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Analysing the ride sharing behaviour in ICT based cab services: A case of Mumbai, India

Pranav Shah[a], Varun Varghese[b], Arnab Jana[b*], Tom Mathew[a]

[a]*Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai-400076, India*
[b]*Centre for Urban Science and Engineering, Indian Institute of Technology Bombay, Mumbai-400076, India*

Abstract

The land passenger transport sector lies on the cusp of a major transformation, guided by last mile connectivity, digital technology, and collaborative consumption. The recent emergence of transportation network companies, in tier-I cities of developing countries, which provide economically and environmentally convenient sharing services over the last decade motivates this research. The objective of this research is to find the extent to which different considerations persuade people to choose non-sharing rides over sharing rides so that policy recommendations for a modal shift from a non-sharing service to a sharing service can be suggested. A revealed preference survey was conducted in the city of Mumbai capturing information on an individual's travel patterns, socio-economic characteristics, and attitudes. A novel methodological framework was conceptualized to test the impact of these socio-economic, attitudinal, and other underlying factors on sharing of cab rides. The framework was then tested using structural equation modelling (SEM). The results showcased that latent variables for 'socio-economic status' and 'spending attribute' negatively impacted sharing. Meanwhile, travel characteristics such as the number of companions and how they value comfort in a ride also had significant negative impacts on sharing choice. The findings of the study were then used to discuss policy recommendations for the modal shift from non-sharing to sharing services.

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Keywords: Ride sharing; ICT based cab services; TNC; ABCA; Attitudinal parameters; Developing countries

1. Introduction

Urban population in India is expected to increase from 377 million in 2011 to approximately 600 million by 2030. The country currently has approximately 468 cities with a population of more than 1,00,000 inhabitants (Census 2011). Economic development of cities depends on the development of primary, secondary and tertiary sectors, which in turn depends on their transportation infrastructure in order to cater to the demand for goods and services to provide access to the required activities. Moreover, backlogs in the urban transportation infrastructure in cities may lead to decrease in the efficient functioning and decrease in the expected output of the city. Cities with lack of efficient public transport infrastructure result in users eyeing for alternative modes of transport. This includes an

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increase in the use of private vehicles, which could lead to reduced traffic safety, further deterioration of air quality as well as increase in road congestion (Gadepalli, 2016; Pucher et al., 2005). People in densely populated cities like Mumbai, with a population density of 20,980 persons per sq. km (Census 2011), generally prefer travelling by public transport to private transport because of convenience in cost and time. Meanwhile, only 9.7 per cent of the total urban population own car, jeep or van and only 35.2 per cent of the urban population own two-wheeler (Census 2011). The usage of personal cars and two-wheelers is still prohibitively expensive for large sections of the society, who still rely on public transport (Census 2011). In addition, dial-a-cab services, which involves short-term advance booking of cabs through call or application, have been on rise in India since 2007. From the consumers' side too, there has been tremendous increase in cab bookings through mobile applications. These Application Based Cab Aggregators (ABCA), based on the broader concepts of sharing economy have quickly acquired a high share in the market in the past few years (Jaiswal, 2018). India witnessed entries of many private companies in tier-1 cities of the country and Mumbai was the first city where players like Meru Cabs and Ola Cabs were established in 2007 and 2010 respectively (Jaiswal, 2018). Uber, another Transportation Network Company (TNC) headquartered in San Fransisco, started operating in India in 2013. These Transportation Network Companies cater to real time demand by aggregating cabs for customers. They offer last mile services through an innovative blend of technology, low cost and convenience. These companies develop and adopt technologies that are at par with the latest technologies, which are very appealing and convenient to the customers. Unlike other taxis or cabs that charge on the basis of distance, time or their respective metering system, the pricing model of these cab aggregators are much more complex and also depend on the demand and supply of cabs in the region.

Trade growth of goods and services and upsurge in the activities are generally high in cities of developing countries. Every city needs to enhance the transport infrastructure to cope up with the increase in transportation demand. In addition, these transportation infrastructure need to be efficiently used in order to minimize costs and maximize the output. Adopting sharing based business models can help in increasing the trade of goods and services and can increase the number of activities with reduced cost per trade or per activity. Companies like Ola and Uber have adopted the sharing economy concept, where people can share a ride with unknown people who are travelling on a similar route. Uber, for example, offers 'UBERPOOL' (a ridesharing service) that is up to 50 per cent cheaper than a non-sharing Uber ride. Simultaneously, increasing traffic congestion, consumption of fuel and environmental pollution along with inflated pricing in cities like Mumbai call for major efforts by these TNC companies to suffice the dynamic demand and provide the cab sharing/pooling services. Ride sharing involves effective usage of car seats with minimum empty seats. Thus, the occupancy rate increases and in total, the efficiency of the urban transportation increases. Ridesharing has several advantages for the stakeholders (drivers and passengers), for the society and for the environment too. These advantages include savings in travel cost for the passengers and increase in total revenue for drivers, reduced total travel time, mitigation of traffic congestions, fuel conservation, and decrease in the air pollution (Furuhata et al., 2013).

