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Article

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Journal of Urban Management

Provided in Cooperation with:

Chinese Association of Urban Management (CAUM), Taipei

Suggested Citation: Basu, Anindya (2019) : Viability assessment of emerging smart urban para-transit solutions: Case of cab aggregators in Kolkata city, India, Journal of Urban Management, ISSN 2226-5856, Elsevier, Amsterdam, Vol. 8, Iss. 3, pp. 364-376, <https://doi.org/10.1016/j.jum.2019.01.002>

This Version is available at:

<https://hdl.handle.net/10419/271361>

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Research Article

Viability assessment of emerging smart urban para-transit solutions: Case of cab aggregators in Kolkata city, India

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ARTICLE INFO

Keywords:

Para-transit
App cab aggregators
Technology
Big data
ICT
IoT

ABSTRACT

The dimensions of transport development are closely linked with the socio-economic profile and technological level of a city. The entire trafficscape of the city of Kolkata evolved as the efficiency of the mass transport services declined, disposable income of the majority increased. There was gradual privatisation with increase in the share of para-transit modes. As the literate, technologically conversant urban population wanted a smarter alternative to regular taxis and auto rickshaws the app-based cab aggregator services brought in the silent revolution in the transport communication system. The main objectives of the paper are to bring out the essence of changing scenario, to access qualitatively and quantitatively that how far analysis of big data and reliance on technology through ICT and IoT has been able to meet the gap between expected and actual service delivery of the said para-transit mode through SWOT analysis, regression analysis and perception studies involving primary and secondary database and to have an idea about the future trajectory of this emerging app cab market. The study found that though majority of the commuters were satisfied with availability, reliability, cost effectiveness, safety, cashless option, driver behaviour, comfort and absence of bargaining there were issues regarding transparency and surge pricing. The drivers too were content with their improved earnings but were unhappy with the long hours and were apprehensive with regular incentive cuts. So, the situation is volatile with promising future if the companies manage to balance between the virtual capabilities and actual reality.

1. Introduction

Cities are viewed as engines of growth. For cities to run, they are dependent on movements of people, goods, and information. As cities grow, the role of these motorised modes of transportation becomes important developing integrated multimodal public transport framework (Pal, 2016). Efficient passenger transport services are an essential component of a metropolitan city. Usage of public transport infrastructures is the need of the hour but since they follow fixed routes and schedules individual mobility needs cannot be catered. The lack of required supply of public transport services leaves citizens with little choice but to depend on private motor vehicles and gradually a generalised aspiration for private vehicle gets associated with class determination in the society. Vehicular traffic congestion is a burning problem which has wide-spread social, economic and environmental impacts (Mihyeon & Amekudzi, 2005). Taxis and other for-hire vehicles historically have been an important part catering to personalised needs and demands. But the mobility requirements of the urbanites are getting increasingly dynamic and heterogeneous. To reach a less car-dependent life-style, there is need for devising innovative, smart urban transport modes. The arrival of innovative commercial app-

Peer review under responsibility of Zhejiang University and Chinese Association of Urban Management.

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<https://doi.org/10.1016/j.jum.2019.01.002>

Received 23 September 2018; Received in revised form 25 November 2018; Accepted 26 January 2019

Available online 04 February 2019

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based cab services involving modern technologies has brought new dimensions in the transportation field. Though these have offered variety there has been persistent tension between the traditional for-hire operators and the modern ones inviting clearer regulatory measures.

2. Literature review

Long back in 1963, Srivastava, S.K. in his book ‘Transport Development in India’ presented a historical evolution of transportation system in India and commented that how economy and transportation system are closely linked (Srivastava, 1963). Calcutta Metropolitan Planning Organisation (CMPO) (1956) published a report entitled ‘Traffic and Transportation Plan for the Calcutta Metropolitan District 1966–1986’ which dealt with the then mass transit system and its future possibilities. Khan (1980) in his seminal book ‘Transport Management’ made a detailed study of transport network in India following a systems approach. He also framed a model from comprehensive transport planning and management. Fouracre and Maunder (1986) through their book ‘A Comparison of Public Transport in Three Medium -sized Cities of India’ stated that initially para-transit services were considered to be a part of the public transit system in India but as their modal share increased the transportation planners treated them as a spate segment. In the article entitled “Optimal Vehicle Size for Road-based Urban Public Transport in Developing Countries” Vijayakumar (1986) tried to critically review the urban public transport system based on vehicle size in order to determine which vehicular policies are pro para-transit. Ray (1995) through his book “Transport Planning for Developing Countries” highlighted the need for proper transport planning as he rightly opined that haphazard development causes more problems.

The Master Plan for Traffic and Transportation in Calcutta Metropolitan Area (2001–2025) published by the Calcutta Metropolitan Development Authority (2001) chalked out a detailed plan for the upgradation and management of public and private mass transport services in Kolkata. Tiwari (2007) in the article “Urban Transport in Indian Cities” suggested that there is need to promote non-motorized modes of transport like bicycles, cycle rickshaws or even walking as they are more inclusive and non-polluting. Halder (2007) in his book “Studies in Urban Transport” has critically reviewed and compared the physical and financial performance of various modes of urban transportation. Tiffin and Kissling (2007) in their book “Transport Communications: Understanding Global Networks Enabling Transport Service” made an effort to link transport with modern communication system especially the IT-enabled avenues. In his book “Economics of Road Transport” written in 2008, Batta has focused on the significance of public transport systems in Indian cities and tried to analyse the causes behind the decline in public transport sector and gradual privatization of mass transport services (Batta, 2008). Geenhuizen (2009) in “ICT applications on the road to sustainable urban transport” discussed various negative externalities of transport and tried to reason that how existing and potential ICT applications in the transport sector can assist the urban transport sector in becoming sustainable. He reasoned how ICT innovations like from simple electronic communication (signals) to interactive and highly intelligent applications are effective in fatality reduction as well as congestion relief and fuel-intelligent vehicles help in reducing fuel consumption.

