INFLUENCE OF SMART MOBILE TRAVEL APPS ENABLED TAXIS ON LOCAL URBAN ROAD TRANSPORTATION SYSTEMS IN DEVELOPING COUNTRIES

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ABSTRACT

Innovation and technology are critical to reinforce sustainability in road transportation. In recent years' smart technologies such as 'Smart Mobile Travel Apps' are influencing mobility particularly in cities. For example, 'smart mobile Apps' enabled ride shares and taxi services have become significant components in cities. However, while they are offering new opportunities in the urban mobility system, they are also bringing in certain sustainability and functional challenges. Therefore, using the case studies of ride share and taxi services provided by use of such 'Smart Mobile Travel Apps' in two cities - Cape Town in South Africa and Kolkata in India, this study examined the acceptability and availability of Smart Mobile Travel App enabled taxis and the challenges faced by these taxi services in cities of developing countries. An inductive and explorative survey research method was used for this study. Findings suggest that 'Smart Mobile Travel Apps' enabled ride shares and taxi services are highly acceptable and available to people for local accessibility in cities, although the cost of travel varies. However, there are challenges with regards to internet connectivity and its reliability and skill to use these Apps. Furthermore, there is a need for free internet connectivity hot spots in different parts of the cities for smooth operation and improved accessibility of these taxis.

Key words: Local accessibility; Internet connectivity; Smart travel apps; Taxi services; Urban

1 INTRODUCTION

Emerging smart technologies are adding new dimensions to the road transportation system in many cities across the world. While they are offering new opportunities in the urban mobility system, they are also bringing in certain challenges. In recent times technological applications – 'Smart Mobile Travel Apps' such as UBER, OLA, MERU, etc.,

are playing a critical role in providing local accessibility to individuals or groups at any point of time at any location in the cities where they offer their services. However, challenges such as availability of internet connectivity, reliability of internet connectivity, cost of travel, and pickup and drop off of the passengers (on the road sides of the busy roads, at nodal points, on road parking facilities, etc.) have been emerged. These challenges are in some cases aggravating the already existing urban road transportation problems such as congestion and on road parking, which warrant creation or upgrading of urban road infrastructure and internet connectivity technology to meet the demands of such smart mobility facilities. Besides, it has financial and business implications on the traditional taxi services. So, there is a necessity to explore the influence of 'Smart Mobile Travel Apps' enabled taxies on the road and ICT infrastructure, on the traditional taxi services and urban travelers based on which appropriate policy interventions to meet the demand may be engendered. Therefore, the objective of the study was to examine the acceptability level of these taxis, the challenges these services face and how these apps influence local travel behaviour of people in cities of developing countries. The scope of the study is confined to the users' perception on acceptability of smart App enabled taxis and cost of travel; availability of 'Smart Mobile Travel App' enabled taxis and ICT infrastructure and use challenges for smooth operation and access of Smart App enabled taxis. This study was conducted by using case studies of taxi services provided by use of such 'Smart Mobile Travel Apps' in two cities in developing countries - Cape Town in South Africa and Kolkata in India. For this purpose, services of "UBER" in Cape Town and "UBER and OLA" in Kolkata have been considered. An inductive explorative survey research method was used for this study. The survey was conducted among local urban travelers, tourists, taxi drivers belonging to traditional taxi services as well as taxi drivers offering travel service by using these 'Smart Mobile Travel Apps' through semi-structured interviews. Besides, critical literature reviews and discussions were also conducted with urban development experts, urban planners, transportation planners and engineers and smart technology experts. Findings suggest that there is a substantial acceptance of the travel services offered by using these Smart Mobile Travel Apps for local accessibility in cities, although the cost of travel varies. Despite some challenges, these 'Smart Mobile Travel App' empowered taxi services are observed to be available on demand within a reasonable period of time. However, certain challenges with regards to internet connectivity, its speed and reliability exist, which hampers the operation these taxis and cause reliability challenges to users. Also, such services demand free high speed internet connectivity as well as internet hot spots, where travelers can use these Smart Mobile Travel Apps and avail the services of smart App enabled taxis without much challenges.