From the suppliers' perspective, cab sharing serves as a form of para-transit for a group of individuals that affords greater spatial coverage but requires significantly lower public investment. Therefore, these companies, especially in congested metropolitan areas like Mumbai have provided these services, branding them as economically convenient. From the riders' perspective, the impedance towards greater adoption of sharing service is rooted in various concerns like its flexibility, reliability, security and efficiency (Chan & Shaheen, 2012). The social, environmental, transportation, and land management benefits from cab sharing (Chan & Shaheen, 2012) encourage the incentives for ride-sharing behaviours but their solutions are not provided and its implementation is not concluded. An individual mode choice preference does depend on various factors like the individual's socio-economic characteristics, ride characteristics as well as spending attitudes, which might be the reason that sharing service is not always preferred. However, there is not much evidence regarding the choice of sharing modes in the emerging transportation sector for the Indian context. Furthermore, a higher heterogeneity in the population of developing countries like India gives rise to the need of focusing on the riders' behavioural patterns while choosing alternatives in ACBA cabs. In addition, there might be existing underlying factors that impact sharing choice and it calls for developing a framework to test these effects. Therefore, we aim to find the extent to which different considerations persuade people to choose non-sharing rides over sharing rides so that policy recommendations for a modal shift

from a non-sharing service to a sharing service can be suggested. The objective of this research is to develop a methodological framework to study the causal factors that determine the how and why people choose sharing vis-à-vis non-sharing services of ICT cabs. The findings of this study would be beneficial in identifying factors which influence the choice and would aid in understanding the extent to which these conditions could be changed for making important policy decisions.

The introduction is followed by a brief review of the literature on ride-sharing, its determinants, and related policy implications. Section 3 describes the study area, whereas, Section 4 is divided into two parts, the first part explains the data collection methodology adopted. Meanwhile, the second part discusses the research methodology, while discussing the hypothesis. Section 5 describes the data collected and section 6 demonstrates the results. Finally, in section 7, the study is concluded by discussing the key findings, policy discussions, limitations, and the way forward for this research.

2. Literature Review

On demand ride-sharing has often been remarked as one of the major representative sectors of the sharing economy. Li et al. (2016) in their study on the impacts of app-based sharing services on urban congestion noted that after Uber's entry, the congestion on the streets considerably reduced. In addition, Berlingerio et al. (2017) and Dewan & Ahmad (2007) also noted negative impacts of car-pooling services on congestion. Meanwhile, Basu et al. (2017) compared the traditional and emerging para-transit services in India to argue that intermediate public transport services had various advantages over existing private transport modes since they are associated with traffic reduction, relatively cheaper pricing, and last mile connectivity. Shaheen et al. (2017) in their study of app-based sharing services suggested the difference between traditional ride sharing and app-based services. They identified that the primary difference was of the lack of common origin and destination for all its riders. They tried to estimate its effect on modal shift and induced travel and concluded that there was no evidence which suggested an increase in travel due to the use of app-based services. In addition, they noted that a high proportion of individuals did not buy a car just because ride-sharing services were available to them. However, a major requirement to use such services is the required access to information and communication devices. Gheorghiu & Surugiu (2016) concluded that the having a permanently updated information system in the urban public transportation systems improves the overall efficiency. Meanwhile, Grotenhuis et al. (2007) argued about the importance of the quality of integrated multimodal travel information in public transport systems. However, various studies have provided evidences on individuals preferring to use public transport modes over public transport modes. Mugion et al. (2018) investigated the role of service quality in sustainable mobility in urban public transport in Rome, they noticed that individuals preferred sustainable modes of transport over one's own car. However, when the productivity of different modes are concerned it was observed that private sector modes provided a higher productivity (Boitani et al., 2013). There is a possibility that these app-based services provide the productivity associated with private transport modes while promoting sharing of rides. Rao & Alexander (2017) examined the competitive advantages of taxi aggregation model by conducting an industry analysis and found out that the service provided by taxi aggregation model is viable to conditions in developing countries like India. However, the role of para-transit services in India has not been properly identified in transport policy making (Tiwari, 2007). A possible reason for this might be the lack of empirical evidence on what factors affect its choice. Sharing in general makes a great deal of practical and economic sense for the consumer, the environment, and the community (Belk, 2014).

