variation in the frequency of trips for different vehicle classes.

6. Analysis of statistical significance

Keeping in mind of objective of the present study, hypothesis testing is carried out. The analysis has been carried out in SPSS software and the test results for different parameters are shown in Table 4. The parameters which are significant are possible predictors for the modelling of willingness to own FASTag.

The result shows that out of the total SC users, 48.18% of them do not have FASTag. On the other hand, BC users are mostly opted and have FASTag (60.90% of total BC share). Further, it is to be noticed that Bus, and MAV users are among the users using FASTag (90.48%, and 82.50%, respectively). It has been seen that most of the buses were governmental buses (State Road Transport Corporation), so they are compulsorily having FASTag. Remaining 9.52% of the Bus users are among the private buses. Moreover, heavy vehicles have to drive continuously for days and hence heavy vehicle owners mostly opted for FASTag, thus showing higher penetration of FASTag for heavy vehicles except for HCVs. The LCVs and HCVs are found to have less share of FASTag. The chi-square results show that the p-value is less than 0.05; hence there exists a significant difference between the two categories of respondents.

Analysis for trip frequency shows that users traveling at least once a week are generally FASTag users. Moreover, observation shows that for users travelling more than 4 times a week, 83.33% of the total are still using manual transactions. This may be observed due to the discount allowed for local or frequent users through the manual lane. Out of the total 2.17% (37 users) of the respondents travelling less than once a year, 73.44% are found to be manual users. Further, chi-square analysis shows that a significant difference exists as the p-value is less than 0.05.

Trip purpose is also found to be a statistically significant parameter, with a p-value less than 0.05 and a chi-square value of 23.32. The analysis for the trip purpose between two groups of respondents shows that the users having trip purpose as work, commercial and social mostly have FASTag.

Finally, it is concluded that the BC, Bus, and MAV users adopted mostly the FASTag system. Also, the frequent drivers are showing less favor to the FASTag system due to the discounts given to them. Additionally, the users making fewer trips from toll road shows less interest in the FASTag system. The users whose trip purpose is work and
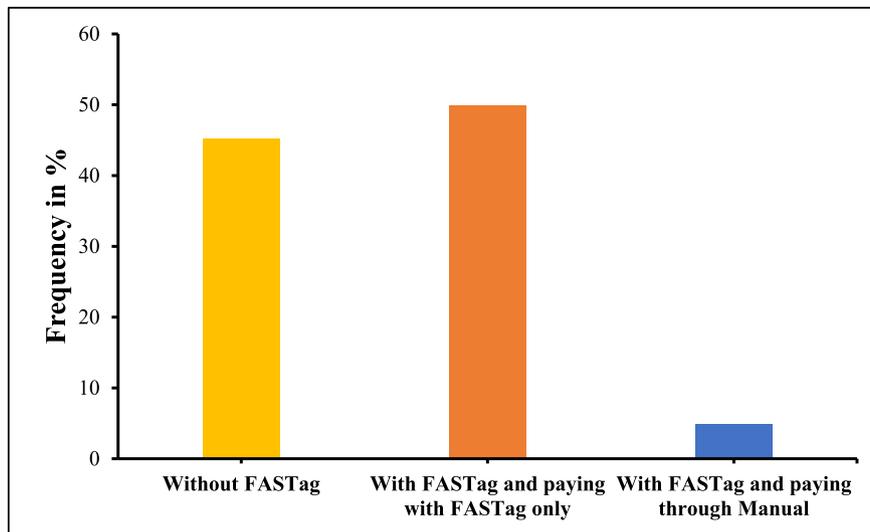
(a)
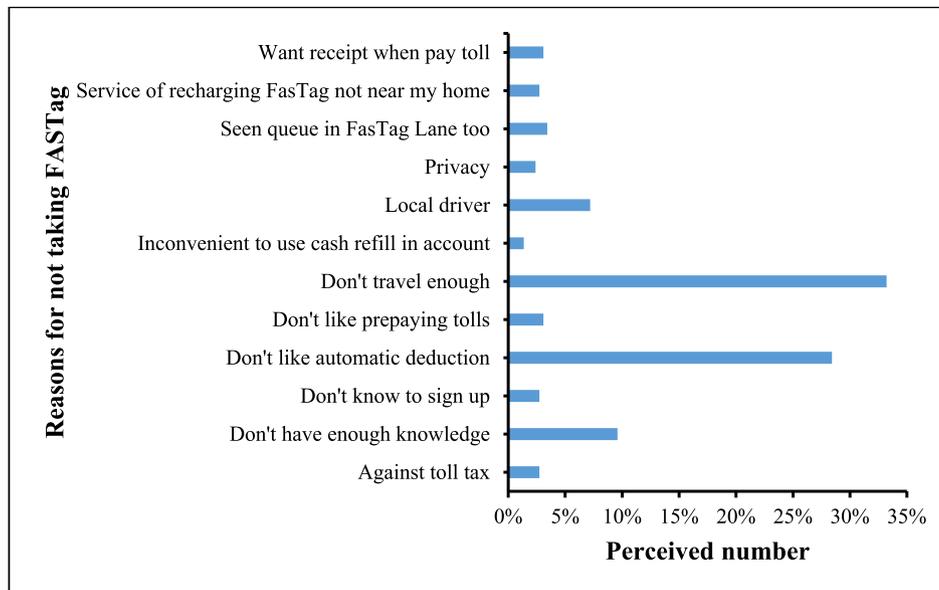
(b)