Joshi and Mehta (2015) wrote an article Radio Taxi Industry: Current Scenario, Industry Forces and Challenges in India, where they found that huge money was invested in setting up the technology-based cab fleet and that has proved to be the win-win situation for government, cab companies, chauffeurs and the most importantly passengers, though certain issues are there to tackle. Venkatesh and Easaw (2015) through their article ‘Measuring the Performance of Taxi Aggregator Service Supply Chain’ put forward that the success of ride sourcing companies is dependent of ever-growing influence of technology which paved way for effective alignment of demand and supply of cabs. The paper highlighted the innovative manner in which the aggregators like Ola and Uber have penetrated the Indian market using smart phone technology. It stated that how the peculiar nature of services added to the complexity in service delivery. Hanif and Sagar (2016) in their article “An empirical research on the penetration levels for a Call-a-Cab service in Mumbai” found that the cab services have a tremendous potential for growth in Mumbai as the transport needs of the corporate world and even of middle-class and affluent class is growing day by day. These services save one from facing the hassle of finding parking space, heated negotiations over taxi fare etc. The study shows that its customer satisfaction level is very high, which is a positive point for its growth and expansion. Kumar and Kumar (2016) wrote an article “A Study on Factors Influencing the Consumers in Selection of Cab Services” finding out that there is stringent competition in the organized cab services industry therefore organization need to motivate consumers. The authors suggested that providing coupons as means of discounts could be the best alternative for the price sensitive customers and would improve the brand image. In the article “Cab Aggregation Industry in India- An Overview, Current Scenario, Issues and Possibilities for Consolidation” by Sarvepalli and Prakash (2016), it was covered that how taxi aggregation industry in India provided the solution for transportation problems innovatively using technology. It touched upon the point that the consolidation is slowly happening in the industry and stated that only the companies that focus on the better service quality will only foster in the future. Companies that can bridge the gap between expectations and reality and align themselves as quickly as possible to the changing trends are the ones that will sustain their position in the market. Shukla et al. in the article Ola vs Uber: The Battle of Dominance in 2017 studied that how increased purchasing power resulting in uplifting lifestyles helped in the development of app cab markets. The author pointed out that Indian consumers are smart, very demanding and highly price-sensitive with no brand loyalty and the companies have to be constantly inventive to maintain their customer base and optimize cost at all levels. Tafidisa et al. (2017) through the article “Exploring the impact of ICT on urban mobility in heterogenic regions” pointed out that ICTs have been widely applied in the monitoring, operation and management of transport services and those have proven to have a great potential to increase the efficiency in the use of urban transport infrastructure and simultaneously reducing negative impacts on the environment. The authors investigated the impact of ICT especially two specific applications i.e. urban congestion charging system and use of eco-routing navigation system in transportation sector in selected European cities with heterogenic characteristics. The major ICT interventions that according to Agarwal and Alam (2018) through their article “Use of ICT for sustainable transportation”

can change the face of transportation system are - autonomous or driverless cars, car sharing, car-pooling, eco-driving, congestion relief, GPS/Navigation software, Automatic license plate recognition (ALPR) Technology, E-world, Informational signalling (Variable Message Signs/ Electronic signboards), Video Surveillance and Response, Advanced Driver's Assistance (ADAS), Sensor Support with an Extended Viewing system, Advanced Traveller Information systems, Smart Parking facility. Some of these measures have been implemented while others are in experimental state for future development.

3. Study area

Kolkata, one of the twenty-three megacities of the world, is the main commercial and cultural centre of eastern India with a rich historical legacy. This seventh largest city of India, has a population of 4.48 million, population density of 24,252 persons per square kilometre and is under the jurisdiction of the Kolkata Municipal Corporation (KMC) covering an area of 187.33 square kilometres and road length of only 5026 km (Census of India, 2011). Though it is very densely populated city, a negative population growth has been recorded in the recent Census of 2011, registering - 1.88% (Fig. 1).

Being a growing metropolitan city Kolkata, with very high population and vehicular pressure and very low road space, faces severe traffic congestion and vehicular air pollution. The urban space of the megacity of Kolkata is characterised by complex traffic pattern expressed through multimodal mass, para and private transport system. The public mass transport system, normally regarded as a medium for the socio-economically weaker section, who do not have access to personalized modes having higher rates, is the mainstay of the city's transportation. But recent studies in the developed countries have proved that mass transport could be equally popular with the rich people (Blumenburg & Crane, 2004). Presently, the role of para-transit mode has become very important as they provide quicker and cheaper alternative to the common public (Table 1).

Motorized para-transit modes like taxis and autorickshaws are an important part of urban surface transport mobility of the city apart from bus, trams, metro-rails and sub-urban rails. The para-transit modes developed around eighties to increase the efficiency of stagnated traffic at affordable cost and offered avenues of employment too. But it also had its own set of issues; initially these were allowed only in peripheral areas, created bottlenecks at certain crossings and contributed to further congestions. The total number of registered motor vehicles in Kolkata increased by 9.5% from 1999–2009 (Transport Research Wing, 2009). The city gradually got used to the huge volume of mixed daily traffic. But average speed during peak hours in Central Business District (CBD) area goes down as low as around 10 Km/hr leading to time and energy waste along with higher pollution level (Singh, 2012).

4. Objectives and methodology

The main objectives of the paper is to look at the past and present transportation scenario of urban transportation in a mega city of a developing country, to bring out the actual change in terms of demand and supply of modes of transportation; to access that how far analysis of big data and reliance on technology has been able to meet the gap between expected and actual service delivery of a para-transit mode i.e. taxi or cab; to gauge the perception of the stakeholders involved and to have an idea about the future trajectory of this emerging app cab market.

For the study, literature review has been done, collection of secondary and primary data has also been carried out to perform qualitative and quantitative analysis. A SWOT analysis has been done to ascertain that how Information and Communication Technology (ICT), Internet of Things (IoT) have been able to make the traditional taxi variants smart and viable to the commuters. An in-depth perception study was also carried out involving regular passengers (involving a sample size of 80) and drivers (having a sample size of 30) to find out the causal factors of choosing this modern para-transit mode. Statistically, a relationship between frequency of usage and income, profession, educational level, age and sex has been calculated.

5. Prior scenario of public transportation

Rapid motorization in sprawling cities for high personal mobility poses threat to the very sustainable fabric of the cities affecting road safety to environmental stability. There is personal car segment for the upper and section of middle-class population while rest depend on mass and para-transit modes for urban mobility (EU Commission, 2007). In the cities, for-hire passenger transport services are on high demand for micro-transit for door-to-door individual needs.