2. MOBILE TRAVEL APPS AND LOCAL URBAN ROAD TRANSPORTATION

Technology and innovation are argued to be critical for sustainable road transportation. Radical changes have been experienced in mobility of people and goods over the years because of the influence of these factors; for example, be it through use of fossil fuelled vehicles or use of smart technologies (Bajpai, 2016; RAND Corporation, 2014; Ziegler, 2015). Technologies have already emerged to develop autonomous vehicles (AVs), or to make a car driverless by allowing robots to fully take over a driver's chores or to make the

cars partially automate under a driver's control (Bajpai, 2016; O'Kane, 2015; KPMG. 2012; Ziegler, 2015). Besides, the other primary innovations that have emerged are- to decarbonize vehicle fuel and improve fuel efficiency of vehicles in the wake of challenges of pollution and climate change; and to enable access to transport modes on an 'as needed' basis. The semi-automated vehicles based on these emerging technologies are performing certain functions of a driver such as parking, cruise control, lane keeping, avoidance of front collision, etc. Even these vehicles have automatic braking system (NY Times, 2015). Further, they have developed mobility options of various forms of on-demand shared ride by using Information Communication Technologies (ICT) such as 'Smart Mobile Travel Apps' (Bajpai, 2016; O'Kane, 2015; Ziegler, 2015). Thus, the innovations and emergence of new technologies in mobility systems have provided opportunities to reinforce sustainable road transportation.

Incidentally, the emergence of 'Smart Mobile Travel App' enabled vehicles on the roads and the business operation of these vehicles provided both opportunities and challenges to the road transportation system in the cities. These vehicles work on the principles of picking up and dropping off the riders on demand basis or allowing ride sharing following similar business operations (McKinsey & Co., 2015). Three important technologies such as GPS navigational device, smartphones and social networks, facilitate this process. In this process an optimization algorithm takes the ride request from a smartphone call, uses GPS device to determine the location of the request and instantly provides route to the nearest available driver or vehicle pick up station for the real-time matching of drivers and riders (Bajpai, 2016; Rayle, Shaheen, Chan, Dai, & Cervero, 2014). As a result, the riders have on demand access to hire or share cars, scooters, bikes and even rickshaws in some countries. Social network software complements this coordination and develops trust and accountability between drivers and riders (Bajpai, 2016). Moreover, it is seen that the emerging 'Smart Mobile Travel App'-based real time ride sharing and taxi services such as UBER, OLA, Meru and many others, are experiencing unprecedented expansion and are building on-line communities and serving a variety of mobility needs. Furthermore, by using these 'Smart Mobile Travel App' enabled services, a number of firms are also providing to its members and outsource rides to commercial drivers, or use their own fleet of vehicles to serve their members (Bajpai, 2016).

The 'Smart Mobile Travel App' enabled vehicles have brought in a number of benefits. A study from Canada and USA on demand car sharing programme suggests that each car sharing vehicle had replaced 9 to 13 vehicles (Martin, Shaheen, & Lidicker, 2010; Shaheen & Chan, 2015). Consequently, it is also argued that the reduction in number of personal vehicles can have a notable impact on reducing GHG emissions (Bajpai, 2016). It also provides the advantages of ride sharing with short wait time, flexibility in using them at any time and location and free from hassles of parking. Because of these services in large cities a lower household car ownership has also been experienced (UMTRI, 2015). Furthermore, the 'Smart Mobile Travel App' enabled on-demand vehicle services are in constant use to pick-up and drop-off people instead of sitting idle in parking lots. Due to such operational advantages, they are expected to reduce the demand for parking spaces, particularly in central business districts (CBD) of cities, as a result the land used for parking can be used for other important purposes such as for development of commercial,

