LOW CARBON LIVING CRC

RP2021e: Greening Inner-urban Travel with Sharing Economy Mobility Services

Barriers to the provision of shared mobility services

Final Report

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The author(s) confirm(s) that this document has been reviewed and approved by the Project Leaders Committee and by its program leader. These reviewers evaluated its:

- originality
- methodology
- rigour
- compliance with ethical guidelines
- conclusions against results conformity with the principles of the Australian Code for the Responsible Conduct of Research (NHMRC 2007),

and provided constructive feedback which was considered and addressed by the author(s).

Contents

List of Figures

List of Tables

Executive Summary

The 21st Century has seen the rapid rise of sharing economy mobility services. Enabled by ubiquitous 'smart' devices and secure electronic financial transactions, shared mobility has allowed the collective ownership and use of transport assets in new commercial ways. Share cars, share bikes, share e-scooters and many more transport assets have landed on our streets and footpaths providing new opportunities to meet end-user mobility demand.

This report explored the key barriers to the provision of these sharing economy mobility services to highlight the actions that can be taken by policy makers and other organisations to support their availability. The study involved two stages: a literature review investigating the current state of knowledge both domestically and internationally; and in-depth interviews with experts from organisations such as service providers, lobby groups and policymakers. The objective was to learn their perceptions on shared mobility service provision barriers and expected developments on increasing the use of shared mobility services.

The analysis found that the Australia cities have similar shared mobility issues that are evident in other places around the world, for example, the paucity of suitable parking spaces/numbers and locations for shared mobility facilities, and the need for smart technology that elicits information for meeting travel demands.

The study found a number of barriers relating to the not always smooth interaction between policy makers and commercial enterprises, suggesting opportunities for new cooperative business models, joint partnerships and shared responsibilities in the provision of shared mobility services. In particular, the lack of acknowledgement in accepting shared mobility services as merit goods, in the same way as other public transport services, prevented shared mobility from being supported by the government policy intervention.

Personal data security and legal liability are problems that may prevent or discourage people from using shared mobility services. The lack of charging infrastructure may be delaying the transition to lower carbon impact mobility services. The still-developing concept of the shared autonomous vehicle may disrupt the shared mobility service sector at a time when it is still trying to get a foothold as an industry.

The use of shared bicycles may be limited by the lack of adequate supporting infrastructure such as dedicated and separated cycling routes to support rider safety.

When looking into multi-modal shared mobility, policy support for infrastructure is lacking particularly for linking modes of travel and a platform with shared information to enable this integration possible. For Australian cities, the challenges of lower population density, relatively poor public transport quality and quantity, high private car ownership, and cheap car parking are barriers to the uptake of sharing economy mobility services.

Policy action can address some of these barriers and establish a more level playing field for new commercial enterprises. For example, Renewal SA has set up flagship development in the inner-urban South Australian suburb of Bowden where the focus is dealing with many of the aforementioned issues by providing dedicated parking locations and support to promote shared mobility services.

Sharing economy mobility services can play a role of reducing private car ownership, but supporting policies that encourage higher population density and a connected network of public transport that includes share bikes and e-scooters will be necessary to transition shared mobility from a niche service to a mainstream mobility service.

The barriers to the provision of sharing economy mobility services are mostly regulatory, legal and social in nature. This study concludes that shared mobility in low-density cities requires strong policy leadership in transport, urban planning, health, social and environment sectors. Businesses and government organisations can support environmentally sustainable transport modes such as shared mobility services through effective policies, the development of new strategies, and the delivery of action plans.

Project Overview

RP2021e Greening Inner-urban Travel with Sharing Economy Mobility Services

The sharing economy is undergoing massive expansion, with exemplars like the car sharing market expected to involve millions of consumers globally by 2020. Increasingly, consumers consider public sharing systems a viable alternative to product ownership, a paradigm that competes with the dominant logic of private ownership and control. Sharing systems have evolved as a disruptive technology driven business concept on the premise of providing end-users with access to the benefits of product ownership, but without the commitment to capital expenditure.

This research project is designed to investigate the potential social, economic and carbon benefits of the sharing economy mobility services by answering the question: To what extent can sharing economy services deliver the low-carbon mobility needs of those who live, work or play within inner-urban precincts?