Though India is the second highest populated country in the world, the number of cars in India as a percentage of world's total number is 2.4% (Urban Emissions, 2015). There has been a huge shift in the population composition in India, the middle-class population rose from 15 million in 1991 to 160 million in 2011. As the population segment with increasing disposable income rose sharply the clamour for better transportation services and willingness to pay more for that became palpable.

Currently, Indian taxi market is highly fragmented. Till early 2000, unorganized taxi market was the only alternative for point-to-point passenger transport. In 2003, radio cab business emerged and changed the entire scenario. Delhi-based Mega Corp initiated the Mega Cabs brand and started air-conditioned taxi-service in six cities of India - as Bangalore, Mumbai, Calcutta, Chandigarh, Ludhiana and Amritsar (Rahman & Anand, 2014). The organized sector is classified into - owners segment i.e. purely car rental services with metered radio cabs which operate only with owned vehicles like Meru which was first launched in Mumbai in 2007; affiliates segment is concerned with multiple car rental agencies and primarily provide different tour packages; aggregator segment has crept in lately with the start-up initiatives like Ola.

In case of Kolkata city, street hailing cabs were the common mode available which catered to passengers from public space without any advance reservation. The taxi market share is dependent on factors like household income, availability of alternative

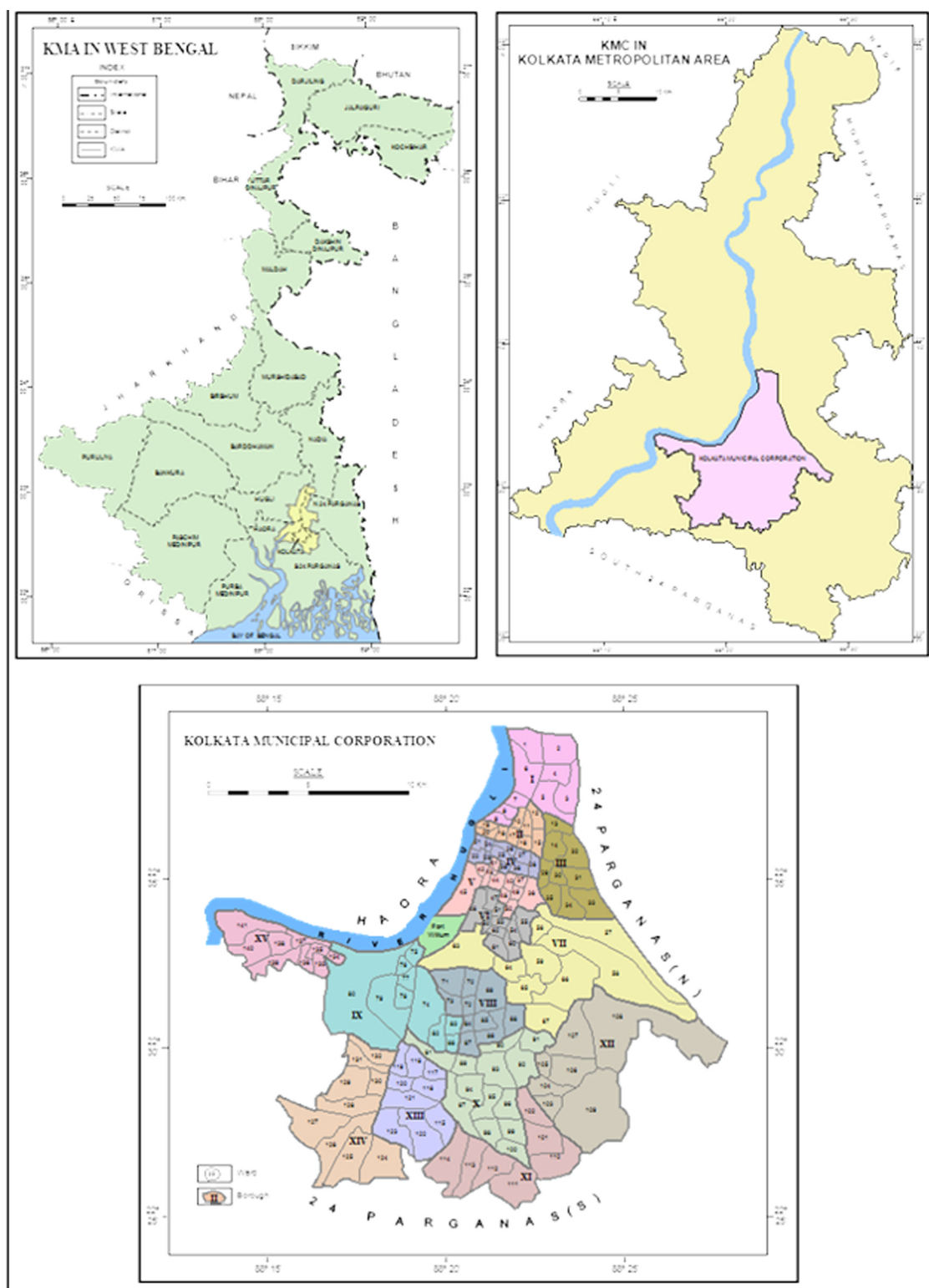


Fig. 1. Locating the study area.

modes of transport, ease and cost of parking etc. Another type was the private hire vehicles (PHVs) which carried out pre-arranged trips at negotiated rates having an obligation to return to a 'home base' between trips and do not look for passengers in the streets. Both of these variants, provided an essential mobility option involving almost door to door services unmatched by all modes except

Table 1

Passenger mobility on an average week-day through mass and para transit modes in Kolkata.

Data Source: Master plan for traffic and transportation in Calcutta Metropolitan Area (2001–2025), CMDA, 2001.

Transport Types	Modes	Volume of Passengers (in millions -2001)	Percentage	Projected Volume of Passengers (in millions -2011)	Percentage
Road Based Mass Transport	Types of buses and tram	11.47	61.40	13.60	57.88
Rail Based Mass Transport	Sub-urban, Metro and Circular railways	3.47	18.58	4.80	20.42
Para Transit	Taxi	1.10	5.89	1.70	7.23
	Auto Rickshaw	1.65	8.83	2.30	9.79
	Cycle Rickshaw	0.75	4.01	0.70	2.98
	Total	3.50	18.73	4.70	20.00
Water Based Mass Transport	Ferry	0.24	1.29	0.40	1.70
Total		18.68	100.00	23.50	100.00

the personal car.