Fig. 4. (a) Variation of respondents towards payment of toll (b) Reasons for not using FASTag.

commercial and making a trip at least once a week are showing keen interest in the FASTag system.

Attitudinal variables, as discussed, were collected to draw results orienting toward the perception of users. The questions such as awareness of toll roads and using any other route than toll road are found insignificant and hence, not considered in further analysis. But the revealed answers of the users of reaching faster with toll roads, and experiencing a delay in peak hours are found to be significant with a p-value less than 0.05. Hence, both of these factors are considered for further analysis.

Previous awareness about any policy is found to be one of the significant factors by many of the researchers (Gomez et al., 2017; Heras-Molina et al., 2017). Hence, for the present study, the previous awareness about FASTag was inquired. The p-value was lower than 0.05 showing a significant difference between the two groups of respondents regarding awareness.

Socioeconomic and demographic factors are the most important factors for analysis related to the user's perception (Navandar et al., 2019b; Vasudevan et al., 2019). The trip purpose, frequency, attitude,

and perception is mostly affected by the factors such as age, gender, household size, monthly income, etc. Hence, the statistical significance tests are carried out to check whether differences exist between the groups having FASTag and without FASTag. The results show that a statistically significant difference exists between the two groups of respondents for gender, age, household size and employment status, while family monthly income and education level are found to be insignificant. It is seen from the results that as the user's age increases, the percentage to switch towards FASTag also increases. Moreover, the full-time employed users with FASTag are found to be about 60.26% of the total full-time employed respondents.