residential or civic infrastructures (Shoup, 2005). Similarly, these vehicles could able to reduce vehicle travel distance and gas miles that are often spent to search parking spaces in large metropolitan areas (Transportation Alternatives, 2008). However, despite the benefits documented and opportunities to reinforce sustainable road transportation, certain challenges are also experienced because of plying of these vehicles and the nature of their operations. The challenges of these 'Smart Mobile Travel App' enabled vehicle services and their operation include but not limited to the impact on the road infrastructure such as demand for separate lanes, specific parking facilities, pick and drop off operations in busy streets, as well as on the traditional taxi services and behaviour of urban travellers, which consequently have influence on the overall sustainability of road transportation system in cities. Literature suggests that these aspects have not been explicitly explored particularly in developing countries.

3. CASE STUDY AREA

The study was conducted by using two large cities such as Kolkata in India and Cape Town in South Africa. Kolkata is a metropolitan city located in the Eastern part of India. It is one of the four mega national cities of the country and functions as a provincial capital. It has a population about 14.6 million and area of 1886.7 sq. km with a population density of 7483 persons/sq km. It serves as the major commercial hub for the Eastern region of the country. The city also experiences a floating population of about a million people, who transit to the city for various purposes every day. As a result, it requires a large scale intra-city movement by millions of people for different purposes. The local transportation facilities include Metro rail, local rail system connecting regional cities, public transportation system using buses, local taxis and three wheeler automobiles, and human driven tricycles. Also, in recent years, e- rickshaws (battery driven tricycles) and 'Smart Mobile Travel App' enabled local taxis operated by UBER and OLA have become integral parts of the local transportation system.

Cape Town is one of the largest cities of South Africa located in the South- western part of the country. It functions as one of capital cities of the country having the parliament being located in the city. It has a population of 3.74 million and spread over an area of 2444.97 sq. km with an average population density of 1500 persons/sq.km. However, the city is well known for its tourism activities and is one of the top and most visited tourist destinations in the world. Consequently, there is a large demand for local transportation facilities. The local transportation facilities include metro rail transportation, public bus transportation (MyCITI), Red city bus (for tourists), and public taxis. In recent times, 'Smart Mobile Travel App' enabled taxis operated by UBER have also been incorporated.

Both cities have largescale intra-city movement demands for both normal urban activities and tourism activities. Operation of 'Smart Mobile Travel App' enabled taxi services have also been significantly established and consequent challenges are experienced. These cities have diverse demographic and functional characteristics and it is envisaged the study by considering these two diverse cities will offer a more holistic insight to the challenges and thus chosen as case studies for this exploration.

4. METHODS

The investigation followed an inductive explorative method of research. A survey was conducted among various stakeholders in important areas of the two cities. Table 1 presents the profile of respondents of the survey. A total of 118 people were surveyed with 67 from Kolkata and 51 from Cape Town. The respondents include 16.1% 'Smart Mobile Travel App' enabled taxi drivers, 11.0% normal taxi drivers and 72.9% taxi users (31.4% tourists and 41.5% local taxi users). The four major urban activity areas in Kolkata, where survey was conducted are- International Airport, Esplanade (commercial center), South city area and City Center 1. Similarly, Cape Town International Airport, V&A water front and City Center of Cape Town city were chosen for the survey purpose. These areas were chosen because 'Smart Mobile Travel App' enabled taxis are observed to be predominantly operated in and around these areas, as well as there are huge demand for taxis and local accessibility in these areas of the respective cities. Random sampling process and semi-structured interview method were used to conduct the survey among the willing respondents. The survey focused on variables such as acceptance of 'Smart Mobile Travel App' enabled taxis, cost and availability for use of such taxis, the challenges faced by travelers, taxi operators and drivers, demands of travelers and taxi drivers. Open ended questions about the above variables were also resorted to along with structured questions while making the survey and interviews in order to get in depth perception of the respondents. Besides, discussions were also conducted with urban development experts, urban planners, transportation planners and engineers, and smart technology experts.

