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User Perception towards Ride hail Service: A case of Nagpur city, India

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Abstract

In recent times, there is an increase in the utilization of the ride-hail service (viz., mobile application-based shared service) by the younger generation due to tremendous changes in technology, extensive usage of smartphones, and perceived convenience during travelling. For evaluating ride-hail service further, it is necessary to understand the user perception towards the ride-hail service and public transportation system (viz., bus in this case) to efficiently plan the public transportation services. Hence, the present study analyzes user perception while making trips, using ride-hail service and public transport buses. A long stretch of 3.8 km has been selected in the Nagpur city for the study and the stretch attracts a good number of trips by ride-hailing and public transportation. To perform the analysis, a survey has been conducted in the stretch which includes an online survey (viz., based on the Google form) and an offline survey (viz., at selected bus stops on the route between university campus and shopping complex). A binary logit model has been developed to understand the user perception towards ride-hail service and to identify the significant contributing factors towards the preference of the ride-hail service over the public transport bus. From the model results, it has been noted that age, accessibility, waiting time, travel time, income, and travel cost of the trip are the most significant contributing factors that affect user decision for availing the ride-hail service. It has been concluded from the study that the inferences obtained would be useful in the direction of developing warrants for transport planners and policymakers to improve the service quality of public transport buses (viz., frequency and routes) in cities especially in the Indian context.

Keywords: Ride-hail service; User perception; Public transport; Binary logit model.

1. Introduction

The mobile application-based ride-hail service has gained prominence globally in recent years due to the rapid changes in technology, an increase in the use of smartphones, and convenience in the travel process, especially in urban areas. These services are referred to as ride-sourcing/ride-hailing/ride-sharing and the service providers are usually referred

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to as Transport Network Companies (TNCs). These TNCs pose a challenge to many traditional transport mobility service providers which include conventional taxis, auto-rickshaw (three-wheeler taxi), and public transit services (viz., bus service). Further, these companies have altered the mode choice in many cities globally. These services have also created meaningful travel alternatives to the users, in particular to the younger generation, due to an increase in the use of smartphones which facilitates a reliable and affordable ride-hail choice of mode (Li and Liu, 2014). Further, these services have gained popularity where public transport service (viz., public transit bus) has failed to serve the isolated areas or during odd hours travelling (viz., mid-night). TNCs also alter the economy by providing meaningful employment in urban areas (Chan et al., 2016). In contrast to these benefits, researchers have identified that these ride-hailing services have been increasing the traffic congestion, particularly, during peak hours in urban areas, and are sometimes unsafe during nighttime (Agarwal et al., 2019).

The daily commuters from developing countries like India are consistently facing difficulties while taking a ride using the existing mobility services like auto-rickshaw, public transit bus, private taxi, etc. These mobility options characterize higher access time to the nearest available bus stop location, higher waiting time for the bus/taxi/auto-rickshaw, variable travel fare (for taxi and auto-rickshaw), and higher travel time during peak hours, especially in buses. In the case of public transit bus service, the users have to walk to the nearest bus stop and must wait for the bus, which may lead to loss of their interest to choose such transit service on regular basis (Daniels and Mulley, 2013). However, researchers have evaluated the perception of bus users and potential bus users to understand the transit service quality, and results concluded that awareness about the service has a positive effect on the utilization of the transit service (Bellizzi et al., 2020). Another study that evaluated the transit service quality of Metro service in Madrid, Spain, based on a user perception-based survey, identified that comfort is the most important factor in transit service (Eboli et al., 2020). On the other side, the ride-hailing service (viz., mobile application assisted shared service) has the association between users and service providers (viz., TNCs) by utilizing smartphone applications which in turn leads to saving their service access time as well as waiting time (Shen et al., 2015). The travellers use the TNCs application to request a ride and they can see the registration number of the available ride-hailing cars/taxis, and the contact number of drivers. The travellers can choose their desired destination by giving destination points and are provided details of the estimated fare (viz., travel cost) to be paid to the driver as well as the expected time to reach the destination point. In such applications, passengers can select from different vehicle categories based on the affordability and comfort (viz., shared option, mini-taxi, micro-taxi, prime sedan, etc.), the corresponding waiting time, and the vehicle seating capacity helps the traveller to make a decision depending on the number of co-passengers (Chan et al., 2016). Due to these features of TNC's, travellers' are attracted to ride-hailing services as compared to the public transport bus service in recent times. Researchers have also shown that there is a significant change in travel behaviour, travel mode choice, and car purchasing behaviour due to their shift towards application-based ride-hail services (Tang et al., 2019). Also, there is a considerable increase in the adoption of ride-hail services by people from different social backgrounds due to the flexibility offered by them when compared with the public transit service (Lesteven and Samadzad, 2021). Hence, it is important to understand user perception of ride-hailing services and public transport bus trips in the cities of developing countries like India. It becomes essential to answer the following questions: What is the user

perception towards ride-hail service and public transport buses? What are the different contributing factors in choosing ride-hail service over the public transport bus service in the Indian context?

