Australasian Transport Research Forum 2018 Proceedings
30 October – 1 November, Darwin, Australia
Publication website: http://www.atrf.info

Identifying Barriers in Shared Mobility Implementation, a Review

Li Meng[1], Stephen Berry[2,] Sekhar Somenahalli[3], Andrew Allan[4],

[1,2,3,4] University of South Australia

Email for correspondence: li.meng@unisa.edu.au

Abstract

Urban mobility options have substantially increased in recent years, enabled by the widespread availability of smart device software Apps, geo-positioning technology, and the ease of electronic financial transactions. These options are likely to be supplemented soon by the rapidly advancing development of autonomous vehicles. Commercial sharing services, such as share cars and share bicycles, are expecting to complement fixed route public transit systems to support the first/last mile challenge of public transit services [a part of Mobility as a Service (MaaS)], as well as stimulate additional demand for short distance mobility. This paper reviews the development of commercial bike and car sharing schemes, then examines the technologies and policies that support MaaS. This research draws upon the experiences learnt and indicates the potential difficulties encountered in the successful planning of shared mobility services. The results provide an in-depth discussion of the characteristics and needs of shared mobility services and investigates the barriers of applying the Internet of Things (IoT), cybersecurity and blockchain in first/last mile mobility challenge. The findings will assist the community, business providers and government policymakers who are keen to promote shared mobility as a pathway towards more efficient, environmentally sustainable and socially responsive mobility solutions.

Keywords: shared mobility, shared autonomous vehicle, blockchain, cybersecurity, government intervention

1 Introduction

For much of the twentieth and twenty-first century, cities have increasingly faced the issues of air pollution and traffic congestion. Given these challenges, it is likely that we face a transition away from private car use, and a variety of alternative travel modes may be required to support the growing mobility needs of increasingly urban communities (Buliung et al., 2012). This phenomenon, more recently accelerated by the availability of smart devices, has contributed to the rising concept of shared mobility (Botsman & Rogers 2010) which is based on a type of commercially collaborative consumption that provides convenient and economical urban travel beyond the concept of private car ownership and use (Cohen & Kietzmann 2014; Hamari, Sjöklint & Ukkonen 2016).

Shared mobility started as car sharing with a small-scale demonstration project as early as the 1940s in Switzerland and emerged at a commercial scale in the mid-1990s. It is now developed as a peer-to-peer (P2P) based activity for obtaining, giving, or sharing access, coordinated through community-based online services (Botsman & Rogers 2010), such as through smart device software Apps. This type of transport belongs to shared economy mechanisms that enable companies to offer goods as a service rather than sell them as products. Shared economy facilitates a redistribution market, where people with no personal relationship commercially share assets. With shared mobility, users do not separately pay the full costs of the asset, insurance, fuel, maintenance, or parking in designated spaces, but are charged for the time of the vehicles used, or the distance covered, or a combination of two, coordinated through an online App and paid electronically (Cohen & Kietzmann 2014). Besides the economic gains, Hamari et al. (2016) stated that participation in the shared economy is to some degree motivated by sustainability and enjoyment.

The definition of shared mobility has varied with intersecting pathways over time. The traditional concept of ride-sharing was called car-pooling, where all participants compromise their personal travel scheduling flexibility to share travel in the same car to reach similar destinations (Habib et al., 2011). In recent years, the practices mentioned more about 'sharing' terms, the difference between 'ride-sharing' and 'ride-sourcing', with the former functioning along the lines of a not-for-profit service to match supply and demand if the trip is matching their own trips, and the later operates for profit and provides rides as business services supported by a flexible and user interactive platform (Rayle et al. 2016). 'Ride-sourcing' such as Uber and Lyft can be distinguished from a traditional taxi by the use of an online trip matching platform with an efficient electronic order and payment system. This paper discusses shared mobility services from the perspective of commercially sharing a physical asset such as a bike or car (and in the future an autonomous vehicle) rather than sharing a ride.