7. Development of a model for drivers' willingness to own FASTag

In order to model the drivers' willingness to own the FASTag, different parameters such as vehicle type used by the user, trip purpose, trip frequency, previous awareness about the FASTag, time of passing toll plaza and socioeconomic and demographic are necessary (Gomez
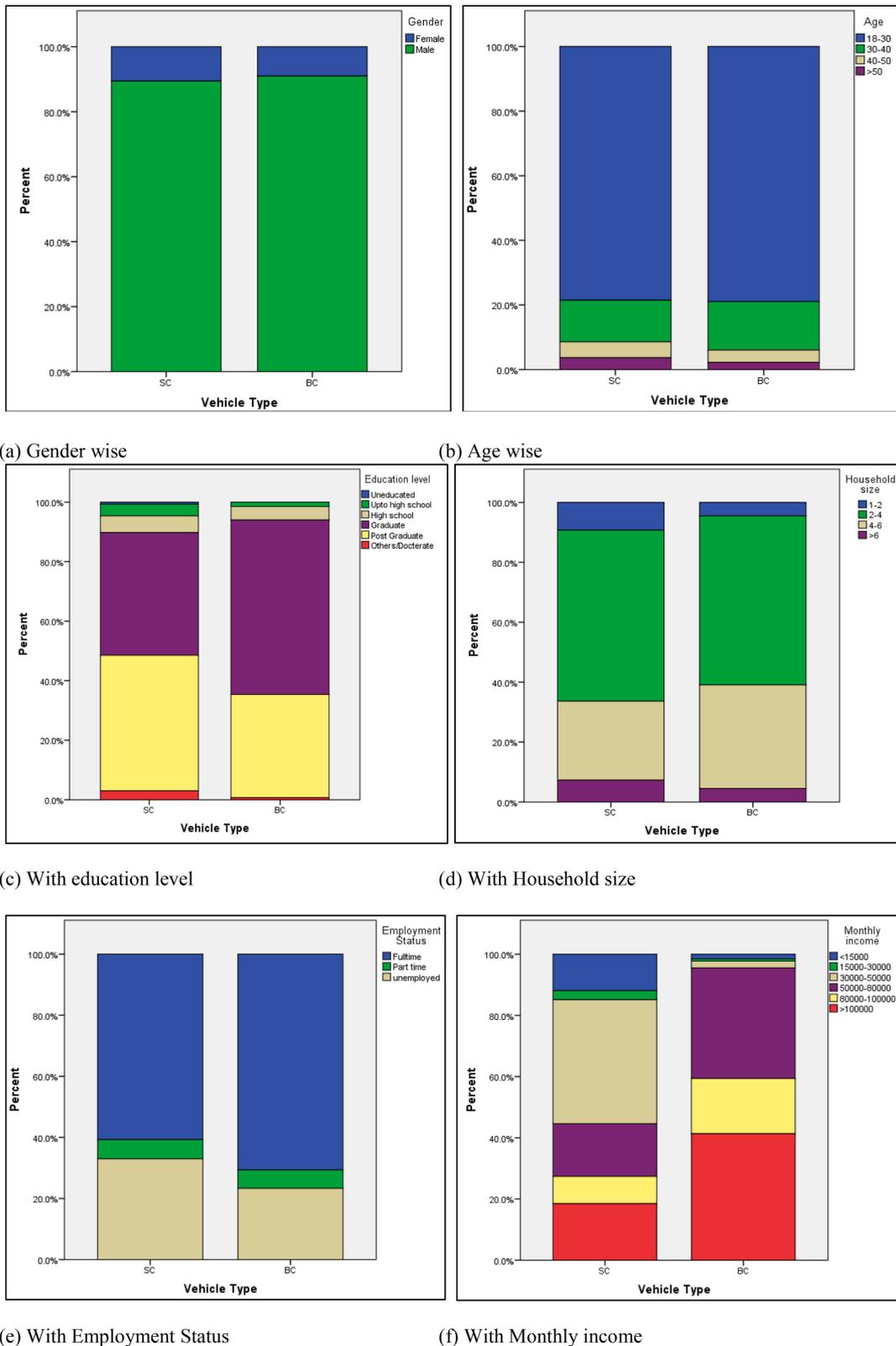
(a) Gender wise   (b) Age wise

(c) With education level   (d) With Household size

(e) With Employment Status   (f) With Monthly income

Fig. 5. Variation in socioeconomic and demographic factors for different vehicle class.

et al., 2017; Heras-Molina et al., 2017). This can be done with the help of the binary logit model(Agarwal et al., 2019; Vasudevan et al., 2019), probit method(Navandar et al., 2019b), etc., but the binary logit model is found to better as it is easier to introduce random parameters to estimate as a simulated maximum likelihood regression. Various researchers use binary logit models to study the mode shift characteristics

(Agarwal et al., 2019; Vasudevan et al., 2019), shift for dynamic pricing (Bari et al., 2015; Burris, 2003; Eliasson and Mattsson, 2006; Kim and Schonfeld, 2008) and willingness to own tag (Gomez et al., 2017; Heras-Molina et al., 2017). The model will be thus useful to identify the possible factors and their impact on drivers' willingness to own FASTag.

The parameters which are significant (Table 4) are used for the

Table 4
Statistical analysis of parameters.