In this context, a recent study has explored and identified that there is a significant growth in ride-hail service in different countries including India which may lead to significant changes in travel patterns and ridership of public transit services (Malalgoda and Lim, 2019). However, this topic has gained the attention of very few researchers in the context of emerging cities in developing countries, and the above questions have not been completely addressed by these limited studies. Hence, the present study explores the user perception towards the ride-hail service and its impact on public transport bus service in the Indian context. The main objective of the study is to understand the probability of choosing a ride-hail service over the public transportation bus and to identify the significant contributing factors which affect the decision of travellers to choose ride-hail service as their preferred travel mode. The study also explores the choice of ride-hail service by using the econometric modelling approach, viz., binary logit-based discrete choice model.

The structure of the remaining paper is as follows: the second section presents the existing literature review in the context of the study objectives. The third section focuses on data collection and model formulation. Preliminary statistical results and model results are presented in section 4 and the discussion on the developed empirical model has been presented in section 5. In section 6, conclusions from the study have been presented.

2. Background of the study

In ride-hail service, the passengers need to book a ride by using TNCs application, and the request is sent to the nearest available drivers; subsequently, the drivers may accept or reject the trip based on the destination of the passengers and the method of booking/payment depends on the TNCs application system. Travellers can choose different payment options which include TNCs money system, credit card, cash, and recently introduced Unified Payments Interface (UPI) system. The fare (viz., travel cost) for each trip may also vary based on the number of cars available at the time of the search, estimated travel time of the trip, peak hour demand, etc. The users, especially the younger generation, are more attracted by the advantages of ride-hail services due to the flexibility and convenience provided by this service. These services may change travel patterns significantly in an urban scenario and it would have a significant impact on the public transit system particularly bus trips. In the context of understanding this impact, Nguyen-Phuoc et al. (2020) conducted a study on exploring the significant factors that contribute towards user mode choice as ride-hail service in Vietnam, and the results suggest that perceived benefits of mobile application bookings have a significant positive impact on users' preference for ride-hail service.

Research studies have reported that the demand for ride-hail services is increasing especially amongst the younger generation, higher-income groups, and highly educated groups (PRC, 2016; Clewlow and Mishra, 2017a; Chu et al., 2018). Researchers have also explored the underlying factors for using ride-sourcing (ride-hail service) as well as traditional taxi services, and the purpose of such ride-sourcing has been explored for San Francisco city (Rayle et al., 2016). This study concluded that the waiting time for public transport travel mode is a significant contributing factor in favour of the choice of such ride-hailing services. In another study, the impact of shared mobility platforms on travelers' mode choice has been explored (Clewlow and Mishra, 2017b). In another study,

large-scale data has been evaluated related to the impact of ride-hail service on travel choice behaviour, and it has been concluded that the short trip users whose travel time is within 30 minutes are attracted towards the application-based ride-hail service (Tang et al., 2019). Some other studies have also explored the impact of ride-hail service on public transportation-based trips. A research study by American Public Transportation Association (APTA) noted that there is a significant reduction in public transit service ridership due to the increase in demand for ride-hailing services in cities (APTA, 2018). Another study has evaluated the taxicabs as complimentary service or substitute to public transportation, and based on the results it has been concluded that the gaps of mobility for the transit access are fulfilled by the taxicabs making them substitute to public transportation (Austin and Zegras, 2012).