6. Present situation of passenger transportation

Transportation Network Companies (TNC) was a term coined by a California Public Utilities Commission (CPUC) which stated that it is “an organisation, including, but not limited to, a corporation, limited liability company, partnership, sole proprietor, or any other entity ... that provides prearranged transportation services for compensation using an online-enabled application or platform to connect passengers with drivers using a personal vehicle” (CPUC, 2016). In India, the modern cab aggregators are referred as on-demand information technology-based transportation aggregators.

The change in, for-hire passenger transport services has been quite rapid, from street hailing ones to radio cabs, then to taxis providing online booking facilities and finally cabs deploying smart phone-based applications to attract more patrons. The taxis using app-based platform referred as commercial transport apps (CTA), apply software applications for two-sided market connecting drivers and passengers on real time basis and efficiently matching supply and demand sides with apt resource allocation.

The key technologies that the app-cabs make use of are Global Navigation System Services like GPS, pervasive cellular and Wi-Fi access, on-line payment systems and rely on big data analytics i.e. algorithms for digital matching of supply and demand and also for determining fair pricing. The mobile device-based app platforms make use of the navigation services based digital maps for tracking the drivers and passengers through latitude-longitude co-ordinates, the centralised platform matches the demand and supply on real-time basis – puts both the parties in touch and provides the fare considering the potential surcharge during high demand times. The sophisticated technology and algorithms to measure service metrics provide speediness and productivity - minimizing the pick-up and waiting time. The smart data analysis helps in driver-passenger bidirectional search involving map matching, hotspot analysis and taxi route planning (Xie, Yan, & Zhou, 2014). The firms employ prediction algorithms and resultant heat maps to predict expected demand at different times of the day so that adequate numbers of cars are there at the right place and time (Hwang & Elish, 2015). The data base that the platforms handle involves information regarding registered clients, drivers and vehicles, along with trip data including pick-up and drop-off locations, travel route and timing. The entire business model of the app cab services depends on enormous amount of big data, apart from direct operational data, they also collect information about customers likes and dislikes so that tailor-made service can be meted out (Cordray, 2015).

Across the globe, Uber is the most well-known CTA, with a market valuation of over USD 60 billion in early 2016 (International Transport Forum, 2016). There are other regional companies using similar business models like Lyft in USA, Cabify in South America and Spain, BlaBlaCar in France, Didi Chuxing in China GrabTaxi in Singapore and Ola in India. The fact is that all app-based cab services follow similar technological interfaces and business models, so the competition among is very stiff. While many are opting for alliances for smoother and effective business, new entrants are also trying to have a go at the market share.

In case of India, operators such as Uber, Ola and TaxiForSure are in business. There has been confusion that whether these are to be treated as radio-taxi or cab aggregators. The central government, through its budget of financial year 2015–16 clearly defined the term aggregator by stating that “aggregator means a person, who owns and manages a web-based software application, and by means of the application and a communication device, enables a potential customer to connect with persons providing service of a particular kind under the brand name or trade name of the aggregator” (Shah, 2015). These taxi aggregator companies do not really own cars or keep drivers as their employees; they are concerned with creating a pool and simply connect the passengers with the drivers using technology. It is being projected that in the next 5 years, organized players such as Uber, Meru and Ola will capture 15% of this market, which is growing at an astounding rate of 45% per year (Ghosh, 2015). Keeping up with this pace about \$400 million of venture capital has been invested from 2010–2014 (Agarwal, 2014).

7. Germinating from the ‘Car-Pool’ Idea

With rapid urbanization and increasing disposable income of the growing middle class, many can afford to have their own car. But that leads to traffic congestion, higher fuel consumption, increased air pollution, shortage of affordable parking spaces. So, overcome these issues along with avoidance of time consuming, rigid public transportation modes the only viable option left is economical and flexible car-pooling. If one strictly goes by the term, car-pooling then it refers to a private owned vehicle shared by multiple passengers headed for the same destination. This concept of ride-sharing has been there for long but shared vehicular journeys are becoming increasingly popular alternative transportation paradigm in recent years with advancement of technologies. Flexible or casual carpooling is convenient as it lowers the cost of commutation without any prior commitments. To satisfy this need, dynamic multi-hop two-sided ridesharing based on mobile technologies has come handy.

About 78 percent of the world’s urban population lives in Africa, Asia, and Latin America and the Caribbean accounted for only 20 percent of global carsharing membership in 2014 (UN, 2015; Shaheen, 2015). Brazil’s São Paulo was the first emerging market country to introduce carsharing in 2009 through the company Zazcar. So, to tap this huge market prospect numerous start-ups have come up across the globe.

Internet of Things (IoT) refers to the new wave of intelligent interconnectedness among many various objects to make our lives easier in a smart city (Maji, Sen, & Debnath, 2017). Efficient mobility and connectivity are a major part of smooth functioning of a smart city. Smart city uses information and communication technologies to get hold of and to integrate the key information for context -aware response to core system needs (Qin & Li, 2010). The third generation of internet commonly known as semantic web is the soul of the IoT (Rafiee & Emadi, 2016). Semantic web makes inter-machine communication intelligent and context-aware so that they can operate without direct human intervention. It is stated that technical architecture of smart city consists of three conceptual