Shared mobility plays a critical role in the development of Mobility as a Service (MaaS), especially when shared cars or bikes are used first/last mile and multi-modal sharing. Shared mobility has emerged out of the backdrop of a digital technology revolution, enabled by massive flows of information, improved online security, and ubiquitous smart devices. However, various barriers exist, for example, there is an attitude-behaviour gap, whereby people perceive the activity positively but do not necessarily translate this into personal action; and there is a lack of experience in the business models of the service providers (Cohen & Kietzmann 2014). These issues could impact on the quality of MaaS, public transport planning and day to day travel events. This paper focuses on a review of the current literature to discuss (multi-modal) commercial shared mobility's developments, benefits and barriers to the business model. The paper then progresses to discussion of the applications of first/last mile and multi-modal mobility and supporting technologies of online Apps, cybersecurity, blockchain and ends with the analyses of the challenges for shared mobility planning. This paper addresses one of the knowledge gaps further developing the evidence base for policies supporting shared mobility implementation.

2 Car sharing

Literature has categorised two types of car sharing: one-way car sharing (Shaheen et al., 2015) [or point-to-point car sharing (Le Vine et al., 2014)] and roundtrip car sharing. One-way car sharing is further divided into one-way station-based services (i.e. where a vehicle is returned to a different designated station location), which is also called a fixed based (Philip Boyle and Associates, 2017); or one-way free-floating services (vehicle returned anywhere within a geographic area). One-way car sharing does not require its users to return the vehicle to the same location from which it was accessed (in contrast to roundtrip car sharing), and users typically pay by the minute versus the hour and may not require a reservation. In roundtrip car sharing systems, the user must return the vehicle to its starting point at the end of their usage episode; it includes both travel to and from a destination and the time spent whilst there. Advance reservation via the internet is typically required and payment includes an additional time-based parking charge for a planned trip activity. When the hire lengthens, the fixed-base service often becomes relatively cheaper compared to the free-floating service. Generally, free-floating services support short trips that are usually one-way. Fixed-based car share services facilitate reduced car ownership by providing readily available vehicle access for longer journeys.

2.1 The development of car sharing

Car sharing is not a new phenomenon although rapid growth of commercial schemes enabled by smart devices has transformed car sharing from niche to mainstream in many cities. The first recorded car sharing system commenced in Zurich, Switzerland in 1948 to serve people who could not afford or preferred not to purchase a vehicle (Shaheen and Cohen, 2013). The program operated until 1998, using the round-trip operating model. One of the earliest North American experiences with car sharing began with two experiments: Mobility Enterprise (a Purdue University research program, 1983 to 1986) and the Short-Term Auto Rental (STAR) demonstration (San Francisco, California, 1983 to 1985). There are similar car sharing schemes in Europe that include: Procotip; Witkar, Green Cars; Bilpoolen; Vivallabil; and Bilkooperativ (Shaheen and Cohen, 2013). Since 2008, fixed-base car share services have grown in scale and availability, with service providers operating in over 1,000 cities and 27 countries. For example, Zipcar manages around 10,000 vehicles in the United States of America alone (Philip Boyle and Associates, 2017).

In the same period, other types of sharing models have become available including allowing people to rent their car to neighbours, shared ownership of a single vehicle (fractional ownership), and 'free-floating' one-way, short-term car hire, such as personal vehicle sharing. There are four sub-models of personal vehicle sharing:

- fractional ownership
- hybrid peer-to-peer (P2P)-traditional car sharing (individuals access vehicles by joining an organization that maintains its own fleet of cars and light trucks—but also includes private vehicles—throughout a network of locations
- P2P car sharing (employs privately-owned vehicles made temporarily available for shared use by an individual or members of a P2P company)
- P2P marketplace (enables direct exchanges between individuals via the internet).

These personal car sharing types have been supported by government policies and businesses to different degrees in the past, such as benefits reduced tolls or free parking provided by employers.

In Adelaide, South Australia, a fixed-base car share service began in August 2008 with two vehicles located at a purpose built 'green' development in Sturt Street. Policy makers at local government level embraced the concept of commercial car sharing and in 2012, the Adelaide City Council set a goal of reaching 100 car share vehicles in their council district by 2020. By November 2016, the service had grown to 14 cars in 11 different locations supporting 446 private and business users (Philip Boyle and Associates, 2017). Policy support at state government level enabled the car sharing scheme to spread to other locations outside the central business district such as the Bowden urban renewal project.