There are limited studies that have highlighted the impact of the ride-hail/ride-sourcing services on public transportation ridership in many cities. These studies have reported that TNC (viz., Uber – considered in the reported literature) is a substitute or complementary service for public transit and the study noted that the TNC is complementary to the transit services for larger cities (Hoffmann and Ipeirotis, 2016; Hall et al., 2018). Whereas, researchers have stated that most hours of the day TNCs compete with public transportation and it might complement during midnight in New York City (Jin et al., 2019). There is still ambiguity concerning how the ride-hail service competes with public transportation services or substitutes it, especially in the context of medium-sized cities in developing countries such as India. A recent research study has noted that there is no evidence of ride-hail service competing with other transport modes including private cars, public transport buses, and non-motorized transport modes (Habib, 2019). Another study has shown that integrating the ride-sharing service with public transit services enhances urban mobility and increases transit ridership (Stiglic et al., 2017). It has been identified in another study that the adaptation of ride-hail service is associated with land use characteristics including mixed land use as well as independent users' income levels (Alemi et al., 2018). Researchers have observed that the frequency of using ride-hail services depends on socio-demographic characteristics and land use mix (Alemi et al., 2019).

Some of the shortcomings of the public transportation system (viz., lack of last-mile connectivity, fixed-route operations, and frequency) can be addressed by the integration of the private car trips as shared mobility service (Murray et al., 2016). Shaheen and Chan (2016) have studied the potential impact of ride-sourcing on the public transportation system by first and last-mile connectivity and the results concluded that ride-hail service has a significant contribution to last-mile connectivity. Furuhata et al. (2013) also explored in this direction, for identifying the possible ways to integrate ride-sourcing with public transit services, to enhance the effectiveness of the public transportation system. Another study found that car-sharing significantly reduces the number of public transit trips (Le Vine et al., 2014). However, this study concluded that one-way car sharing might be a substitute while the round trip will be complementary for public transit trips. Some studies have attempted to understand the acceptance behaviour of potential ride-sourcing passengers (Keong, 2015; Haba, 2018). Efforts have been made to evaluate the subjective norms and continuous intention to use such ride-sourcing technology and the results suggested that subjective norms have a significant effect in the use of technology as well as adopting a change in technology for ride-sourcing by the travelers' (Weng et al., 2017). Some studies have found that the neighborhood areas with a high density of population as well as high-density employment locations have more chances to utilize such service

(Wang and Mu, 2018; Deka and Fei, 2019). In this line, some studies have also noted that ride-sourcing will reduce car ownership in urban areas having a high-density population, due to parking as well as congestion problems (Greenblatt and Shaheen, 2015).
Wang et al. (2016) have reported that the traffic congestion problem can be mitigated with ridesharing, by encouraging travellers to use high occupancy vehicle lanes with discounted toll rates. However, researchers have also reported the negative impacts of shared mobility, in particular, the fact that ride-sourcing may increase the congestion during peak hours and Vehicle Kilometers Travelled (VKT) (Currie, 2018). A recent review-based study highlighted that the ride-hail service may improve the comfort and accessibility of passengers, while it may also increase the VKT (Tirachini, 2019). In recent times, the TNCs have adopted different optimizing techniques to pick up the travellers and the TNCs system assigns the ride to the driver at least 2 km away from their pickup location to reduce deceitful bookings. However, this may significantly increase the VKT for each TNC vehicle, and it would also have a significant impact on congestion as well as environmental pollution. However, these TNCs have also introduced carpool-based trips for travelers, where travelers can share their rides with co-travelers based on their destinations, and this would reduce the VKT and congestion to an extent. In this line, studies have also explored activity-based ridesharing and it has been reported that riders' preference match would significantly reduce the detour time (Wang et al., 2018).
From the existing literature, it is understood that the studies have explored the impact of ride-sourcing/ride-hailing services on the public transportation system. However, it is not clear that which contributing factor significantly increases the traveller preference for ride-hail service over the public transit service. Further, these existing studies have mostly focused on cities in developed countries, which may have completely different mode choice decision indicators as compared to developing countries. In this context, the present study analyses the user perception towards the ride-hail service and public transport bus in terms of mode choice keeping in mind the cities in India. Further, this study also focuses on evaluating the effect of significant contributing factors on the probability of choice of ride-hail service.

3. Methodology

The study methodology is divided into two parts. The first part deals with the data collection process adopted and the description of the study area. The second part describes the model formulated for analyzing the user perception towards ride-hail service.