Variables	Question Addressed	Provided Options	Manual	FASTag	Comparison	DOF	P value	Significant
Trip Related Attributes	Vehicle Type	SC	51.82%	48.18%	$\chi^2 = 67.98$	5	0.000	Yes
		BC	39.10%	60.90%				
		LCV	59.46%	40.54%				
		Bus	9.52%	90.48%				
		HCV	52.63%	47.37%				
		MAV	17.50%	82.50%				
	Travel on toll roads	More than 4 times a week	83.33%	16.67%	$\chi^2 = 64.54$	4	0.000	Yes
		At least once in a week	40.65%	59.35%				
		At least once a month	38.95%	61.05%				
		At least once a year	42.00%	58.00%				
		Less than once in a year	73.44%	26.56%				
	Trip Purpose	Work	44.44%	55.56%	$\chi^2 = 23.32$	4	0.020	Yes
		Educational	52.63%	47.37%				
		Commercial	33.66%	66.34%				
		Social	46.23%	53.77%				
		Other	60.00%	40.00%				
Attitudinal variables	Does using toll roads helps to reach faster	Yes	43.42%	56.58%	$\chi^2 = 5.16$	1	0.023	Yes
		No	51.67%	48.33%				
	When you often pass toll plaza	Peak Hours	40.34%	59.66%	$\chi^2 = 19.30$	1	0.000	Yes
		Off-Peak Hours	54.08%	45.92%				
FASTag Related Attributes	Are you aware of FASTag	Yes	38.24%	61.76%	$\chi^2 = 165.58$	1	0.000	Yes
		No	98.44%	1.56%				
Socioeconomic Variables	Gender	Female	56.82%	43.18%	$\chi^2 = 5.20$	1	0.023	Yes
		Male	44.20%	55.80%				
	Age	18——30 years	49.01%	50.99%	$\chi^2 = 32.54$	3	0.000	Yes
		30——40 years	30.43%	69.57%				
		40——50 years	29.41%	70.59%				
		> 50 years	61.90%	38.10%				
	Education Level	Uneducated**	100.00%	0.00%	$\chi^2 = 5.43$	5	0.365	No
		Some high school	41.10%	58.90%				
		High school diploma	46.00%	54.00%				
		Graduate	44.64%	55.36%				
		Post-Graduate	46.24%	53.76%				
		Others/Doctorate	60.00%	40.00%				
	Household Size	1——2	60.47%	39.53%	$\chi^2 = 15.06$	3	0.020	Yes
		2——4	47.04%	52.96%				
		4——6	38.64%	61.36%				
		> 6	44.68%	55.32%				
	Employment Status	Full-time employed	39.74%	60.26%	$\chi^2 = 33.80$	2	0.000	Yes
		Part-time employed	45.16%	54.84%				
		Unemployed	59.86%	40.14%				
	Family Monthly Income	< ₹15,000 (<$199)	48.68%	51.32%	$\chi^2 = 10.75$	5	0.057	No
		₹15,000 - ₹30,000 ($199 - $398)	36.67%	63.33%				
		₹30,000 - ₹50,000 ($398 - $663)	45.81%	54.19%				
		₹50,000 - ₹80,000 ($663 – $1060)	52.00%	48.00%				
		₹80,000 - ₹1,00,000 ($1060-$1326)	37.25%	62.75%				
		> ₹1,00,000 (> $1326)	44.14%	55.86%				

Note: - DOF = Degree of freedom
Level of significance is taken as 95%
*1 Dollar ($) = ₹75.43 (as on April 22, 2021, https://www.xe.com/currencyconverter/convert/?Amount=1&From=USD&To=INR)
**Expected count was less than 5.

development of the model. All of the variables used to develop the model are nominal and ordinal. The inter-correlations between the variables was checked and found that none of the factor is inter-correlated with each other. Due to the presence of nominal and ordinal variables, the base case is needed to properly interpret the results. Hence, one base case is assumed for each of the parameters to compare the results, for example, SC for vehicle type, a work trip for trip purpose etc. Further, the positive and negative signs and statistical significance will give the users' perception in comparison with the base case. As showing a willingness to own FASTag is a nominal variable having an answer of yes and no, it is coded as dichotomous values of 1 for "shift to FASTag" and 0 for "not shift to FASTag". Further, 80% of the total dataset is taken for developing the model and the remaining 20% of the dataset is kept for

validation. The parameters and calibration statistics of the developed model are shown in Table 5.