2.2 Shared Autonomous vehicles

Autonomous (driverless) vehicles are expected to have a growing presence on our roads in the near future, with small-scale trials already happening in many cities. The extension of this concept to Shared Autonomous Vehicles (SAVs) would retain door-to-door travel without the private asset costs and congestion that accompany single occupant owner-occupied vehicles (Ohnemus & Perl 2016). SAVs have the potential to reduce crashes, ease congestion, improve fuel economy, reduce parking needs, bring mobility to those unable to drive, and over time, dramatically change the nature of travel. SAVs may induce an increase in travel activity by meeting unmet mobility demand. Barriers to the uptake of autonomous vehicle may be less technical and more likely economic due to high initial costs (Fagnant & Kockelman 2015). Other challenges include legal liability, security and privacy.

3 Shared bicycles

The literature has discussed shared bicycles as ‘Bicycle sharing’, ‘Bikeshare’, ‘Public bicycle’ or ‘Public bike’. This paper discusses commercial bike sharing schemes which traditionally targets users interested in leisure-oriented mobility and are most prevalent in areas with a high tourist and/or student concentrations. Bike sharing schemes are commonly found in two forms: (a) schemes that require the bikes to be locked in purpose built docking stations to complete the service; or (b) dockless schemes that allow the users to complete the service by parking the bike where-ever they chose.

The principle of commercial bike sharing is simple, with users becoming a member of an enterprise that shares the use of the bike asset, often at a small or even zero cost for trips of short duration. This flexible short-term usage scheme can provides supplementary travel connections to the car and public transport. The shared bicycle service typically allows users to make reservations, pick-up, and drop-off the asset purely through self-service processes or their enabled smart device (i.e. phone or table). Bike sharing can marry well with the first/last mile travel concept and represents an eco-friendly mobility solution.

4 Integrated multi-modal mobility

4.1 Integration

Public transport services are unable to bridge all locations, providing the potential for first/last mile shared mobility services. A dispersed pattern of land use dominates relatively low density suburban areas in many Australian and American cities. The distances between schools, homes, industry, recreation and retail services make it difficult to traverse by means other than a private vehicle. Typically, the overall transit system fails with first/last mile problem in low density suburban form (DeMaio, 2009). A compact urban development, smart new transport with efficient and affordable new options, such as multi-modal sharing, would present a potential solution to this complex challenge and help meet transport demand and sustainability objectives (Cohen & Kietzmann 2014; DeMaio 2009).

Integrating public transport and sharing economy mobility services may be the key to address the first/last mile problem. Lesh (2013) suggested the 1/2 to 1 mile radius around public transport connection points is the limit at which users perceived the distance too ‘far’ to walk, and beyond which the attractiveness and efficiency of public transport quickly diminishes for the user. Car and bike sharing systems may provide first/last mile mobility services, providing users with a transport option to link their final destinations with existing public transport infrastructure. Examples of integrating bike sharing schemes with public transportation systems include the cities of Antwerp, Dublin, Cardiff, and San Francisco (Parkes et al. 2013).

Potentially, the combination of sharing systems with future on-demand mobility (applied via mobile Apps) may be useful in low-density suburbs where previously car ownership has been essential (Ohnemus & Perl 2016). Further policies and strategies may need to be developed or deployed to meet the requirements of multi-modal mobility. For example, in the future, shared autonomous vehicles may offer a convenient alternative for the first/last mile of travel in suburban areas (Ohnemus & Perl 2016). The future new sustainable mobility paradigm may be achieved through four key objectives: fewer trips, modal shift, distance reduction and increased efficiency (Cohen & Kietzmann 2014).

4.2 Enabling the paradigm shift

A paradigm shift to multi-modal mobility services that integrate sharing mobility services will take the cooperation of many actors. The sharing of knowledge leading to city-to-city policy transfer is a very active process in the field of transport and may enable the paradigm shift (Marsden et al. 2011).

5 Advanced technologies for shared mobility

There are four main technological advances that are enabling the growth of sharing mobility services. They are big data (Romanillos et al. 2016; Sagiroglu & Sinanc 2013), the Internet of Things (IoT) (Lanza et al. 2016; Zhang & Wen 2017), blockchain or similar secure payment mechanisms, and cybersecurity (Pasqualetti, Dörfler & Bullo 2013; Von Dollen 2009).