3.1 Study area and data collection

The present study objective is to identify the significant contributing factors towards the usage of ride-hail services and the public transport bus service. A busy road stretch of 3.8 km length in Nagpur city, India is selected as a study area. A video graphic survey has been conducted on the stretch as a preliminary survey to understand the modal share of ride-hail and public transport buses. The selected route for the survey between Ambazari to Eternity Mall, Sitabuldi, Nagpur city is represented in Fig. 1. As the majority of mode share is contributed by the private vehicles in the city, it was observed that ride-hail service accounts for 5%, and public transport bus accounts for only 1%.

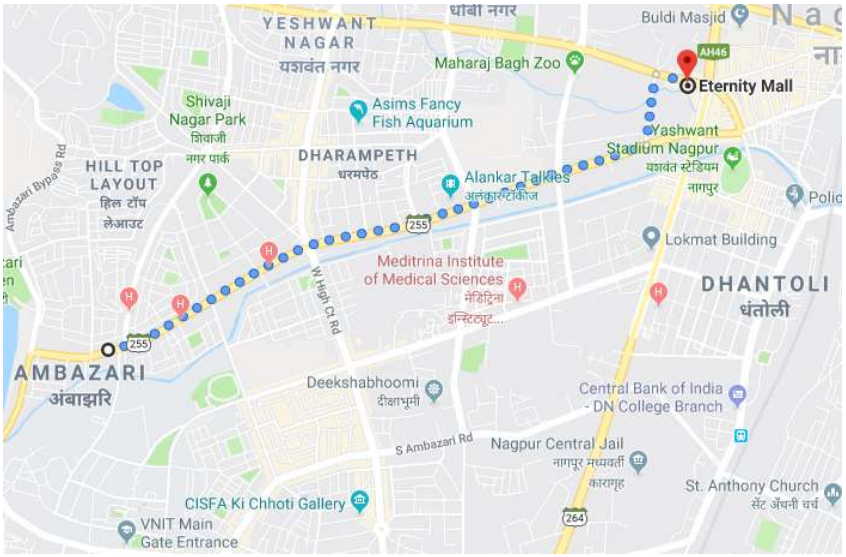

Figure 1: The selected route for the survey in Nagpur city, India (Route courtesy: Google maps)

In the study, a questionnaire survey has been conducted to collect the data related to the study. The objective of the questionnaire survey is to understand the factors affecting the perception of the potential use of mobile application-based ride-hail service as well as public transport bus service on the selected route. The survey has been administered in two ways, which includes online survey (viz., Google form) and offline survey (viz., intercept survey conducted at selected bus stops), and was conducted from 08th Jan 2019 to 05th March 2019 during evening peak hours. The online survey form requested the details from ride-hail service users, public transport bus users' and users of both the services (viz., almost 62% of the respondents were university campus students in the online survey). The offline intercept survey is conducted at various bus stops in the study stretch and mainly focused on the public transport service users along the selected corridor to understand their perception towards ride-hail service, their experiences with public transportation bus services, and how these experiences would affect their travel mode choice in the future. The questionnaire form (viz., online as well as offline) has been designed based on the pilot survey conducted through online and offline modes. The survey samples were selected based on the stratified random sampling procedure.

A three folded questionnaire format was designed for the survey based on past literature, preliminary field studies, and expert opinions. The first part of the questionnaire consists of the general socioeconomic and travel data which includes gender, age, occupancy, income, mode of transport, the purpose of the trip, frequency of the trip by public transport, and ride-hail service. The second part of the data focused on the factors which influence the selection of mode as ride-hail service; which includes door-to-door service, tracking system, accessibility (viz., ease of access during travel planning), comfort, safety, privacy, parking, and waiting time. The third part of data focused on the factors related to public transport bus service such as comfort, safety, accessibility (viz., accessible to the nearest public transportation bus stop by walk mode), trip fare, travel time, frequency of bus service, over-crowding of the bus, etc. The respondents also answered other questions related to ride-hail services such as frequency of using ride-hail service, electric vehicle, pool/share options, car ownership, and opinion about the plan to

purchase a car soon.
The questionnaire form has been prepared in English and the surveyors have explained the details of the questionnaire in the local language (viz., Marathi) to the respondents for better understanding. The questionnaire was prepared in such a way that it takes no more than 5 minutes to complete. Further, those who have not responded or not filled the online form have been excluded from the data set. A total of 778 responses (viz., due to elimination of incomplete forms, lower number of useful responses from the travelers could be yielded) has been recorded from both online as well as offline survey, out of which 530 responses are from the online survey. The response details from the survey and the descriptive statistics of the data are summarized in Table 1. In the table, the mean and standard deviation values are presented in the form of code values stated in parenthesis, viz., for gender, men are coded as 1 and women are coded as 0, and the corresponding mean value observed from the response is 0.63 which indicates that the data consists of more male responses. Further, as expected, the mean for age criteria is 1.2 which indicates that the majority of respondents are from a younger age who utilize the ride-hail service more frequently. The frequent passengers of public transport buses along this route are dominated by the student users (using the student pass to travel at discounted rates) and other daily workers and the mean value of trip rate 2.14 confirms the same.