Various studies from across the world have investigated the influence of different factors on sharing of cab services. Liakopoulou et al. (2017) performed a study in Thessaloniki (Greece) which investigated preferences of students towards the creation of a carpooling system serving the academic bodies of the city. Meanwhile, Delhomme & Gheorghiu (2016) compared the differences in behaviour between French carpoolers and non-carpoolers. Similarly, in Toronto, Lin & Lin (2017) analysed mode choice behavior of transit users in response to TTC (Toronto Transit Commission) rapid transit service disruption. Whereas, Cherchi et al. (2017) modeled variability in mode choice behaviour using panel data to account for correlation across all days of a single week and different days of the week in Karlsruhe (Germany). Subsequently, Kotoula et al. (2017) investigated the behavioural change

of students traveling to and from the university after considering relocation of the university premises from the center of the city Xanthi (Greece) to a more isolated area. Kunhikrishnan & Srinivasan (2018) demonstrated that factors like comfort and service availability can also significantly influence sharing choice. Meanwhile, Shaheen et al. (2017) analysed the influence of parameters like car ownership and basic demographic characteristics on sharing behaviour.

The review of modelling techniques showcased that discrete choice models were the most commonly used frameworks to test the impact of parameters on sharing choice. Daziano et al. (2017) conducted a stated preference survey among some potential car buyers and developed a conditional logit model for the analysis. Meanwhile, other studies used a multinomial logit model (Hagenauer & Helbich, 2017, Sun et al., 2017), random parameter logit model (Aziz et al., 2017), and nested logit model (Mahmoudifard et al., 2017) for the analysis of data. However, Roy (2017) explains about improving the proficiency of model by using a structural equation model (SEM) since it examines a series of dependence relationships. In addition, Gerber et al. (2013) stated that latent parameters like attitude are qualitative and thus SEM technique can be adopted to quantify them in a better fashion. Meanwhile, Donald et al. (2014) illustrated the use of confirmatory factor analysis as a measure to ensure validity and reliability of the SEM. There are substantial advantages of using SEM over other multiple regression methodologies. Firstly, all the coefficients are estimated simultaneously in the SEM model and therefore it becomes easier to assess the significance and strength of a particular relationship in context of the whole model. Secondly, SEM can handle hierarchical regression. Thirdly, multi co-linearity can be assessed (Jana et al., 2012). The mentioned advantages seem to be effective in interpreting the choice behaviour specially which are complex in nature involving several observed and unobserved constraints.

The brief review of the literature provided a glimpse of the type of researches happening in the field of sharing cab services. The benefits of the same were identified, meanwhile the effects of various parameters and the modelling methodologies being used were reviewed. The review of the literature bring to fore the existing research gaps. It was noted that as most of the studies were based in developed countries, there was a lack of understanding in how various socio-economic factors and the existing disparity in the same effect sharing behaviour. In addition, it was noted that para-transit policies haven't got much attention in developing countries, especially when it constitutes a large share of the mode share here. Moreover, most of the studies used discrete choice models, therefore unable to identify the effect of various underlying latent factors on the behaviour. This study by basing its analysis in a city from the developing world aims to fulfill the above-mentioned research gaps.

3. Study Area

Primary surveys for this study were conducted in the city of Mumbai, India. Mumbai (also known as Bombay, the official name until 1995) is the capital city of the Indian state of Maharashtra. It is the most populous city in India with an estimated population of 12.44 million (Census 2011). In addition, samples from nearby districts – Navi Mumbai, Thane and Mira Bhayander were also collected because these districts lie in close proximity to Mumbai and have also experienced major economic growth (MCGM, 2016) and are served by the app-based sharing companies. Mumbai lies on the west coast of India (see Figure 1) and has a deep natural harbour. In 2008, Mumbai was named an alpha world city (Peter Taylor, 2008). Mumbai is the financial, commercial and entertainment capital of India. It is also one of the world's top ten centres of commerce in terms of global financial flow, generating 6.16% of India's GDP and accounting for 25% of industrial output, 30% of income tax collection, 60% of custom duty collections, 20% of central exercise collections, 40% of foreign trade and 70% of capital transactions to India's economy (MCGM, 2016).

Nearly 50% of the trips in Mumbai is made on foot, meanwhile, nearly 75% of the motorized trips are made in public transport modes such as trains and buses (MCGM, 2016). Public transport systems in Mumbai include the Mumbai suburban railway, monorail, metro, Brihanmumbai Electric Supply and Transport (BEST) buses, and ferries, whereas intermediate public transport modes (IPT) include taxis and auto rickshaws. Auto-rickshaws are