6 Government

6.1 Policy intervention

Besley (1988) discussed two methods of introducing merit good into policy making being first-best policy and second-best policy. A first-best policy needs only to consider the determination of two variables for the first-best allocation: an optimal lump-sum transfer of income and a direct choice of the merit good quantity. Second-best government policies are implemented when governments lack the information necessary to optimise the income distribution, and must charge the same price to all consumers of the merit good. In the other words, they may be unable to set tax rates that vary across individuals. First best policies may face market failure or distributional arguments (Besley 1988), therefore governments need to implement second best policies for a new product where there is insufficient information to make decisions. In supporting shared mobility, a social planner, or politician, does not 'know best' but may choose some individual preferences in a very specific policy intervention to alter the value of merit goods. The planner may overthrow individual preferences on shared mobility but at the same time engage in total sympathetic identification with the interests of his citizens to achieve a merit good.

6.2 Policy innovation

Policy makers are often seeking successful examples practised in other places. It should be noted that policies cannot, merely be transferred over space, in fact, their form and their effects are transformed by journeys of implementation (Peck 2011). Policy practice should adapt continuously to remake relational connections across an intensely changeable and dynamic socio-institutional landscape. The reasons are complex and depend on local circumstances that are not suitable for the simple type of 'copy' of examples from elsewhere but require a new innovative idea. This implies that contemporary phenomena like global policy models and peripatetic best practices, despite being methodologically and politically eye-catching, should not be blindly worshipped by virtue of their evident mobility per se (Peck 2011). Transferring policy for multi-modal shared mobility needs to be restructured to fit in macro-institutional environments.

In developing a successful policy for multi-modal shared mobility, it is important to improve the quality and trustworthiness of evidence based research and to provide better channels to access that information. In addition, peer-peer exchange networks are necessary as a means for promoting the detailed exchange of information and implementation of a policy in practice as the reliance on social learning processes increases (Marsden et al. 2011). When this policy approach is emphasized, the academic research base could provide shorter and more policy-relevant summaries, and for the policy maker, peer-peer experience exchange would work more effectively in multimodal shared mobility.

6.3 Policy communications

The adoption of policies is linked to the success of communicating the benefits. Social media has been perceived as medium to assist in reducing the knowledge translation gap, creating communities of practice and reducing traditional hierarchical divisions (Roland 2018). Policy makers may benefits from utilising social media as a means of transferring their goals and engaging wide audiences. For example, in a campaign to reduce drinking and driving, an economic effects analysis indicated that social media, as a means of policy implemention, could be more effective than other methods and the societal benefits were gained greater than the costs (Elder et al. 2004). Through web-based and mobile media, travellers can share information about travel experiences to enable interaction with policy makers and other stakeholders. Social media has the power to dramatically increase our ability to share, cooperate and take collective action without traditional institutions and organizations (Rheingold, 2003; Shirky, 2008).

7 Summary and conclusion

Car sharing and bike sharing, as services in their own right or as part of a multi-modal system to support first/last mile mobility, have their own specific characteristics and barriers to the development. In order to accelerate adoption, they will need to be supported by smart technologies and government policy interventions, and in turn, shared mobility can enables technology growth and successful policy making.

First/last mile shared mobility would integrate car sharing, bike sharing and public transport in one service platform to provide an integrated trip experience from start to finish, but would require the collaboration and co-operation of public transit services, regulators, and shared mobility providers.

Shared mobility will be driven by the digital technological revolution and new business models. Blockchain and cybersecurity could be technologies the transfer to the transportation field, although they would probably benefit through learning the experiences from the finance industry. In spite of the phenomenon of big data that is closely related to the development or capability of IoT (likely to be accelerated with 5G wireless internet), there is a lack of richness in qualitative data demonstrating travellers' preferences with regard to forecasting and future (stated preference) data on demand and supply.

Policy intervention is very important in shared mobility promotion and in new technology applications. Shared mobility could benefit from being treated as a merit good and gain greater support from government policy, regulation and funding (at least in its nascent stages). The characteristics of merit good for sharing and multi-modal services require a second-best policy as the government cannot obtain full information to optimise the income distribution. On the other hand, policy should not be directly transferred, rather transformed by journeys of implementation with the effort of linking specificity and network relations. There is possibly a lack of quality and trustworthiness of evidence-base research and peer-to-peer exchange networks for detailed information. Social media has been demonstrated to be more effective than other communication tools and may be more cost-efficient. There are likely to be long-term benefits from a social media campaign that overweigh the short-term frustration provided by non-shared mobility collaborators.

The revolution of SAVs in the next few decades could help promote technology applications in shared mobility services. The high cost of SAVs necessitates that shared ownership or shared ridership is the most cost effective way of accelerating uptake.