The table shows the variables and their respective parameters, obtained model coefficients, standard error, p-value and odds. The coefficients are calculated by means of maximum likelihood for parameter estimation by using SPSS software. The coefficients denote predicted change in log odd falling in that group. The variables showing a positive coefficient sign will determine that the odds are increasing, that is event being more likely to happen. On the other hand, the negative coefficient sign shows the decreasing odds that there is less chance of event. The standard errors (SE) estimate the variability of the coefficient for n numbers of trials. In short, precision of the coefficient is measured with help of SE, and possibly it should be as low as possible. The p-value for

Table 5
Developed logit model.

Parameters	Dependent Variables	Coefficients	S.E.	P-value	Odds
Vehicle Class	SC (Base)			0.000	
	BC	0.449	0.178	0.012	1.566
	LCV	−0.737	0.178	0.012	0.479
	Bus	2.335	0.687	0.001	10.332
	HCV	−1.007	0.514	0.050	0.365
	MAV	1.220	0.533	0.022	3.388
Frequency of trip	Less than once in a year (Base)			0.000	
	More than 4 times in a week	1.826	0.612	0.003	6.209
	At least once a week	1.709	0.602	0.005	5.522
	At least once a month	1.694	0.592	0.004	5.441
	At least once a year	0.591	0.615	0.336	1.806
Trip purpose	Work (Base)			0.182	
	Educational	0.225	0.276	0.415	1.253
	Commercial	0.605	0.318	0.057	1.831
	Social	0.203	0.221	0.359	1.225
	Other	−0.205	0.277	0.458	0.814
Does using toll roads helps to reach faster	No (Base)			0.000	
	Yes	0.576	0.182	0.002	1.779
When you often pass toll plaza	Peak hours (Base)			0.000	
	Off-peak hours	−0.451	0.155	0.004	0.637
Are you aware of FASTag	No (Base)			0.000	
	Yes	5.013	0.741	0.000	150.350
Age	18—30 years (Base)			0.000	
	30—40 years	0.385	0.212	0.070	1.470
	40—50 years	0.966	0.357	0.070	2.628
	> 50 years	−1.067	0.417	0.010	0.344
Employment Status	Fulltime (Base)			0.005	
	Part time	0.099	0.323	0.760	1.104
	Unemployed	−0.573	0.184	0.002	0.564
	Constant	−6.150	0.976	0.002	0.002
	−2 Log likelihood	1134.24			
	R-square	0.396			
	Overall prediction	73.80 %			

S. E. = Standard Error, Level of Significance = 5 %.

each term is calculated for 5% significance level; thus, significant factors are retained for the final model. While modeling, the factors such as gender (p-value = 0.144), education level (p-value = 0.365), household size (p-value = 0.438) and family monthly income (p-value = 0.057) are found to be insignificant and hence removed from the model (Tables 4 and 5). Each variable in the model shows the coefficient and significance with respect to the base case for that parameter. The coefficient value of base case variable is always zero, which means 'log' of zero value is one; that is one-unit increase in base the odds remain the same.

For the vehicle class, the SC is considered as base case. The results show that the coefficient of BC, Bus, MAV are positive with respect to SC. It means that the one-unit increase in SC user will likely to increase odds of BC user by 1.566 [exp(0.449)], similarly for Bus by 10.332 [exp (2.335)], and for MAV by 3.388 [exp(1.220)]. Further, coefficients of LCV and HCV are found to be negative, meaning that these vehicle classes have less chance of taking FASTag with respect to SC. This can be correlated with descriptive statistics that; LCV and HCV have fewer FASTag users than cash users. While other categories of vehicles have more FASTag users and hence they show a positive coefficient.

Similarly, for frequency of trip, less than once in a year is taken as base case. The coefficient for all other variables is found to be positive

with respect to base case. The odds of users traveling more than 4 times a week is 6.209 [exp(1.826)], meaning there is a higher probability of owning the FASTag. For trip purpose, work trips are taken as base case. The coefficients are found to be positive, showing the owning for FASTag except for the other purpose trips also.

Attitudinal variables such as using toll roads help users reach faster and when users pass toll plaza (peak or non-peak hours) have only two responses; hence, 'No' and 'peak hour' are taken as base case. It is found that users who are more likely to use toll roads to reach faster and those who pass through peak hours are more likely to own FASTag.

Awareness about the system or facility is found to be important variable for willingness to shift (Heras-Molina et al., 2017). In present study, not aware is taken as base case, and it is found that the coefficient for aware users is positive and significant. Further, it shows that the odds of aware user are about 150.350, which shows that more aware the user about FASTag are more will be the willingness to own FASTag.