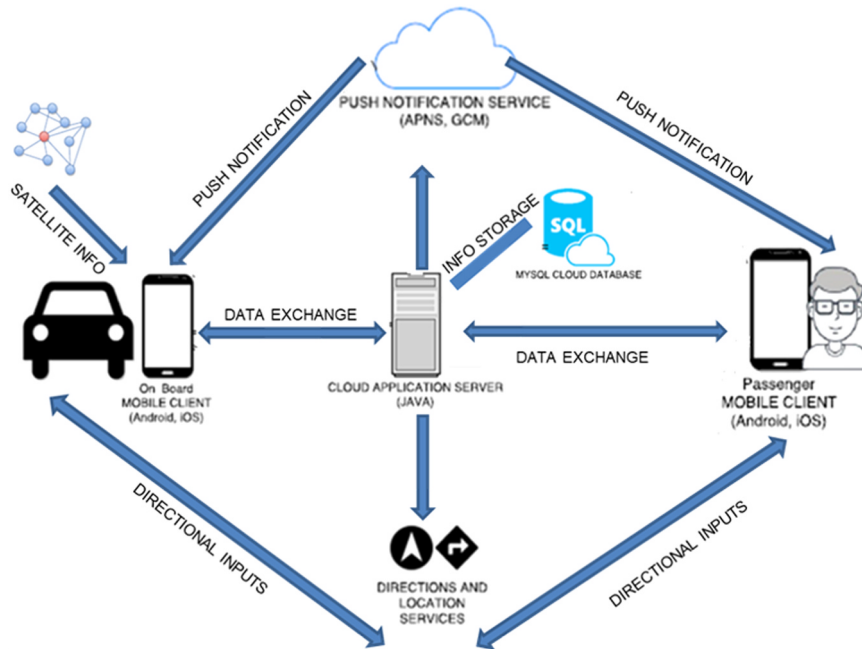


Fig. 2. Functional sketch of app cab dynamism. (modified by author from Mallus, Colistra, Atzori, Maurizio, & Pilloni, 2017).

layers- perception layer, network layer and application layer, which will identify objects and collect data through several sensors; then make accurate transmission and processing of information through integrated system and finally analyse and process information for achieving the goal of creating a more adaptive environment through cloud computing, fuzzy recognition and other intelligent technologies (Su et al., 2011). A paradigm shift in transportation sector is imminent in smart cities where technology-based urban mobility will be of prime focus (Fig. 2).

Intelligent Transportation System (ITS) intends to offer a variety of technological solutions, mainly applying information technology to the growing transportation problems in smart metro cities by providing accurate, timely and alternative use-information to transportation providers and users (Sheoran et al., 2014). The intelligent computing entities interact with the surrounding environment and take informed decisions dynamically. The ‘technology bundles’ involve digital connectedness, communication facilities, tracking systems, embedded sensors, on-board navigation which usher smooth reservation and dispatching of vehicles (Ferreira, Trigo, & Filipe, 2009). Initially, ridesharing services relied on a static approach where bookings have to be done beforehand but presently relatively new type of carpooling i.e. dynamic ridesharing has come up, which utilises the technology available to the fullest through intelligent computing entities taking informed decisions and matches up drivers and riders on a very short notice or even instantaneously (Agatz, Erera, Savelsbergh, & Wang, 2010). This on-route ride sharing offered by app services are efficient, user-friendly for which they have been an instant hit filling in the gap between public transportation and personal cars.

8. Major players involved

Start-up businesses have always been an important part of global economy and in present times its significance has gone up manifold. Steve Blank has defined start-up as “a temporary organization in search of a scalable, repeatable, profitable business model” (Blank & Dorf, 2012). India, has also been not an exception, government have made regulations favouring them and even provided incentives as encouragement. Ola – meaning ‘hello’ in Spanish, one of the major players in Indian market was founded by two Indian Institute of Technology (IIT) Bombay graduates, Bhavish Aggarwal and Ankit Bhati with an as an innovative start-up identified the problems in urban transportation in Indian metros and then converted them into business opportunities by starting easy and friendly cab services in December 2010. Cabs can be booked through website as well as through mobile applications through simple procedures. It supports both cash and cashless payment.

The growth of the Ola cabs has been phenomenal with a network of cars over 2,00,000 across 102 cities handling on an average 150,000 booking requests per day (Sharma, 2015) with about 6,00,000 drivers (Virkus, 2017). Though Ola has the lion’s share amongst the app-based cab services and had a successful acquisition of TaxiforSure in March, 2015 for \$200 million (Business Standard Reporter, 2015), several rounds of venture capital investments have made the brand more financially viable. As of September 2015, it was valued at \$5 billion (Shukla, Chandra, & Jain, 2017). Presently it is facing a very stiff completion from Uber. To have a wider customer base, offering variety Ola introduced auto-rickshaw services in Bangalore city (Abudheen, 2014) and currently Ola-auto services are available across 10 cities (Shukla et al., 2017). Besides, it provides different types of cab services to the passengers ranging from economic level to luxurious ones catering to all kinds of needs.

Uber Technologies Inc. is a San Francisco based taxi aggregator which has a valuation over \$44.5 billion and has an exposure in

functioning many cities across the world. It was founded as UberCab by Garrett Camp and Travis Kalanick in 2009 and mobile application was launched in 2011. As of 2016, Uber provided its cab services in over 66 countries and 545 cities worldwide (Shukla et al., 2017). So, it has the exposure and power to challenge Ola in Indian market and currently serves 26 cities in India. Both Ola and Uber are currently competing on a price platform vying for minimum base price and discount offers to woo passengers and increase customer base. Since a large section of Indian population is not very comfortable with on-line money transfers Uber has pioneered cash payments for its services.

Spokes Model of horizontal differentiation can be a theory which can explain the functioning of the cab aggregators (Venkatesh & Easaw, 2015). The horizontally differentiated goods differ in variety but not in quality; same is the case with the app cab services as their way of functioning, pricing is almost similar but to capture different market segments they are trying to offer different variants like mini cabs, autos even bikes. To attract more clients across economic lines apart from single-party occupancy of the vehicle the app services are also offering on-route ride sharing amongst multiple parties like para-transit modes through UberPool, OLAShare. Lyft line, Didi Chuxing and Hitch are in operation. In economics it is commonly said that the short run the companies invest aggressively even incurring losses, in the medium run they vie for zero profit condition and in the long run the loss-incurring companies either disappear or converge reducing the number of active firms. For proper demand management - Initially chase strategy is implemented which tries to match capacity to demand, then level strategy is resorted to that aims at maintaining capacity that can serve the maximum demand. The case is same with the app cab companies which with time have to come in terms with the reality bringing sanity in the market.

The co-founder of Ola Bhavish Aggarwal in an interview (Sahay, 2017) admitted that there is a stiff competition in the app-cab segment in India but is unfazed by the high capital pumping from its primary rival Uber as he feels that India is a resource constrained country and a cost centric economy where one needs to price properly and cater to the passengers with price transparency and a standardized experience. He termed the concern as 'local guerrillas' capable of handling 'American carpet bombing' and was hopeful of becoming profitable in coming two years. On the other hand, Uber CEO Dara Khosrowshahi while visiting India in his interview (Faisal, 2018) emphasized on responsible growth and wanted to project Uber as a mobility platform encouraging shared transportation in India, whom he viewed as a strong emerging market.