3.2 Model formulation

To understand the binary outcomes such as Yes/No or the percentage contribution of one variable when compared with the other variables, the best suitable model is a binary logit model (Peng et al. 2002). The present study aims to analyze the user perception towards the ride-hail service and its impact on public transportation share and to identify the significant contributing factors towards the traveler's preference for ride-hail service. Due to this fact, the present study proposes a binary logit model for a better understanding of the reasons for using application-based ride-hailing services over public bus services. The framework for the binary logit model is that each traveler (designated as 'i') has two alternatives (designated as 'j'). Then the travelers' utility of choosing a particular alternative mode can be given as follows.

Table 1: Details of the data collected from the survey and descriptive statistics.

Factor	Description (code)	Number of Responses	Percentage (%)	Mean	Standard Deviation
Gender	Male (1)	493	63.37	0.63	0.482
	Female (0)	285	36.63		
Age	16-25 years (1)	487	62.6	1.2	1.025
	26-35 years (2)	104	13.37		
	36-50 years (3)	117	15.04		
	>50 years (4)	70	9		
Occupation	Student (1)	482	61.95	1.46	0.657
	Employee (2)	237	30.46		
	Work (3)	53	6.81		
	Other (4)	6	0.77		
Monthly income	< $ 150 (1)	177	22.75	2.61	1.116
	$ 151- $ 450 (2)	164	21.08		
	$ 451- $ 650 (3)	223	28.66		
	> $ 650 (4)	214	27.51		
Purpose of the trip	Leisure/Social Activity (1)	249	32.01	2.14	0.873
	School/College (2)	169	21.72		
	Work (3)	360	46.27		

Five scale based factors*

Type of Factor	Highly Important (%)	Important (%)	Neutral (%)	Least Important (%)	Not at all Important (%)
Comfort/convenience	11.7	66.71	10.03	9.64	1.92
Safety	29.69	35.35	18.77	15.04	1.15
Accessibility	34.58	40.36	19.79	3.6	1.67
Trip Fare	33.93	9	53.47	3.6	0
Travel time	24.29	36.63	21.08	15.04	2.96
Waiting time	31.75	37.15	19.02	9.25	2.83

Note: The variables presented in the existing study are based on the common variables which affect the decision to utilize ride-hail service and public transport bus service, while other variables such as fare system, the tracking system used, type of ride-hail service (shared/un-shared), frequency of use of ride service are not included in the model analysis; **The information was summarized from online survey data*.

$$U_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \quad (1)$$

X_{ij} is a vector of explanatory variables that are estimated to influence the travelers' decision to choose the application-based ride-hailing service. The variables considered include socio-demographic attributes (viz., gender, and age occupation),

comfort/convenience, safety, accessibility, waiting time, travel time, fare, etc. Further, variables such as the purpose of the trip, and travelers' income levels might have a significant influence on the utilization of ride-hail services. The β_j represents the coefficients of vectors from the model prediction corresponding to the X_{ij} for alternative j.

In general, the error terms in the logit model are assumed to follow the Gumbel distribution and the error terms in the probit model are assumed to follow Normal distribution. The binary logit model was developed in this study by assuming that the error terms ε_{ij} are independent and identical and follow the Gumbel distribution. This model predicts the probability that a traveler would select a mobile application-based ride-hailing service over the alternative travel mode as public transport bus based on the possible set of influence variables (viz., accessibility criteria, waiting time, occupation, income, the purpose of the trip, comfort/convenience, safety, accessibility, fare of the trip, travel time). Further, it can be noted that the probability of choosing a ride-hail service by the traveler from the set of explanatory variables can be calculated from Equation 2.

$$P_{ij} = \frac{\exp(\beta_j X_{ij})}{1+e \quad (\beta_j X_{ij})} \qquad (2)$$

The parameters (βj) are estimated by maximizing the log of the likelihood function.