The project has four main parts:

- Work Package 1: Barriers to the provision of sharing economy mobility services
- Work Package 2: Servicing the needs of major inner-urban trip generators
- Work Package 3: Mapping demand for sharing economy mobility services
- Work Package 4: Quantifying the carbon abatement impact

This report represents the Final Report of Work Package 1, and explores the key barriers to the commercial provision and user participation in sharing economy mobility services, including:

- Regulatory and legal barriers
- Access to public realm
- Integration with the existing transport infrastructure
- Provision of supporting infrastructure

1. Introduction

Throughout the twentieth century and into the twenty-first century, cities have increasingly faced the issues of traffic congestion, urban sprawl and transport-related air pollution. In Australian cities such as Adelaide around 80% of residents drive to work in their fossil-fuelled private vehicle, with few utilising public transport or active transport modes (ABS 2017). Given these challenges, it is likely that we will have to transition away from private car ownership and instead, consider a variety of alternative modes to support the growing mobility needs of increasingly spread-out urban communities (Buliung, Bui & Lanyon 2012).

Ubiquitous smart devices and the ability to make instantaneous electronic payments has contributed to the rising concept of sharing economy mobility services (Botsman & Rogers 2010), a type of commercially collaborative consumption. Shared mobility services can provide convenient and economical urban transport solutions beyond the concept of private car or bike ownership and use (Cohen & Kietzmann 2014; Hamari, Sjöklint & Ukkonen 2016).

Shared mobility began as car sharing with a small-scale demonstration project as early as the 1940s in Switzerland, and emerged on a commercial scale by the mid-1990s in numerous countries. It is now developed as a peer-to-peer (P2P) based activity for obtaining, giving, or sharing access to a transport asset, coordinated through membership-based services (Botsman & Rogers 2010), typically managed through smart device software 'apps'. This type of transport option belongs to shared economy mechanisms that enable companies to offer a specific kind of service rather than simply sell assets as products.

The shared economy facilitates a redistribution market, where people with no personal relationship commercially share a collectively owned and managed asset. With shared mobility, users do not separately pay the full costs of the asset, insurance, fuel, maintenance, or parking in designated spaces. Instead, they are charged for the time of the vehicles used, or the distance covered, or a combination of two, often coordinated through an online process and paid electronically (Cohen & Kietzmann 2014). Although the service may have commercial motivations, Hamari et al. (2016) noted that environmental sustainability goals or enjoyment often drive participation in the shared economy in sharing otherwise unaffordable assets.

Commercial shared mobility services differ significantly from the concept of ride-sharing or car-pooling, where participants compromise their personal travel scheduling flexibility to share a vehicle to reach a similar destination as part of an interpersonal agreement (Habib et al., 2011). Commercial shared mobility services such as bike sharing or car sharing are based around the sharing of a physical asset between many strangers, rather than travelling on a shared journey. In the case of the commercial shared mobility services such as Uber, they act as a taxi service, with the user determining the trip and the provider (owner of the asset), obliging, rather than seeking to share a ride to a common destination. 'Ride-sourcing' commercial shared mobility services differ from 'ride-sharing' services with the former operating for profit by providing rides as a business service, while the latter typically functions as a not-for-profit service to match supply and demand if the shared trip closely matches their own journey (Rayle et al. 2016). 'Ride-sourcing' such as Uber and Lyft can be differentiated from a traditional licenced taxi business model by the use of an online trip matching platform combined with an efficient electronic payment system, rather than commencing trips from dedicated taxi stands or by hailing a taxi from the roadside. This study discusses shared mobility services from the perspective of commercially sharing a physical asset such as a bicycle or car (and in the future an autonomous vehicle) rather than sharing a ride.

Shared mobility is a consequence of the 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 firstly people perceive the activity positively but do not necessarily translate this into personal action; and secondly there is a lack of experience in the business models developed by service providers (Cohen & Kietzmann 2014). These issues could impact on the quality of 'Mobility as a Service' (MaaS), public transport planning, and day -to- day travel events.

Although typically commercially provided, the influence of government should not be underestimated for emerging mobility services (Dudley, Banister & Schweanen 2017; Philip Boyle and Associates 2017; Shaheen, Cohen & Martin 2010). For example, in some locations, ride-sourcing services operate on public roads providing disruptive services to the frustration of policymakers (Dudley, Banister & Schwanen 2017). In the United Kingdom the battle between Uber and Transport for London has played out for many years, and in 2017 the policy agency refused to renew Uber's licence to operate for several months claiming the company was not a "fit and proper" operator of taxi-type mobility services. Shared asset services such as bike and car sharing often collide with policymakers over access to public assets including footpaths (sidewalks) and on-street car parking places, as well as other policies (Shaheen, Cohen & Martin 2010). These interactions with government policies can greatly affect the success of shared mobility services.