three-wheeled motorized vehicles which constitute a major share of Mumbai's para-transit usage. Auto rickshaws are allowed to operate only in the suburban areas of Mumbai, while taxis are allowed to operate throughout Mumbai, but generally are more prominent in South Mumbai. Taxis and rickshaws in Mumbai are required by law to run on compressed natural gas (CNG), and are a convenient, economical, and easily available means of transport. Traditional taxis i.e. black-and-yellow cabs perform an average of 10 trips daily with the each trip length having an average of 5.1 km (MCGM, 2016). On the other hand, auto-rickshaws complete an average of 16 trips everyday having average length of the trip of 2.9 km (MCGM, 2016). In addition, ICT cabs, in the past decade, have hugely increased their market share in the last mile connectivity services sector. These IPT modes are sporadic in nature but they offer very high flexibility to the passengers, who decide the destination of the IPT trip. Next, these Intermediate Public Transit modes compete heavily with the public transportation system in the Greater Mumbai. Both the modes have different service offerings, one being the last mile connectivity and other being low cost and time convenient travel in particular routes. Although the modal split for IPT is expected to slightly decrease due to the recently launched metro and monorail systems, the actual number of trips by IPT is expected to rise in Greater Mumbai.

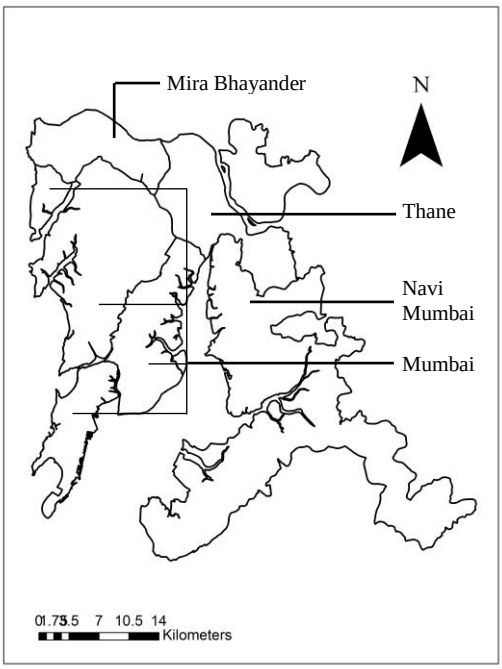

Fig 1. Study Area

Many IPT modes in Mumbai can also be classified as for-hire vehicle (FHV). This sector has been dominated by city taxis and autorickshaws for decades. But over the last 15 years, there have been huge private sector investments and advancements in technology which has led to a transformation in the way of interaction of people with FHVs. Now, apart from the old-fashioned way of choosing to hail a taxi or autorickshaw, urban commuters call, text, WhatsApp or e-hail them, or even request just a seat in a shared taxi or bus by the use of mobile phones. Bengaluru-based Ola and San Francisco-based Uber currently dominate this market. The goal of minimizing congestion in such a densely populated city like Mumbai can be achieved by improving the efficiency of the transportation systems. Focusing on ICT based aggregator cab services, the efficiency can be boosted by increasing the sharing rides instead of non-sharing rides. Unlike western countries which have already adopted the ICT cab services, these services are relatively new to Indian cities. In addition, their adoption would depend on an individual's socio-economic status as well as their personal attitudes. Since Mumbai is a city with people from different backgrounds and high heterogeneity, not much is known about the factors that might affect the mode choice in emerging para-transit services.

4. Methodology

4.1. Data Collection Methodology

A revealed preference study was performed to gather information such as household characteristics, trip characteristics, spending attributes as well as individual preferences. The survey was conducted through both the platforms – online questionnaire forms as well as the offline (pen-and-paper) route. The web-based platform (online) was a google form floated randomly to individuals in Mumbai, Navi Mumbai, Thane and Mira Bhayander. Snowball sampling technique was adopted to gather a good sample size (Richardson, Ampt, & Meyburg, 1995). Figure 2 represents some screenshots of the online survey. On the other hand, the pen-and-paper (offline) survey was conducted using a convenience sampling technique.