9. Who is it replacing

There is a common notion that these app-cabs are direct substitution for traditional taxis but that is not always the case; these also substitute personal car usage and even affects public transport market shares as well as other para-transit ones. In fact, these also pave way for some new trips which otherwise would have remained untapped.

The negative factors that created apathy towards the traditional taxi services were – blatant refusals of passengers for short distances, cherry-picking of long-distance travellers, poorly maintained vehicles, rigged meters, overcharging, abusive bargaining rude behaviour and regular strikes over unreasonable demands. The main parameters that create the difference between traditional taxis and the aggregator services are: convenience – delivering instant services, quality- providing cleanliness, comfort, air-conditioned interior and on-board safety and control – having transparency regarding billed amount. The app-cab services adopt the safe model of 'zero inventory' following which they themselves do not own any car but only act as aggregator (Table 2).

10. Results and discussions

10.1. Passenger perceptions

Through a questionnaire survey the study tried to bring out major reasons for which the passengers preferred app-based cab services, through Likert scaling technique, in the city of Kolkata. A sample size of 80 was taken for passenger study; all the respondents had a minimum travel experience of five times by app cabs. 69% of the respondents are male and rest 31% represent females, so the composition is visibly skewed. From the age group composition, it was seen that 37.5% were of below 30 years of age, followed by 32.5% between the age 30 to 45 years, 18.75% of passengers were 46 to 60 years of age while only 11.25% were of above 60 years of age; so, the service was more appealing towards the younger section of people. Educational level of the commuters was varied – highest were graduates 42.5%, followed by 38.75% school level educated while 12.5% of the respondents were post graduates. Interestingly, 6.25% of the respondents were either illiterate or did not have any form of formal education exposure but yet availed app cabs which indicated that the booking procedures are not very cumbersome. As far as income parameter was concerned

Table 2

Number of registered para-transit-based motor vehicles in Kolkata (2014–16).

Data Source: Annual review, KolkataTraffic Police, 2016.

Year	Taxi	Luxury Taxi	Auto Rickshaw
2014	33,397	18,687	40,229
2016	34,118	27,094	40,740
Absolute Increase	721	8,407	511
Increase in Percentage	2.16	44.99	1.27

the upper middle-income group having Rs.51,000–70,000 monthly income leads the pack with 30% of the total cab usage, followed by the middle-income group of Rs.31,000–50,000 monthly income 28.75%; the lower and higher income groups are comparatively less inclined in app cab usage. While analysing the occupational structure, it became evident that the salaried service class at 32.5% represented the highest segment of commuters, 30% belonged to the business class, 10% passengers are represented by the young student community and not formally employed segment (like unemployed, strugglers, housewives etc) denoted 12.5%. While analysing frequency of visit it came out that proportion of daily commuters was the highest 46.25%, 31.25% used cabs on weekly basis, 11.25% resorted to cabs fortnightly, monthly and occasional travels were least at 2.5% and 8.75% respectively.

An effort has been made to bring out relationship between frequency of usage and income, profession, educational level, age and sex. H_0 : Frequency of app cab usage is not affected by income, profession, educational level, age and sex. H_a : Frequency of app cab usage is affected by income, profession, educational level, age and sex. Since the observed value of F in 5 degree of freedom in numerator and 74 degree of freedom in denominator is 12.68, is more than the 5% tabulated value (2.21). Thus, null hypothesis is rejected at 5% level of significance. The conclusion is frequency of app cab usage is dependent on income, profession, education, age and sex. It is known that if $p \leq \alpha$ (where $\alpha = 0.05$), null hypothesis will be rejected. Here the p value is 0.000 So null hypothesis is rejected means there has significant relationship among frequency of app cab usage, income, profession, educational level, age and sex. Here the R^2 is 0.4614 means 46.14% variability of response variable (frequency of app cab) is explained by the predictor variables (income, profession, educational level, age and sex).

$$\text{Coefficient Equation: } y = \beta_0 + \beta_1 \times X_1 + \beta_2 \times X_2 + \beta_3 \times X_3 + \beta_4 \times X_4 + \beta_5 \times X_5$$

The coefficient of frequency of app cab usage and income & educational level are -0.05647 and -0.10227 respectively that means 0.05647 and 0.10227 are the estimate of the expected decrease in frequency of app cab usage, corresponding to 1 unit increase in income & educational level when other predictors are constant. The coefficient among frequency of app cab usage and profession, age & sex is 0.102217, 0.645941 and 0.644787 means when other two predictors are constant 0.102217, 0.645941 and 0.644787 will increase in frequency of app cab usage with 1 unit increase in level of perception of profession, age and sex. The standard error between the predictors and response are less (Table 3).

The main parameters taken to analyse the satisfaction level of the commuters were availability, reliability, cost effectiveness, safety, cashless option, driver behaviour, comfort and absence of bargaining. Majority of the respondents were very satisfied with comfort provided by the A.C. cabs and availability of the cabs round the clock. Satisfied scale was clocked by most for factors like reliability and safety. Parameters like absence of bargaining, cashless payments and cost effectiveness could generate moderate satisfaction among the passengers. Dissatisfaction was only caused by driver behaviour for most of the respondents. Interestingly, extreme dissatisfaction for none of the factors was noted by majority (Fig. 3).

The four prime factors that drive the commuters to hire app cabs are – comfort highlighted by 42% of the respondents, followed by availability for 33%. The other driving factors though of much lesser importance were, safety marked by 14% and cost effectiveness by 11% of the passengers respectively.

10.2. Drivers' perspectives

For the app-cab services, they are not the owners but mere aggregators for which the drivers are not their employees but registered partners who can independently choose their working hours in shifts with the regulators. The app-cab companies also encourage part-time drivers to log on during periods of peak demand to improve their allocative efficiency. Initially to attract drivers towards the app-cab platform strategy of offering tips as high as Rs. 5000 were offered to them for serving a single trip per day but as the business gained ground it has come down drastically to Rs. 750 for a minimum of 10 trips per day. This has left the drivers disillusioned and to earn the desired level of income they have to now work in a target-oriented approach for long hours. While recruiting the drivers the aggregator companies carry out a background check, collect personal and professional information and run police verification. In some cases, a training programme is also conducted for the drivers involving behavioural training, etiquette

Table 3

Relationship between frequency of usage and income, profession, educational level, age and sex.