Relevant statistical analysis such as tabulation, percentage analysis and descriptive statistics were used to arrive at the results. Additionally, the responses from the interviews were analyzed by using manual qualitative method of analysis to draw inferences.

Table 1 Respondents profile

Types of Respondents	**Kolkata**		**Cape Town**		**Total**	
	Number	%	Number	%	Number	%
App enabled Taxi drivers	12	17.9	7	13.7	19	16.1
Traditional taxi drivers	8	11.9	5	9.8	13	11.0
Tourists taxi users	(14)	(29.8)	(23)	(58.9)	(37)	31.4 (43.0)
Local people taxi users	(33)	(70.2)	(16)	(42.1)	(49)	41.6 (57.0)
Total Taxi users	47	70.2	39	76.5	86	72.9
Total	67	100.0	51	100.0	118	100.0

Note: Total taxi users = tourist taxi users+ local people taxi users
The numbers within parentheses indicate the share of total taxi users

5. RESULTS AND DISCUSSIONS

The perceptions of the respondents on the acceptance, cost of travel, availability, ICT challenges, and demands of travelers and Smart Mobile Travel App enabled taxi drivers are presented in Table 2a, Table 2b, and Table 2c respectively. While analyzing the data, the inconsistent and vague responses were eliminated through scrutiny of the data set and only credible and complete responses were used for analysis.

5.1 Acceptance of Smart Mobile Travel App enabled taxis and cost of travel

Table 2a presents the acceptance level, cost of travel and availability of the 'Smart Mobile Travel App' enabled taxis. It is found that the 'Smart Mobile Travel App' enabled taxis are accepted (received or welcomed) to about 71.6% respondents in Kolkata and 76.5% respondents in Cape Town. Overall there is a high acceptance rate (73.7%) of these taxi services in both the cities. More than 60% of respondents perceive that Smart Mobile Travel App' enabled taxis are cheaper in general although about 40% disagreed. According to 55.2% in Kolkata and 54.9% in Cape Town, these taxis are expensive during peak hours. Consequently, it is found that overall majority (more than 55%) of respondents perceive that Smart Mobile Travel App enabled taxis are expensive during peak hours.

Table 2a Perception of acceptance of 'Smart Mobile Travel App' enabled taxis and cost of travel

Variables	**Kolkata**		**Cape Town**		**Total**	
	Number	%	Number	%	Number	%
Acceptance level	48	71.6	39	76.5	87	73.7
Cost of travel						
Cheap	41	61.2	31	60.8	72	61.0
Expensive	26	38. 8	20	39.2		38.0
Expensive during peak hours	37	55.2	28	54.9	65	55.1

5.2 Availability of 'Smart Mobile Travel App' enabled taxis

Table 2b presents the availability scenario of 'Smart Mobile Travel App' enabled taxis. About 50% of the total respondents perceive that these taxis are available within a reasonable period of time (<15 mins) after booking, although according to about 30%, there is high waiting period for such taxis. More people experience high waiting period (>15 mins) in Cape Town (33.3%) than in Kolkata (26.9%). Besides, about 11.9% believe that these taxis are available only in important locations of the city and only a mere 7.6% say that such taxis are not available. Therefore, it is construed that these taxis are largely available on demand in both cities although the challenge of availability persists on occasions.