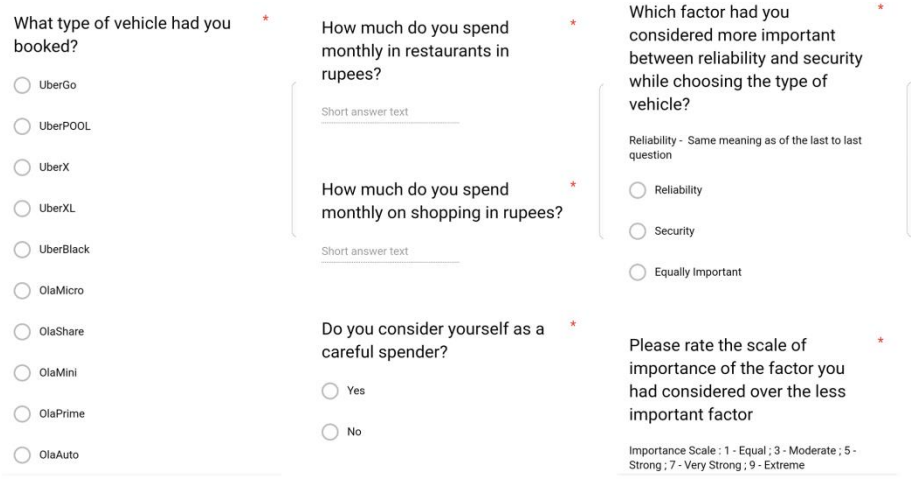

Fig.2. Snapshots of the online survey

The online and offline surveys received a total response of 301 respondents (199 online and 102 offline). Since each respondent had answered the revealed preference of one ICT cab trip, there were 301 trip data in total. It was also noticed that some data entries were missing and some respondents had filled incorrect entries. Consequently, the next task was to filter the data and clear all the incomplete and inappropriate responses. The missing entries and the inappropriate responses accounted for a total of 84 responses (34 online and 50 offline). Therefore, the resulting sample size was 301 - 84 = 217.

4.2. Research Methodology

After the survey process and the elimination of inappropriate entries, we obtained a sample size of 217. Since the sample size is greater than 150, the parameter estimates that have standard errors small enough to be of practical use can be obtained (Anderson J & Gerbing D, 1988). Therefore, causal relationships of the parameters were analysed and a model was developed.

The survey included questions related to the respondent's socio-economic characteristics, their spending attributes, their trip characteristics and their individual preferences. Questions linked to socio-economic characteristics were house ownership, housing type, marital status etc., while questions related to the respondent's past trip characteristics, like no. of people accompanying and type of trip were also asked. Likewise, the respondents were also asked their monthly expenditures in restaurants and shopping along with the question whether they considered themselves a careful spender or not. To determine preferences, namely comfort, security and waiting

time, one-to-one comparisons between the three preferences were conducted on a scale of 9 (shown in Section 5). Table 1, shows the list of all the variables and their respective descriptions.

Table 1. List and descriptions of variables used in the model

Variables	Description
Socio-Eco	A latent variable, constructed to incorporate the effects of observed variables that define socio-economic status
Spending	A latent variable, constructed to incorporate the effects of observed variables that define spending attribute
House Ownership	1, if owned; else 0
Years in Mumbai	No. of years living in Mumbai
Student	1, if a student; else 0
Married	1, if married; else 0
Four Wheeler Ownership	1, if owns a four wheeler; else 0
Two Wheeler Ownership	1, if owns a two wheeler; else 0
Living with Family	1, if lives with family; else 0
Housing type	1, if 3 (or more) BHK apartment or Bungalow; else 0
Careful Spender	1, if the individual considers himself/herself a careful spender; else 0
Restaurant	Mathematically equal to logarithm of (the monthly expenditure in restaurant plus 1)
Shopping	Mathematically equal to logarithm of (the monthly expenditure in shopping plus 1)
Mandatory trip	1, if the trip purpose is education, corporate meeting, office or school; else 0
No. of people accompanying	No. of people accompanying the trip, not considering the unknown one(s) in case of a sharing trip
Female	1, if female; else 0
Comfort	Normalized magnitude of the individual's preference of comfort over security and waiting time
Sharing or not	1, if sharing; else 0

The refined data contained different parameters which were related to individual preferences, characteristics and attitudes as well as trip characteristics. Firstly, Individual preferences were analysed by one-to-one comparison between comfort, security and waiting time. Eventually, the relative weightage of 'comfort' with in comparison to other parameters was determined. The quantification of the parameter 'comfort' was done by finding the relative preference of comfort over the preference security and the preference of waiting time. Respondents were asked to pick their revealed opinions between pairwise comparisons of three preferences that signified their decision when they chose their mode, namely comfort, security, and waiting time. Each pairwise comparison consisted two questions, (1) which preference was more important, and (2) rate the importance of the more important preference over the less important one on the scale of importance between 1 to 9, where 1 defines 'equally important' and 9 defines 'extremely important'. The responses were normalized in the 3x3 matrix to determine the extent of importance of each preference. The following illustration showcases an example for calculating the same

Consider the sample data with the following preferences:

- Security (S) preferred over Comfort (C) – scale of 7
- Waiting Time (R) preferred over Security (S) – scale of 9
- Waiting Time (R) preferred over Comfort (C) – scale of 9

This data is represented in the table and the final values are evaluated as shown in the table 2. For instance, the first column (S) of the third row (R) in the table 2(a) depicts the extent to which the waiting time (R) dominates over security (S), which is 9 in case of this sample. Simultaneously, the third column (R) of the first row (S) portrays the inverse of the former, which is 1/9. Also, the first row-first column, the second row- second column and the third row- third column have the unitary values. Then, sum of all the individual columns are calculated and all the 9 preference values are divided by the sum in their respective columns, as shown in table 2(b). Afterwards, sum of all the individual resulting rows are calculated. Finally the values are divided by 3 to obtain the preferences of each of the 3 factors.