The age of user, between 18 and 30 years, is taken as base case for model development. The results show that users having age greater than 50 years are more unlikely to own FASTag. Finally, the full time employed is taken as base variable for employment status. The odds of part-time is more than one compared to base case. This shows that the part-time users are showing a positive nature towards owning FASTag compared to the unemployed users. The constant value is negative, and odds of negative is mostly towards zero. It shows that when all independent variables are zero, the probability of taking FASTag is also zero. The developed model shows the pseudo-R square of 0.396, which can be assumed to be a satisfactory value (Gomez et al., 2017; Heras-Molina et al., 2017). The overall prediction capacity of the model found to be satisfactorily (73.80%) (Vasudevan et al., 2019).

8. Stated preference for increasing use of FASTag

As discussed earlier, the FASTag penetration is still low in India and hence the study is considered to know the view of cash users and the factors which may affects them for choosing FASTag. Various replenishment/ policy options are asked to the respondents that may change their view from cash payment to the FASTag payment. Waiting time occurring at toll plazas is one of the factor of drivers inconvenience (Navandar et al., 2019b). Hence, one of the options was given about the waiting time. In India, distance-based tolling is not yet started. Also, payment system is of open toll system, driver has to pay irrespective of the distance travelled. Hence, options such as distance-based tolling are also kept. Rewards in terms of discounts are also found to be one of the policies for shifting users from manual to ETC (Campbell et al., 2011). As shown in Fig. 4 (b), some users want a receipt after the toll payment. Hence, it is also given as one of the options for users. Moreover, increasing posted speed limit at toll plazas, giving separate dedicated lanes without speed-breakers (humps), and getting the message of paying toll before 500 m of the toll plazas are given as policy options for MTC lane users. Fig. 6 illustrates the responses given by the cash users concerning different policy options.

The results showed that 30.47 % of the total cash users are willing to shift to FASTag when the payment is taken based on their distance traveled. Out of the total, 20.71% of users give positive responses towards FASTag use if the option is available for payment after completion of total journey by toll roads. Some of the users will shift if the rewards are given on the use of FASTag or showing/ informing the user about toll fee before 500 m of the tollbooth. Further, it is seen that users are not giving importance to the posted speed limit increment for changing their behavior.

9. Conclusions

ETC system, locally called FASTag, is made mandatory for payment of tolls on NHs in India. The present work is undertaken to study the penetration of the FASTag in India and the factors affecting the users for
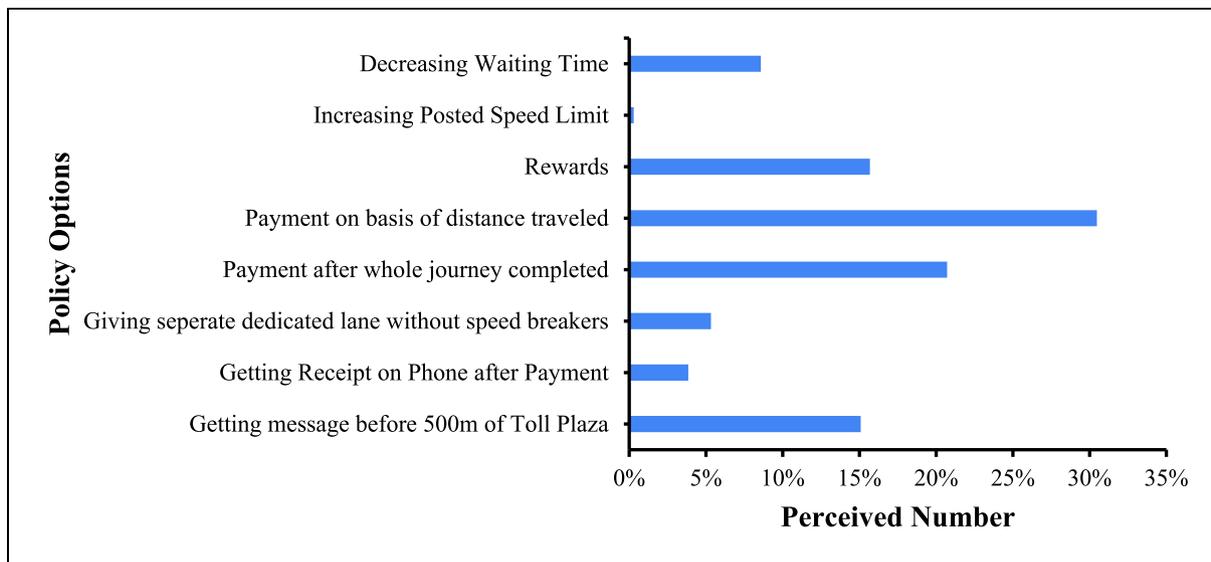
Fig. 6. Stated results for different policies.