4. Results

4.1 Preliminary statistics

In this section, the data from the survey (as described in Table 1) and the factors related to ride-hail service and public transport bus trips have been discussed. From Table 1, the users of mobile application-based ride-hailing services with occupation as 'students' have shown a significant difference in the utilization of these services as compared to users with other occupation levels, perhaps due to faster adoption of the technology. These survey findings are in line with the results of another research study, wherein it is observed that most of the ride-hail service users are highly educated (Rayle et al., 2016). From the survey responses in the present study, it is inferred that the ride-hail services are highly preferred by young-aged group users. It is also observed from the survey responses that more than 56% of the individuals having a monthly income range about $ 450 - $ 715 (the funding/scholarship provided to the students by the educational institute is also considered as income). Further, the respondents of ride-hail service users from the online survey perceived that comfort, cashback-offers, live tracking system, safety, and accessibility are the most important factors which drive the users towards ride-hail service. It is also observed that the factors which influence the commuters to choose public transport are fare (viz., low travel cost) as well as safety and it is comprised based on the face-to-face interview survey at bus stops. It is also clear from the data that public transport users are frequent travelers and accessibility is a less important parameter for them when compared with travel cost. However, there is no clear conclusion on the influence of the waiting time, travel time, and comfort for choosing the public transport bus for travel, although, 56% of users perceive that the waiting time for the bus as well as travel comfort is important for the public transport bus trips. The preliminary statistical analysis (viz., correlation analysis) has been conducted to understand the influence of various factors on the travel mode choice decisions, especially either ride-hail service or

public transport bus, and the same is analyzed further with the help of a binary logit model.

Spearman's correlation analysis was conducted by using a statistical package for the social sciences (SPSS) to understand the impact of variables like age, occupation, accessibility, waiting time, travel time, etc. on the choice of travel mode and the correlation results are summarized in Table 2. From the correlation results, it has been observed that the gender of the commuter does not have a significant impact on choosing a mode, perhaps due to a major proportion of respondents belonging to the younger age group. Further, it is also observed that the income level, the purpose of the trip, and the fare of the trip are positively correlated with their choice of mode selection. On the other hand, factors such as age, occupation, accessibility, waiting time, and travel time are negatively correlated with choice of mode selection. As an example, it can be noted that the correlation coefficient for age is -0.401, which indicates that the increase in the age of travellers reduces the probability of using the ride-hail service. These correlated variables are considered for the binary logit model calibration.

Table 2: Correlation analysis results.

Variable	COM	Gen	Age	OCC	IC	POT	COMF	SAF	ACC	FOT	TT	WT
COM	1.00	-.026	-.401	-.400	.468	.451	-.189	.162	-.421	.450	-.256	-.331
Gen	-.026	1.00	-.044	-.016	.025	-.008	.040	.176	.005	-.004	.046	.085
Age	-.401	-.044	1.00	.905	-.251	-.501	.069	-.098	.274	-.231	.203	.158
OCC	-.400	-.016	.905	1.00	.239	-.520	.084	-.085	.267	-.208	.189	.160
IC	.468	.025	-.251	-.239	1.00	.427	-.132	.118	-.319	.503	-.175	-.279
POT	.451	-.008	-.501	-.520	.427	1.00	-.114	.123	-.348	.450	-.141	-.200
COMF	-.189	.040	.069	.084	-.132	-.114	1.00	.323	.194	-.207	.303	.181
SAF	.162	.176	-.098	-.085	.118	.123	.323	1.00	-.016	.162	.388	.058
ACC	-.421	.005	.274	.267	-.319	-.348	.194	-.016	1.00	-.371	.316	.304
FOT	.450	-.004	-.231	-.208	.503	.450	-.207	.162	-.371	1.00	-.094	-.082
TT	-.256	.046	.203	.189	-.175	-.141	.303	.388	.316	-.094	1.00	.351
WT	-.331	.085	.158	.160	-.279	-.200	.181	.058	.304	-.082	.351	1.00

Note: Where COM: Choice of the mode as ride-hailing or public transport bus; Gen: Gender; Age: Age of the trip maker; OCC: Occupation; IC: Income; POT: Purpose of the trip; COMF: Comfort/convenience; SAF: Safety; ACC: Accessibility; FOT: Fare of the trip; TT: Travel time; WT: Waiting time for the selected mode of travel