Table 2(a). Representation of the preferences

	S	C	R
S	1	7	1/9
C	1/7	1	1/9
R	9	9	1
Total	10.1428	17	1.2222

Table 2(b). Quantitative evaluation of the preferences

	S	C	R	Sum	Answer = Sum/3
S	1/10.1428	7/17	(1/9)/1.2222	0.6013	0.2004
C	(1/7)/10.1428	1/17	(1/9)/1.2222	0.1638	0.0546
R	9/10.1428	9/17	1/1.2222	2.2349	0.74493

Parameters related to household characteristics included dichotomous variables, like household type, house ownership, living with, marital status, student or not, four wheeler ownership and two wheeler ownership, as well as a continuous variable viz. no. of years in Mumbai. Additionally, there were three spending parameters - careful spender (dichotomous) and monthly expenditures in restaurants and shopping (continuous). The parameter ‘careful spender’ was created using a question to the respondents on whether they considered themselves as careful spenders or not. Trip characteristic parameters like type of trip (mandatory or not) and type of cab service (share or non-share) were created as dichotomous variables, whereas, no. of people accompanying was a continuous variable.

The most important features of scientific studies include measuring and relating the variables and revealing the causality (if any). However, observable variables such as the gender and type of tip can be directly measured, while latent variables such as socio-economic characteristics and spending attributes cannot be directly measured. In such cases, it is important to establish regression equalities that show how endogenous structures (predicted-endogenous) are linked with exogenous structures (predictive-exogenous). To attain the objective of apprehending the causal factors and to establish both- measurement as well as regression equations leading to the choice between sharing and non-sharing based ICT cabs, a structure equation model (SEM) was constructed. Figure 3 illustrates the working hypothesis on which the model was built.

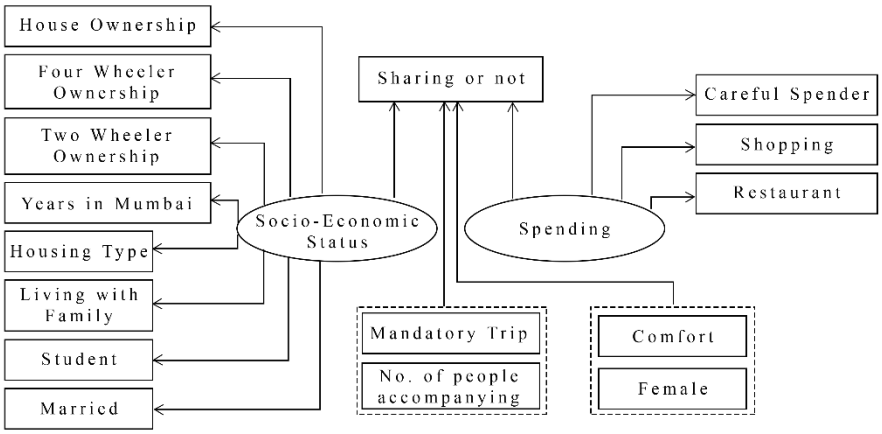

Fig. 3. Working Hypothesis

Model calibrations were performed by the maximum likelihood (ML) method. The model consisted of 16 observed variables and 2 latent variables. The results present the calibrated parameters together with their T statistics at 90% level of significance. The models fit well with respect to the generally accepted measures of goodness of fit.

5. Data Description

The sample size of 217 displayed a good diversity of responses. 30 per cent of the respondents were female while 18.9 per cent of the data mark married individuals. In addition, it was observed that only 18 per cent of the total sample size preferred sharing ride, against 82 per cent of people who chose non-sharing rides. The data indicated 54.8 per cent of people living with their family and 43.3 per cent of people having their own house in Mumbai. The mean no. of years that an individual had lived in Mumbai was approximately 13 with a standard deviation of 12.6 years. Also, 18.9 per cent of people lived in 3 (or more) BHK houses or bungalows as compared to the rest 81.1 per cent of respondents. It was also observed that a person spent an average of Rs. 2032 in restaurants and Rs. 1604 in shopping every month, while 68.2 per cent of them considered themselves as careful spenders. The data also showcased that 56.7 per cent of the respondents were students. Very few individuals (31.8 per cent) owned four wheeler and even fewer people (24.9 per cent) owned two-wheeler. The descriptive statistics of the refined data is presented in table 3. Trip characteristics show that only 18.4 per cent of people had taken the ICT cab ride for mandatory purpose, while the number of people accompanying the trip had a mean of 1.4 and a standard deviation of 1.4.