shifting towards the FASTag payment method. A revealed preference survey is carried out using an online google form and personal interview. The factors considered for the present study are trip-related characteristics, attitudinal variables, FASTag-related attributes and lastly, socio-economic and demographic attributes. The results revealed that most of the users participating in the survey were car users and travel at least once a week.

Further, the results revealed that 96.20% of users are aware of toll roads. Still, 50.09% of users are paying the toll with FASTag. 4.88% of the users have FASTag but are still paying toll charges in cash. The results showed that most users prefer cash payment as they travel less frequently on toll roads.

Further, statistical tests are carried out to check there any difference exists between the different parameters between cash and FASTag users. Additionally, drivers' willingness to own FASTag is modeled using a binary logit equation. It is found that the drivers' willingness is mostly related to trip-related attributes such as vehicle class, trip frequency and trip purpose. The results show that the drivers' willingness to own FASTag is weakly associated with socioeconomic factors such as income level, household size and age. It is found that the drivers more likely to shift towards FASTag when he/she is aware about it. Additionally, full-time employed users using toll roads in peak hours are found to show a positive attitude towards the shift to FASTag.

Further, possible policy measures are enquired to the cash users so that they can shift towards the FASTag system. The results show that the distance-based tolling policy can help penetrate the FASTag in the Indian market more easily. Further research is needed to study the possible way of implementing these policies in the Indian scenario for increasing penetration of FASTag.

The findings of the study are used to know the drivers' attribute, which affects the willingness to own tag, so that policymakers can take into consideration those attributes for better performance in the future.

The present study is undertaken to know the users' willingness to adopt the FASTag system, the future work may be carried out to check periodically the acceptance level and habitual change in users' perception (Vasudevan et al., 2019). Further, future studies can be taken to extent this study with more variables of psychological and sociological parameters. Also, the willingness to shift to dynamic toll pricing for the FASTag users can be evaluated for congestion mitigation in future work.

10. Policy interventions

From the present study, it can be seen that most people are still using

manual transactions. Further, it can be seen that many of them have FASTag but still pay by cash. So, the policy should be such that the users paying by cash should shift to the payment mode of FASTag. As observed from their revealed data, those users who are paying by cash doesn't travel toll road frequently and also doesn't like automatic deductions. This is because a fear of deduction of extra charges to the users leads to the payment by cash. To overcome this, secure and fast automatic deduction methods should be implemented to allow users to shift towards FASTag. Other reasons, such as not having enough knowledge about FASTag, privacy, local driver, etc., are specified by the users for still using the cash payment method for tolls. The knowledge about installation and benefits of the FASTag should be given to the users with the help of advisements through hoardings, or in audio-visual form, or through the campaign. This will help the users to become familiar with the new system easier.

As can be seen from the developed model (Table 5), the passenger car, i.e., SC and BC users are more likely to shift towards FASTag. It can be seen from the descriptive statistics that most of the FASTag holders are of passenger cars. Further, considering this vehicle class, the trip purpose is mostly work and educational trips traveling at least once a week. Moreover, observation shows that users travel more than 4 times a week, and 83.33% of the total still use manual transactions. This is because daily travelers get discounts by paying cash. The travel cost and toll fee are observed as significant parameters for using toll roads by car users (Politis et al., 2020). Hence, the policies such as discounts for frequent travelers for using FASTag or for users going on educational trips can decrease the travel cost and hence can help to promote FASTag usage for passenger cars. Further, as observed from Table 4, the household size was found to be a statistically significant factor. As seen from Table 4, smaller families mostly pay by cash as they can have budget constraints for the trip and the same for larger families (Politis et al., 2020).