4.2 Binary logit model results

A binary logit model was developed by considering the mode choices as either ride-hail or public transport bus and the survey responses related to comfort/convenience, safety, accessibility, and other factors stated in Table 2 were considered as independent variables. 70% of the total 778 samples are considered for model calibration and the remaining 30% of the samples are used for validation purposes. NLOGIT 4.0, an econometric modelling software package is used for developing the model. A null hypothesis (H_0) is formulated that no single variable is contributing towards the travel mode choice and the alternative hypothesis (H_a) is considered as at least one variable that has a significant impact on the selection of mode choice. The summary of the model calibration results along with the model validation results is presented in Table 3. From the calibrated model results, the null hypothesis is rejected and a total of 10 variables were observed to have a significant contribution towards the travel mode selection as ride-hail service or public transport bus trips. The model ρ-square is observed to be 0.82. The calibrated model results are

validated with 234 data samples by using a prediction-success table and it is observed that the model is predicting at a success rate of 86%.

5. Discussion of results

From the model calibration results presented in Table 3, it is observed that the pedestrian age has a significant impact on mode choice selection between ride-hail service and public transport buses. The increase in the age group of travelers decreases the probability of hiring a ride-hail service as compared to the public bus service, and the model results suggest the same. With the advent of smartphones and ease of access to mobile applications, a significant increase in the use of ride-hail services was observed in the younger age group (viz., 16-25 years) when compared with the other age groups. These results are in line with the existing research studies, wherein it has been reported that the probability of younger people using smart mobile phones is higher, which influences their frequent use of ride-hail services as compared to the elderly people (Rayle et al., 2016; Young and Farber, 2019).

From the results in Table 3, it is observed that the variable age (viz., coefficient -0.799) and occupation (viz., coefficient -0.886) have a significant negative impact on choosing the ride-hail service. Further, the responses received from the survey data indicates that the students having monthly pass (discounted travel pass) for public transport bus are more inclined towards bus travel during the weekdays, however, some students who are staying on University campus (viz., hostels) may use ride-hail service frequently during the weekend. The results could not conclude whether the students who do not have a monthly bus pass and who are not living on the campus are using either ride-hail service or public transport bus service. Further, the study also identified that daily work trips and nonwork trips are mostly associated with public transport bus travel as compared to the ride-hail service. Loa and Habib (2021) have reported that the experience with ride-hail service positively influences the choice of commuters towards adopting the service, as compared to commuters who have not used ride-hail service earlier. It may be noted that the present study could not conclude whether the ride-hail trips are a substitute or complementary to the public transport bus users.

Table 3: Binary logit model calibration and validation results

Model calibration results				
Variables	**Estimated coefficient**	**Standard error**	**t- statistic**	**P-value**
Constant	-8.013	1.469	-5.455	0.000
Age	-0.799	0.375	-2.131	0.033*
Occupation	-0.886	0.500	-1.771	0.077 **
Income	1.144	0.230	4.966	0.000
Purpose of the trip	1.031	0.189	5.467	0.000
Comfort/convenience	-0.715	0.202	-3.536	0.002*
Safety	0.589	0.228	2.584	0.009*
Accessibility	-0.868	0.243	-3.578	0.000
Fare of the trip	3.863	0.409	9.442	0.000
Travel time	-0.767	0.249	-3.076	0.002*
Waiting time	-1.106	0.240	-4.609	0.000
Number of samples		544		
Log-likelihood at convergence		-98.143		
Log-likelihood at zero		-539.227		
Chi-squared		882.1681		
Degrees of freedom		10		
Pseudo R-squared		0.82		

Model validation results			
Actual value	Predicted value		Total value
	0 (Public Bus)	1 (Ride-hailing)	
0 (Public Bus)	104 (44.4%)	14 (5.9%)	118 (Public Bus)
1 (Ride-hailing)	18 (7.7%)	98 (41.9%)	116 (Ride-hailing)
Total	122 (52.1%)	112 (47.9%)	Total
The overall success prediction of the model validation is 86% (viz., (104+98)/234)			
Note: *variables are significant at 95% confidence interval; **variables are significant at 90% confidence interval			