In conclusion, there is high potential for shared mobility services to fulfil more of the mobility tasks in our cities, and reduce our private car dependency. Modern technology and government policies could support the development of shared mobility schemes. There is an interactive reinforcing relationship between them, therefore a supportive and collaborative relationship between all the parties is the best approach to address the challenges of meeting our ever growing mobility demand.

References

Besley, T (1988), 'A simple model for merit good arguments', *Journal of Public economics,* 35(3), 371-383.

Botsman, R & Rogers, R (2010), 'Beyond zipcar: Collaborative consumption', *Harvard Business Review,* 88(10), 30.

Cohen, B & Kietzmann, J (2014), 'Ride On! Mobility Business Models for the Sharing Economy', *Organization & Environment,* 27(3), 2014/09/01, 279-296. <https://doi.org/10.1177/1086026614546199>.

DeMaio, P (2009), 'Bike-sharing: History, impacts, models of provision, and future', *Journal of public transportation,* 12(4), 3.

Elder, RW, Shults, RA, Sleet, DA, Nichols, JL, Thompson, RS & Rajab, W (2004), 'Effectiveness of mass media campaigns for reducing drinking and driving and alcohol-involved crashes: A systematic review', *American Journal of Preventive Medicine,* 27(1), 2004/07/01/, 57-65. <http://www.sciencedirect.com/science/article/pii/S0749379704000467>.

Fagnant, DJ & Kockelman, K (2015), 'Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations', *Transportation Research Part A: Policy and Practice,* 77), 167-181.

Hamari, J, Sjöklint, M & Ukkonen, A (2016), 'The sharing economy: Why people participate in collaborative consumption', *Journal of the Association for Information Science and Technology,* 67(9), 2047-2059.

Lanza, J, Sánchez, L, Gutiérrez, V, Galache, J, Santana, J, Sotres, P & Muñoz, L (2016), 'Smart City Services over a Future Internet Platform Based on Internet of Things and Cloud: The Smart Parking Case', *Energies,* 9(9), 719. <http://www.mdpi.com/1996-1073/9/9/719>.

Lesh, MC (2013), 'Innovative concepts in first-last mile connections to public transportation', *Urban Public Transportation Systems 2013*, 63-74.

Marsden, G, Frick, KT, May, AD & Deakin, E (2011), 'How do cities approach policy innovation and policy learning? A study of 30 policies in Northern Europe and North America', *Transport Policy,* 18(3), 2011/05/01/, 501-512. <http://www.sciencedirect.com/science/article/pii/S0967070X10001307>.

Ohnemus, M & Perl, A (2016), 'Shared Autonomous Vehicles: Catalyst of New Mobility for the Last Mile?', *Built Environment,* 42(4), 589-602.

Parkes, SD, Marsden, G, Shaheen, SA & Cohen, AP (2013), 'Understanding the diffusion of public bikesharing systems: evidence from Europe and North America', *Journal of Transport Geography,* 31), 94-103.

Pasqualetti, F, Dörfler, F & Bullo, F (2013), 'Attack detection and identification in cyber-physical systems', *IEEE Transactions on Automatic Control,* 58(11), 2715-2729.

Peck, J (2011), 'Geographies of policy: From transfer-diffusion to mobility-mutation', *Progress in human geography,* 35(6), 773-797.

Rayle, L, Dai, D, Chan, N, Cervero, R & Shaheen, S (2016), 'Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco', *Transport Policy,* 45(Supplement C), 168-178. <http://www.sciencedirect.com/science/article/pii/S0967070X15300627>.

Roland, D (2018), 'Social Media, Health Policy, and Knowledge Translation', *Journal of the American College of Radiology,* 15(1), 149-152. <https://doi.org/10.1016/j.jacr.2017.09.009>.

Romanillos, G, Zaltz Austwick, M, Ettema, D & De Kruijf, J (2016), 'Big data and cycling', *Transport Reviews,* 36(1), 114-133.

, (2013), 'Big data: A review', *Collaboration Technologies and Systems (CTS), 2013 International Conference on*, IEEE, 42-47,

Von Dollen, D (2009), 'Report to NIST on the smart grid interoperability standards roadmap', *Electric Power Research Institute (EPRI) and National Institute of Standards and Technology*).

Zhang, Y & Wen, J (2017), 'The IoT electric business model: Using blockchain technology for the internet of things', *Peer-to-Peer Networking and Applications,* 10(4), 983-994.