Data Source: Primary Survey, 2018.

Source	SS	df	MS	Number of observations = 80	
Model	53.93369	5	10.78674	F (5, 74) = 12.68	
Residual	62.95381	74	0.850727	Prob > F = 0.0000	
Total	116.8875	79	1.479589	R-squared = 0.4614	
				Adjusted R-squared = 0.4250	
				Root MSE = 0.92235	
Frequency of Usage	Coef.	Std. Err.	t	P > t	[95% Conf. Interval]
Income	-0.05647	0.089794	-0.63	0.531	-0.23539 0.1224463
Profession	0.102217	0.077401	1.32	0.191	-0.05201 0.2564412
Educational Level	-0.10227	0.139677	-0.73	0.466	-0.38058 0.1760468
Age	0.645941	0.107398	6.01	0	0.431945 0.8599363
Sex	0.644787	0.238536	2.7	0.009	0.169493 1.12008
_cons	-0.02008	0.653721	-0.03	0.976	-1.32265 1.282484

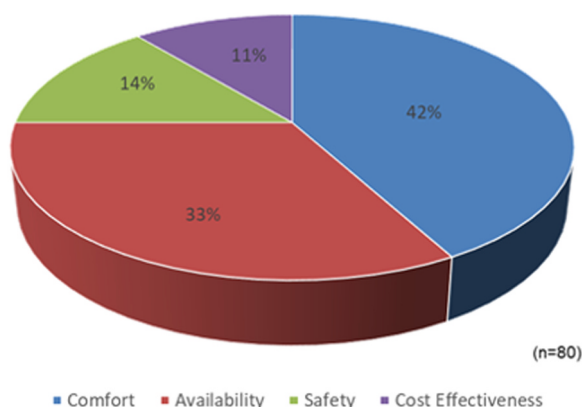


Fig. 3. Major factors behind opting for app cabs by respondents.

grooming and providing technological exposure. The cab aggregators often offered micro entrepreneurship for the drivers by helping the drivers buy their own cars at huge discounts and affordable repayment scheme as they collaborated with them; this move empower the driver and also ensure that they stay with the same concern till the loan period is over (Fig. 4).

Interactions were made with 30 drivers associated with app cabs at least for over a year. Most of the drivers opted for this service for higher income and better life-styles. Initially, they were more than happy with the salary and incentives that they received from the aggregators but with time as the incentives got lowered their expectations took a beating. However, till date they are mostly satisfied (83%) with their earning as it is higher than the traditional taxi alternative. Interestingly, majority of the respondents were wary of how long this process of incentivisation would continue, if the companies did not make profit for too long and felt uncertainty about their future. Working hours remained a serious concern for most (53%); the higher incentives mostly depended on the number of trips covered say for more than nine trips per day and is also indirectly dependent on the timing – if they operated in schedules when there is huge rush or heavy traffic congestion or even in odd hours like late nights and early mornings then from the additional high surge prices their income also increased manifolds. But to get this extra income, they had to spent insane hours behind the wheels which affected their health. Many of the respondents (80%) had a positive feedback regarding the app cab aggregator companies as they not only provided trip-wise incentives but also helped them to procure own cars at discounted rates and affordable repayment schemes which would help them to build their careers as owner drivers even if they left the company at some point in time. Regarding the business volume, the section of respondents who were upbeat (68%) opined that the demand for app cabs will go up with time as services like ride-sharing are more pocket friendly and comfortable for the middle-class population of the city, who are the majority of the client base. While discussing about the passenger behaviour, encouragingly almost all unanimously (96%) gave a positive feedback. In the study-area Kolkata, the relationship between the passenger and yellow taxi drivers have mostly been of negative notes so such a sea-change is hearting indeed. Some pointed out that since rating system was mutual, both passengers and drivers were on the same platform and treated each other with dignity enhancing the quality of ride experience in general.



Fig. 4. Perceptions regarding key concern areas for app cab drivers.

11. SWOT analysis

The SWOT analysis has been carried out to bring out the internal strength and weakness and external threat, opportunity factors. The points discussed emerged from the interactions held with the stakeholders of the system, primarily involving the cab drivers and passengers view-points. Organically from this empirical analysis, the way outs for a better, smarter future emerged.

11.1. Strength

App-based software platforms use technological combinations through smart-phones which eliminates the cost of dispatchers, equipment like radios, taximeters, credit card processor etc. and still manages to communicate useful information to passengers and drivers through real-time localisation updates like route tracing, authorization verification, payment calculation etc lowering the transaction cost. App-based software platforms also improve allocative efficiency. Through big data analysis using algorithmic skill they are able to match supply and demand much better tackling real-time requests for rides with available drivers. The app-cab drivers spent more time with passengers on board than traditional taxi drivers in the same market leading to greater occupancy performance (Cramer & Krueger, 2016). Scale effects reduce latency in handling passenger requests by continuously adjusting demand supply sides by accommodate drivers in any location accordingly. This smooth allocative function reduces the uncertainty associated with waiting for a taxi. Information efficiency is the key word for the app-cab services. Information is collected from drivers' smartphones instantaneously and automatically so that it can be easily dispatched to the nearest client. This helps in optimality, accuracy and speedy delivery of service.

The accountability issues are also well addressed in these platforms. There is provision for mandatory evaluation of driver courtesy and vehicle condition to ensure the proper vehicle condition and dissuade opportunistic driver behaviour; both of which are important for maintaining company's reputation. Many passengers reported a higher level of courtesy from app-cab drivers than taxi drivers which can be attributed to this instant evaluation system. Similar provisions are there for the drivers also who can poorly rate a passenger showing unnecessary tantrums along the trip which can lead to denial of service to the client in future. Since submitting a negative feed back in an app-based platform is hassle-free and more likely to yield desirable response, both the parties freely share their opinion. Software platforms potentially increase accountability by blocking certain opportunistic behaviour as well. For example, some taxi drivers report that telephone dispatchers direct preferred rides to drivers who pay bribes. This would be much less likely to occur with the algorithms supporting smart phone app-based services.