Table 2b Perception of availability of Smart Mobile Travel App enabled taxis

Variables	Kolkata		Cape town		Total	
	Number	%	Number	%	Number	%
Availability						
Reasonable period of time (15mins)	32	47.8	27	52.9	59	50.0
High waiting period (>15 mins)	18	26.9	17	33.3	35	29.7
Available only in important areas	9	13.4	5	9.8	14	11.9
Not available	7	10.4	2	3.9	9	7.6

5.3 ICT infrastructure and use challenges for smooth operation and access of smart App enabled taxis

Table 2c revealed that ICT infrastructure and use related challenges in terms of availability of reliable internet connectivity, speed of connectivity and use and understanding of the Smart Apps by drivers are major challenges in Kolkata. It also presents the demand of the people for smooth operation and efficient service of these taxis. According to the survey results, only 46.3% perceive that the availability of internet connectivity in Kolkata is reliable. Similarly, only 34.3% believed that the speed of connectivity is adequate and according to only 25.4%, the drivers can properly use the apps and have good understanding of the operation of the Apps. However, these challenges are found to be of lesser extent in Cape Town as more than 70% say that the availability of internet is reliable, 62.7% believe that the speed of connectivity is good and about 72.5% drivers can properly use and understand the operation of the ‘Smart Mobile Travel Apps’. Overall ICT infrastructure and use challenges exist in both cities although to a greater extent in Kolkata.

Furthermore, according the perception of respondents, the major demand is the availability of either free internet for smooth operation and reliability of the services. According to respondents in Kolkata about 62.6% respondents seek free internet in general, whereas according to only 45.1% respondents’ free internet is necessary. However, according to majority of respondents in both cities, there is a need for availability of free internet hotspots to improve the operation and accessibility of Smart Mobile Travel App enabled taxis. Thus, it is found that although unavailability of reliable and high speed internet is a major challenge for smooth operation and accessibility of Smart Mobile Travel App enabled taxis, its availability for free is location specific as observed from the survey. While in Kolkata people demand free high speed internet, in Cape Town the demand is considerably lesser.

Table 2c ICT infrastructure and use challenges for smooth operation and access of Smart Mobile Travel App enabled taxis

Variables	Kolkata		Cape town		Total	
	Number	%	Number	%	Number	%
Availability of reliable internet connectivity	31	46.3	36	70.6	67	56.8
Adequacy of speed of connectivity	23	34.3	32	62.7	55	46.6
Ability of drivers to use and understand of the apps	17	25.4	37	72.5	54	45.8
Need for availability of free internet in general	42	62.6	23	45.1	65	55.1
Need for availability of free internet hot spots	58	86.5	36	70.6	94	79.7

Furthermore, qualitative discussions with experts and professionals such as urban planners, transportation planners and engineers revealed that the 'Smart Mobile Travel App' enabled taxis would provide higher local accessibility and perhaps reduce the waiting time and cost of travel. However, according to transportation engineers and planners, there would be road infrastructure challenges[1]. ICT experts and professionals see the ICT connectivity, particularly speed and reliability as major challenges. According to them, although availability of internet connectivity may not be a problem in major cities, reliability and speed of connectivity need improvement to improve the operational efficiency of such taxis and to provide reliable and higher accessibility to the users[2]. Particularly, ICT experts in Kolkata believe this is major challenge in Kolkata and similar cities in developing countries[3]. Thus, the opinions of experts and professionals in general corroborated the findings of the perceptions of respondents surveyed, implying that there is a need for augmentation of ICT facilities in cities for smooth operations of Smart Mobile Travel Apps enabled taxis and to meet the challenges of affordable and reliable high speed ICT connectivity to access these taxis by users.

6. CONCLUSION

Local transportation in cities of developing countries has been a challenges. Taxis are an important mode of transportation particularly to people who can afford and in need for easy and fast accessibility. However, in recent times emergence of 'Smart Mobile Travel App' enabled taxi operations offered by service operators such as UBER, OLA, Meru, etc., are gradually becoming important parts of the local accessibility in many cities across the world including developing countries. The operation of such 'Smart Mobile Travel Apps' enabled taxis engendered certain infrastructural, and service challenges in many cities in