On the other hand, for Buses, the government buses were compulsorily occupied with the FASTag. But still, the private buses were using cash payment. Thus, the promotion of FASTag in terms of its advantage for travel time saving, fuel saving, and congestion mitigation can help private bus drivers to shift. Such policies are also recommended by Odeck and Svein, (1997) for promoting the use of toll roads.

Commercial vehicle drivers have significantly different behavior from that of car users. They travelled more and hence they encountered with a greater number of toll plazas. It can be seen from the developed model that the coefficient of commercial vehicles (MAV) is positive with respect to SC (Table 5). The odds of MAV are higher than BC, showing

Table A1
Description of variables considered.

Variable	Description
Vehicle Type	1 = SC, 2 = BC, 3 = LCV, 4 = Bus, 5 = HCV, 6 = MAV, 7 = Trailer
Travel on toll roads	1 = More than 4 times a week, 2 = At least once in a week, 3 = At least once in a month, 4 = At least once in a year, 5 = Less than once in a year
Trip purpose	1 = Work, 2 = Educational, 3 = Commercial, 4 = Social, 5 = Other
Aware of toll roads	0 = No, 1 = Yes
Do you use any other route to reach destination other than toll road	0 = No, 1 = Yes
Does using toll roads helps to reach faster	0 = No, 1 = Yes
Current Toll Rates	1 = Economic, 2 = Expensive
When you often pass toll plaza	1 = Peak hours, 2 = Off-peak hours
Are you aware of FASTag	0 = No, 1 = Yes
Are you having FASTag	0 = No, 1 = Yes
If Yes from when you are having FASTag	0 = From last 2 months, 1 = 2 – 4 months, 3 = From last six months, 4 = From last one year, 5 = Not applicable
How you pay the toll	0 = Manual, 1 = FASTag
Gender	0 = Female, 1 = Male
Age	0 = 18–20 years, 1 = 20–30 years, 2 = 30–40 years, 3 = 40–50 years, 4 = 50–60 years, 5 = > 60 years
Educational Level	0 = Uneducated, 1 = Upto high school, 2 = High school, 3 = Graduate, 4 = Post Graduate, 5 = Others/Doctors
Household Size	0 = 1–2 members, 1 = 2–4 members, 2 = 4–6 members, 3 = >6 members
Employment Status	1 = Fulltime, 2 = Part-time, 3 = Unemployed
Family Monthly Income	0 = <15,000 ₹, 1 = 15,000–30,000 ₹, 2 = 30000—50,000 ₹, 3 = 50,000–80,000 ₹, 4 = 80,000 – 1,00,000 ₹, 5 = >1,00,000 ₹

positive behavior towards FASTag. Commercial vehicle drivers are more concerned about travel time than travel cost due to the commitment to their employment. Commercial vehicle drivers travelled long distances to deliver perishable or dangerous entities and hence are more concerned about the travel times (Politis et al., 2020). Further, as seen from socioeconomic and demographic characteristics, commercial vehicle drivers are less educated and belong to lower-income groups. Hence, advertising and consultation for commercial vehicle drivers in the local language highlighting the benefits of using FASTag for travel time saving should be made (Cherry and Adelakun, 2012). This can help them to get familiar with the FASTag system.

Further, the older age group is less willing to shift towards FASTag than the younger age group. This can be attributed to the habit of the older age group for paying by cash. The younger group is more concerned and flexible about the environment, travel time and new technologies and hence tends to shift more towards FASTag. Thus, the policy interventions should consider the age factor, such as doing strategic information campaigns for older age groups.

Awareness is found to be the most important factor for shifting (Table 5). Hence, awareness campaigns for all road users can be a positive factor in using FASTag. Lastly, as seen from the stated preference, the payment based on distance travelled, and payment after journey completion can also promote the use of FASTag. India is now trying to implement the distance-based toll by applying a closed toll system, which may help increase FASTag penetration.

Author contributions

The authors confirm contribution to the paper as follows:
Study conception and design: Dhamaniya, Chandra and Bari; data collection: Bari and Dhamaniya; analysis and interpretation of results: Bari, Dhamaniya and Chandra; draft manuscript preparation: Bari,

Dhamaniya and Chandra. All authors reviewed the results and approved the final version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

References

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