Table 3(a). Descriptive Statistics- Frequency Table

Parameters	Responses	Frequencies
Household Type	3 (or more) BHK or Bungalow	41
	Other	176
House Ownership	Owned	94
	Not owned	123
Living with	Family	119
	Alone/Other(s)	98
Gender	Male	152
	Female	65
Marital Status	Married	41

Parameters	Responses	Frequencies
Student or not	Single/Divorced	176
	Student	123
	Not a student	94
Four Wheeler Ownership	Yes	69
	No	148
Two Wheeler Ownership	Yes	54
	No	163
Mandatory Trip	Yes	40
	No	177
Sharing or not	Sharing ride	39
	Non-sharing ride	178
Careful Spender	Yes	148
	No	69

Table 3(b). Descriptive Statistics- Mean and std. deviation

Parameter	Mean	Std. Deviation
No. of years in Mumbai	13.207	12.583
No. of people accompanying	1.36	1.401
Comfort	0.311	0.178
Monthly spending in restaurants	2032.246	3.193
Monthly spending in shopping	1604.425	5.954

6. Results

The conceptual model was designed to analyse the effect of different characteristics and attributes on the mode choice. Established SEM gives results compatible with hypothesis of the study. Two latent variables were constructed which determined the rider's socio-economic status and spending attribute. Bolstering the hypothesis, both the latent variables gave a negative contribution on sharing service as a mode choice. In addition, the observed variables comfort and no. of people accompanying the trip also presented a negative effect on sharing mode choice, explaining that individuals consider non-sharing rides to have greater comfort and that sharing rides involve lesser no. of known people together in a ride. The model also determined various correlations between observed variables.

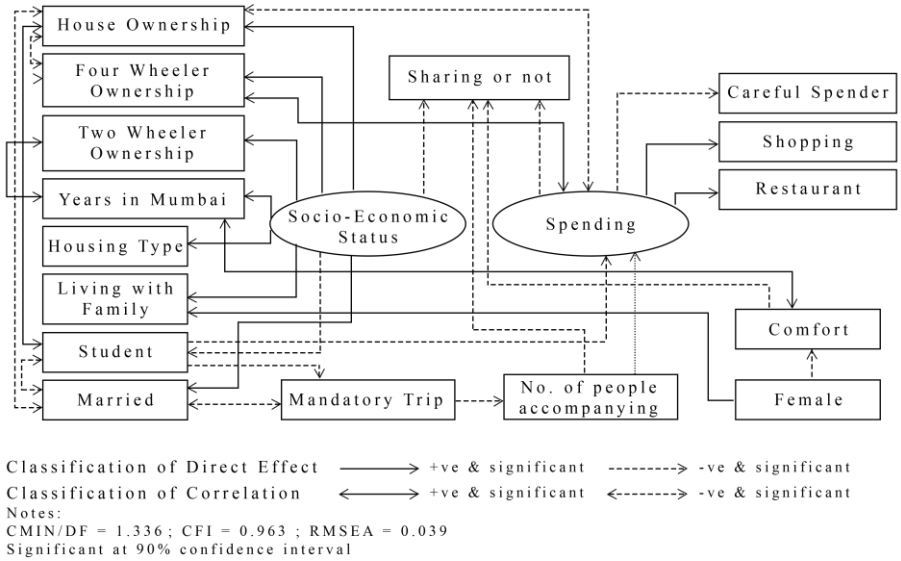

Fig. 4. Sharing or not- Direct Effects and Correlations.

While figure 4 describes the simplified model structure depicting the significant causal effects and correlations, table 4 describes the standardized direct effects and the correlations of the variables on the choice between sharing and non-sharing.

Table 4. Sharing or not- Standardized Direct Effects and Covariances

	Female	Socio-Economic Status	Student	Mandatory Trip	No. of people accompanying	Comfort	Spending	House Ownership	Years in Mumbai
Student		-.320***					*-.064***	*.043***	
Mandatory Trip			-.259***						
No. of people accompanying				-.277***					
Comfort	-.123*						*-.015***		
Spending					.072				
Careful Spender							-.140*		
Shopping							.697***		
Restaurant							.678***		
House Ownership		.916***					*-.030***		
Married		.479***	*-0.060***	*-.028***				*-.045***	
Household Type		.239***							

	Female	Socio-Economic Status	Student	Mandatory Trip	No. of people accompanying	Comfort	Spending	House Ownership	Years in Mumbai
Living with Family	.176***	.827***							
Two Wheeler Ownership		.438***							*.594***
Sharing or not		-.120*			-.213***	-.175***	-.140*		
Four Wheeler Ownership	.171***	.614***					*.049***	*-.039***	
Years in Mumbai		.718***				*.224***			

***Significant at 99%; **Significant at 95%; *Significant at 90%
Numbers in italics represent covariance

The latent 'Socio-Economic Status' was measured by variables namely student, house ownership, married, household type, living with family, two wheeler ownership, four wheeler ownership and years in Mumbai.. High values of coefficients indicate that house ownership, marital status, the question of living with family or not, two wheeler ownership, four wheeler ownership and the number of years in Mumbai best measure an individual's socio-economic status. The sign of the coefficients depict their corresponding results. If the individual owns a house in Mumbai, he has a higher socio economic status. A married individual has a higher social status than an unmarried person. Also, a person living with his/her family shows a higher socio-economic status. Alongside, two wheeler ownership and four wheeler ownership are indicators of higher socio-economic status. Greater the amount of years a person has been living in Mumbai, greater will be the individual's socio-economic status. Negative coefficient between socio-eco on student demonstrates that a non-student marks a greater socio-economic status. Lastly, if a person lives in a 3 (or more) BHK apartment or a bungalow, then it displays a greater socio-economic status. Therefore, greater the socio-economic status of an individual, lesser is the preference of sharing service as mode choice.