Aggressive marketing techniques through online, TV and print media has created awareness among common public and in turn has helped in creating increasing customer base. Segregation of fleet into different segments ensures that they fit to the demand and budget of customers of all sections.

11.2. Weakness

The app-cab services partner in with drivers and as the business is growing fast the number of partners is also on the rise. In many cases there are being lapses regarding proper background checks. If several issues are reported regarding poor behaviour of the drivers then it affects the brand image of the company. For higher incentives and incomes driver opt for longer hours of work and due to fatigue chances of accidents become higher.

Since cost of operating vehicles is quite high, in spite of high demands the companies have still not been able to earn profit or break-even as of yet. To achieve economies of scale, expansion and increased capacity utilization is imperative for which the companies are focusing on growth and investing heavily on new cab supply and client acquisition and retention. Since, they are yet to achieve economic viability; profitability has taken a backseat as of now.

The customers are confused and bit annoyed with the non-transparent algorithmic dynamic pricing model because the surge pricing charged during high demand times like during peak office hours, holiday rushes or late at night are in most cases very steep.

11.3. Opportunity

The convergence of new technology and smarter data handling make app-services precise and effective than. Automated fare information and collection, on-board monitoring of vehicle condition and driver behaviour on real time basis pose possibilities to authorities for better monitoring and service delivery. If more customers are benefitted from the hassle-free service of app-cabs then the tendency to use personal car might show a dip which can ease traffic volume and parking space crunch.

Women safety is an issue in the city. The app-cabs fitted with GPS tracking offers a kind of shield to the women. If a woman is in distress in an app-cab then she can immediately contact authorities by sending the precise location of pool point or press the panic button to relay the locational point avoiding unnecessary time loss.

The drivers also get the unique opportunity to work for flexible hours as per their will and help in rising disposable income of the people.

Apart from regular cab bookings there are chances for diversification like – signing annual contracts with corporate houses, arranging pre-designed short trips on holidays, organizing tours for educational institutes, tapping growing markets in suburban areas where taxi services are not available and offering provision for advance reservation at discounted rates. Regular customers can be offered monthly subscriptions, preferential cab allocation and immunity from surge pricing so that a loyal customer base can be retained.

11.4. Threat

The model of entrepreneurship followed by the app cab services is referred as evasive entrepreneurship (Elert & Henrekson, 2014). These firms create business opportunities by circumventing rules. The firms pose themselves as technological firms and not transportation entities and also as aggregators not as owners so that they can bypass many legal formalities. There is a long-standing issue of competition between the traditional taxis and app cab services. The Competition Act of India, 2003 deals with the competition issues. Any illegal competitive practice that stifles competition through illicit ways like adoption of predatory pricing is governed by Competition Commission of India (CCI). Presently, many state governments like Maharashtra, West Bengal are trying to regulate the app cab firms through state transport regulator by controlling the maximum pricing, surge rates to prevent the predatory pricing distorting healthy competition conventions.

The business model of the app cab companies can easily be replicated and increase competition in the market affecting the price negatively. This in turn will discourage drivers from joining the start-up in new market and hamper the services. Since, Uber was the first company to launch this sort of idea; such imitations are loosely referred as 'Uberification'.

Increasing competition can be felt in this market and since customer loyalty is not much pronounced to draw clients unviable pricing wars are often resorted to. Loyalty between the company and drivers is also quite low as they lack real connection. Though technology is the primary determining factor for success of app cabs, the importance of human capital i.e. a committed workforce is also vital for successful service delivery. Undoubtedly, the rating of drivers acts as a good safety-net but it also creates a pressure on the driver's mind as otherwise he would be fired by the platform. While handling driving partners the aggregators can keep in mind James Heskett's service profit chain model which stated that happy employees are more productive and generate greater customer satisfaction and loyalty which helps in company's growth.

Active regulatory oversight is required in order to ensure public safety, consumer protection and tax compliance. The app-cabs deal with a lot of personal data so that shared data should be protected fiercely without breaching legal and social norms. If the fleet size becomes too huge then proper background checking and having strict vigil on functioning becomes tough.

Since the cabs are always on move they also add to the traffic volume drastically. This in the long run can cause higher congestion and pollution level.

12. Conclusion and recommendations

Carsharing through efficient app-cab services has the potential to become effective element of a sustainable transportation system in emerging markets. A section of scholars has opined that app-based car-sharing services can generate a 'leapfrog scenario' where personal motorization could go down while others are of the opinion that it could generate more interest in car usage and in turn increase personalized vehicle usage, which is referred as 'stepping-stone scenario' (World Resource Institute, 2015).

Several issues became prominent through the study and thus a need for stricter regulatory schemes were felt. Public safety rules should be in place so that sufficient training of drivers is ensured, their criminal backgrounds are properly checked; besides through regular vehicle safety inspections the safety standards of vehicles have to be maintained. In cases of shared app-cab services unknown passengers are together so for having the safe feeling the prior evaluation ratings have to be maintained and are to be considered. To earn more the partner drivers often drive for too long and become fatigued to drive attentively and safely. To avoid overworking related drowsiness the system should keep a track on driver working time and act accordingly. The payment options are varied – there are cashless modes like e-banking, app-wallets, top-up cards and cash transactions are also allowed. Proper handling of monetary exchanges and maintenance of transparency of payments are imperative. Adequate specifically targeted insurance policies have to be subscribed by the app-cab services so that the costs pertaining to any on-road mishaps like crash etc. are not borne by the public. A kind of mechanism has to be in place to ensure that there are market entry restrictions to control market crowding in excess of demand. As at quite low fixed costs drivers can join in, there can be a tendency of excess supply which is neither viable for business nor for road traffic volume.

The positive feedbacks of app cab commuters and drivers from the primary survey indicated that it is a win-win situation for all stakeholders. Commuters across socio-economic, demographic parameters are happy with availability, reliability, cost effectiveness, safety, cashless option, driver behaviour, comfort and absence of bargaining there were issues regarding transparency and surge pricing. The drivers too were content with their improved earnings but were unhappy with the long hours and were apprehensive with regular incentive cuts. Riding on modern technology wave the app cab aggregators have provided a path-breaking shared mobility service in highly competitive price in a congested set-up. So, the of the present urban transportation situation of Kolkata city is volatile with promising future if the companies manage to balance between the virtual capabilities and actual reality emphasising on optimum resource utilization.

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