[1] Opinion of Urban planners, transportation planners and transportation engineers
[2] Opinions of ICT experts.
[3] Opinions of ICT experts in Kolkata

the developing world. Therefore, this study examined the acceptability level, availability and the challenges these taxis services face and the demands of the people for smooth operation and improved services of the 'Smart Mobile Travel App' enabled taxis in cities of developing countries. For this purpose, perceptions of stakeholders and opinions of experts were collected by making a survey through semi structured interviews in two major cities in the developing world- Kolkata in India and Cape Town in South Africa. Findings suggest that 'Smart Mobile Travel App' enabled taxis are quite acceptable to users and are affordable, although they could be more expensive during peak hours. They are also available within reasonable period of waiting time in both the cities. Furthermore, the smooth operation and accessibility such services demand high speed and reliable internet connectivity, which is found to be a cause of concern in cities of developing countries such as Kolkata and to lesser extent in Cape Town. However, according to majority of respondents in Kolkata there should be free internet facilities to access such services, although the demand is to lesser extent in Cape Town. Additionally, the survey result also revealed that there is a need for free internet hotspots for improved service and accessibility of these taxis. Further, there is also a challenge of competent users and drivers of such Smart Mobile Travel Apps as evidenced from Kolkata, where majority of respondents opine that majority of drivers are not adept to use these Apps. Thus, it offers evidences that ICT related challenges for Smart Mobile App enabled taxis are location specific and need to be adapted according to the demand.

The study has certain limitations such as, it is based on limited perception survey and expert opinion. A thorough exploration and analysis would provide further insights to the challenges. Nevertheless, this investigation revealed that 'Smart Mobile Travel App' enabled taxis are acceptable and available but have engendered a number ICT challenges in cities, which need to be looked at while developing policy interventions for developing sustainable cites in developing countries.

REFERENCES

Bajpai JN, 2016. Emerging vehicle technologies & the search for urban mobility solutions. Urban, Planning and Transport Research, 4(1) p. 83-100. DOI: 10.1080/21650020.2016.1185964.

KPMG, 2012. Self-driving cars: The next revolution. Retrieved from http://www.kpmg.com/US/en/ IssuesAndInsights/ArticlesPublications/Documents/self-driving-cars-next-revolution.pdf.

Martin, E., Shaheen, S., & Lidicker, J, 2010. Impact of car-sharing on household vehicle holdings: Results from North America Shared-Use Vehicle Survey. Transport Research Record, 2143. Retrieved from http://trid.trb.org/view/911080.

McKinsey & Co, 2015. Urban mobility at a tipping point. Retrieved from http://www. mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/urbanmobility- at-a-tipping-point.

NYU, 2015. Monitoring global urban expansion. Retrieved from http://marroninstitute.nyu.edu/content/case-studies/monitoring-the-quantity-and-quality-of-global-urban-expansion.

O'Kane, S, 2015. This is the first road-legal big rig that can drive itself. The Verge. Retrieved from http://www.theverge.com/2015/5/6/8556791/self-driving-semi-big-rig-freightliner-inspirationtruck.

RAND Corporation, 2014. Autonomous vehicle technology: A guide for policy makers. Santa Monica, CA.

Shaheen, S., & Chan, N, 2015. Mobility and sharing economy: Impacts synopsis. Retrieved from http://innovativemobility.org/wp-content/uploads/2015/03/Innovative-Mobility-Industry- Outlook_SUM-Spring-2015.pdf

Shoup, DC, 2005. The high cost of free parking. Chicago, IL: Planner's Press.

Transportation Alternatives. 2008.. Driven to excess: What under-priced curbside parking costs the Upper West Side. Retrieved from www.transalt.org/sites/default/files/news/reports/driven_to_ excess.pdf.

UMTRI, 2015. Driverless vehicles: Fewer cars, more miles. Ann Arbor, MI: University of Michigan Transport Research Center.

Ziegler, C, 2015. Google's self-driving cars have been in 11 accidents, but none were car's fault. *The Verge*. Retrieved from http://www.theverge.com/2015/5/11/8586661/google-self-drivingcar- 11-accidents-not-at-fault.