In the present study, it has been observed that with the increase in income level, there is a probability of an increase in the use of ride-hail services as compared to the public transport bus service. The present study findings are in line with the recent study which has noted that high-income individuals of suburban areas are likely to use ride-hail services (Shirgaokar et al., 2021). Other researchers have reported that the neighbourhood household income levels highly influence the ride-hail pickups and drops, rather than the transit supply (Barajas and Brown, 2021). Further, the developed model results suggest that if the purpose of the trip is leisure or social activity, then there is a higher probability of choosing the ride-hail service. From Table 3, it can be noticed that there is a 22% higher probability of choosing a ride-hail service when the purpose of the trip is leisure or social activity as compared to the work trips. Moreover, the present study results are similar to the existing research study findings, which suggest that entertainment trips are mostly associated with the ride-hail service (Tang et al., 2019). In another study, it has been concluded that on-demand services have more chances of competing with the existing public transport services, due to less accessibility, and there is a significant impact of trip

purpose on the usage of ride-hail service (Etminani-Ghasrodashti and Hamidi, 2019). Though the safety of travelers is an important parameter, the present study does not include travelers' perception of safety during nighttime while using the ride-hail service. It is opined that the consideration of gender-specific safety perception during nighttime service would help to get a more clear perception of the safety of ride-hail service as compared to public transport bus service.

Another important factor for the selection of mode choice is the accessibility of the trip. If travelers feel that the accessibility for availing the public transport service is difficult (viz., longer distances to reach the bus stop), then there is a decrease in the use of public transport buses. From Table 3, it can also be noted that the coefficient of accessibility is -0.868, which shows a significant negative impact on accessibility by choosing public transport bus, perhaps due to travelers feeling public transport requires more access time than the ride-hail service. The results also indicate that if the users are given priority to travel time and waiting time, and at the same time if they are not concerned with higher travel costs, then their choice of mode is inclined towards ride-hail service. This indicates indirectly that the trip makers who complete their trip by public transport bus accept higher travel time and more waiting time for the bus. Moreover, it is also inferred that a further increase in travel time and waiting time, might lead to a change in the mode choice to ride-hail service. In a recent study, it has been identified that there is a significant reduction in bus ridership and there is an increase in usage of commuter rail service due to the ride-hail service (Babar and Burtch, 2021).

6. Conclusions

The present study attempted to explore the travel mode choice behaviour between ride-hail service and public transport buses with selected variables. To achieve the objectives of the present study, two different (viz., online as well as offline) methods of data collection are adopted and the data analysis is performed. A binary logit model is developed to support the analysis for understanding the mode choice selection of the travelers. The present study identified the significant contributing factors on the selection of ride-hail service, which includes age, income, trip purpose, occupation, comfort, safety, accessibility, the fare of a trip, travel time, and waiting time. In specific, the study concluded that the younger and middle-aged groups have more probability of choosing ride-hail services when compared to elderly people. It is also concluded that the rise in income level increases the probability of the usage of ride-hail services. Further, the study also concluded that the travelers who give more preference to comfort and safety are mostly associated with ride-hail service. The study also noted that accessibility is one of the important parameters for the users to decide on the usage of ride-hail services or the public transport service. It is further observed from the study that travels time and waiting time are the other influencing factors that shift the user preference towards ride-hail service.

Though the present study explored the user perception towards ride-hail service, it has its limitations in the form of data; with limited sample size, single study stretch in the city, etc. Moreover, the study did not explore the impact of time of day and type of day (weekend or weekday) on the mode choice between ride-hail and public transit buses, which are also important factors for the travelers' perception of safety while using ride-hail service. Further, the present study could not draw any specific conclusions related to changes in public transport ridership. The authors opine that a larger data sample could explore the relationship between ride-hail service and public transportation in terms of

ridership in a better way. Further, authors have hypothesized that the ride-hail service in medium-sized cities in India might compete with the public transport bus service, whereas, in cities with larger radius (viz., increased urban form) which have larger trip distance along with public transit service such as Metro service (viz., in India), the ride-hail service will be complementary.

Despite the above limitations, the study provides crucial insights into various essential factors that contribute to the utilization of ride-hail services in a city. The study results are also useful for understanding the user perception towards the selection of ride-hail service over the public transport bus. Further, the study highlights the importance of the fare of the trip, accessibility, and waiting time which significantly influences the public transport bus trips. These results may be useful to develop more robust prediction models for the transport planners and policymakers to set up suitable guidelines for strengthening the existing public transportation system. These results might also be beneficial in the direction of making policies to include ride-hail service as feeder as well as complementary service to the public transportation system by integrating ride-hail service to the scheduled frequency of public transport services.

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