The next latent variable is 'Spending' which is measured by three variables- shopping, restaurant and careful spender. Greater the individuals spending in shopping and restraint reveals a greater spending attribute. Spending attribute is also measured from the individual's attitude whether he/she considers oneself a careful spender or not. An individual being a careful spender, thus, has a lesser spending attribute. Since the price of a non-sharing service is higher than the corresponding sharing service, an individual who has an attribute to spend more will prefer non-sharing rides. People going for mandatory trips prefer traveling alone or with less number of people. Greater number of people in a trip implies greater total budget causing to increase in spending and leading to lesser preference of sharing rides. We can also observe that non-students choose mandatory trips. Greater is the comfort, lesser is the sharing preference. Negative relationship of being a female with comfort might be a result of females preferring security and waiting time over comfort. It should be also noted that the data showcased that most females lived with their family and owned a four wheeler.

Along with the direct effects, the residual co variances between variables were also measured. It was observed that married individuals related negatively with being a student. Meanwhile, being married had a negative relationship with the purpose of trip being mandatory, which might imply that they prefer taking these ICT cab services for leisure and/or maintenance trips. In addition, positive sign for correlation between comfort and years in Mumbai indicates that a person who has lived in Mumbai for greater number of years, chooses or prefers comfort to over security and waiting time. Students generally spent less as compared to non-students. Meanwhile, it was observed that respondents who preferred comfort over security and waiting time mostly spent lesser than others. People having their own house in Mumbai have lesser spending attribute than those who rent houses or those whose houses are government/company provided, while people owning a four wheeler have greater spending attribute.

7. Conclusion

This paper presents the factors that influence people in Mumbai to choose a sharing or a non-sharing ride in app-based cabs. The research started with creating the survey questionnaire, then floating it amongst online and offline platforms, with the geography being restricted in Mumbai, Navi Mumbai, Thane and Mira-Bhayander. The data collected was refined to eliminate inappropriate responses, resulting in a sample size of 217. A novel methodological framework was conceptualized to test the impact of various socio-economic, attitudinal, and other underlying factors on sharing of cab rides. The framework was then tested using the refined data by SEM. With the primary objective to understand what makes individuals to choose sharing services with an overall goal to improve the efficiency of car sharing systems, this study examined the causal factors behind an individual's choice between sharing and non-sharing services. This study was successful in establishing significant relationships between socio-economic status and sharing choice. It was concluded that an individual's socio-economic status had a negative impact on the sharing mode choice, meaning that individuals who had a higher status in society did not prefer to share their ride. As sharing of services can have pertinent impacts on the overall urban transport systems, its relationship with socio-economic status is demotivating. Future policies should be targeted towards influencing individuals from all socio-economic groups to choose sharing over non-sharing modes. In addition, a latent factor representing an individual's attitude towards spending was created. It was observed that spending attribute related negatively with choosing a sharing ride of Ola, Uber or any other ICT based cab ride. The reason behind this might be because they prefer spending more money for a greater comfort and people in Mumbai consider non-sharing rides to be more comfortable than sharing rides. The effect of other socio-economic factors such as being a female showcased that females mostly live with their families and generally prefer greater security and a lesser waiting time to greater comfort. It was also interesting to find that students in Mumbai generally don't choose these ICT cab services for mandatory trips. Moreover, greater the amount of time a person has lived in Mumbai, they tend to value comfort more than security and waiting time. The inferences from this research pave ways for future studies and for intermediate public transport system policies for encouraging sharing ride services of ICT cabs, especially with regards to socio-economic status and spending attitude. However, this study had several limitations. Firstly, the sample size for Mumbai considered in this study was low and was not based on random sampling. Secondly, land use pattern was not included in the sample set details. In addition, the effect of alternate specific variables such as travel time and travel cost were not tested since the study was focused on identifying other variables apart from these two generally accepted parameters. Future research efforts should consider capturing information for a higher sample and estimate the impact of other trip parameters like cost of the ride, travel time as well as land use. In addition, future studies can also focus on estimating the net impacts of sharing services on public transport mode choice, road congestion, land use parameters, and environmental pollution.

8. References

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