This study maps the barriers to shared mobility services by drawing on both the emerging literature, and a series of in-depth interviews with service providers and policy makers. The study uses learnings from the literature review to shape questions put to service providers, lobby groups and policymakers to understand the issues in developing effective and sustainable shared mobility services. The interview questions covered the development of shared car (hybrid & electric vehicles, autonomous vehicles) and shared bike (manual & electric bike) services, as well as policy, strategies, incentives, legislation, partnerships and future development plans. The data was analysed to identify common development issues and major barriers. These were then compared to international best practice and suggested recommendations for each stakeholder group. This study concludes with a summary of the main themes covered.

2. Literature review

2.1 Car sharing

The growth of sharing economy mobility services has been mirrored by a requisite growth in the academic literature describing various aspects and issues relating to the development and operation of car sharing schemes.

Typically the 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 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. 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). 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.

Users of both services typically reduce their annual vehicle kilometres travelled, and greenhouse gas emission impact, by choosing other mobility options when a vehicle is unnecessary and may achieve considerable net mobility cost savings (Martin & Shaheen 2011). The beneficial impact to the wider community may include lower levels of congestion, local pollution, kerbside parking demand and increased local economic activity. The environmental benefit of car sharing may extend to the purchase of a higher cost but higher performance vehicle, relative to the likely purchase of the individual owner-driver. For example, a car shared by many end-users may be an electric or hybrid vehicle which may have been cost prohibitive to individual owner drivers. Yet, the community benefits of car sharing services may not be substantial if the new service replaces existing public transport alternatives or taxi services, or adds to net car parking demand, or adds to congestion by increasing the net use of cars to the detriment of walking or bicycle use.

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). Whilst this initial growth has been supported by policymakers, the availability of dedicated on-street parking locations has often lagged the demand for spaces from service providers. Policy support at state government level has enabled the car sharing scheme to spread to other locations outside the central business district such as the Bowden urban renewal project.

Issues confronted in car sharing

Parking

For shared cars, fixed-based car sharing requires dedicated and convenient car parking, often on-street; it is, therefore, reliant on public 'investment'. Having car parking spaces reserved exclusively for share vehicles distributed across the city to provide appropriate coverage of the population reduces the total number of car parks available for non-scheme members and can result in community resistance (Philip Boyle and Associates 2017). This requirement can occur in neighbourhoods where parking places are limited or may be otherwise allocated to the local community as a privilege (Le Vine et al. 2014). London's experience is noteworthy when from December 2012 to May 2014, a small-scale scheme of approximately 30 point-to-point car sharing cars operated within limited boundaries of one of London's boroughs (districts). Although there were plans to expand this subject to wider agreement with street-network-management agencies for access to on-street parking spaces, the service was withdrawn in May 2014 when access rights could not be obtained (Taylor 2014).

Similarly, although the Adelaide City Council set a policy goal in 2012 of 100 share cars in Council district by 2020, implementation of the policy has significantly lagged that goal with less than 20 parking spaces allocated to commercial services by 2017. Here we can see the tension between the demand for dedicated parking locations from share car service providers, and sensitivity over local community concerns about the loss of limited on-street parking. This tension is observed for car sharing schemes in many cities (Shaheen, Cohen & Martin 2010). For private car users, the local community will more likely notice share car vehicles when they are not in use than in use, frustrated by the associated parking space they cannot use. This can cause tension and lead to community resistance, particularly from those who are not currently interested in using the service.

On-street, public off-street, free and reduced parking cost are key enablers of car sharing growth worldwide, as parking facilitates exposure and convenient vehicle access (Shaheen & Cohen 2013). Philip Boyle and Associates (2017) suggest policymakers will play a key role in the success of share car schemes through the allocation of on-street and government managed off-street parking spaces, discouraging private vehicle car parking in public places, supporting the strategic designing of car sharing networks, and establishing agreements with service providers.

Insurance and liabilities

A key barrier to car sharing is the availability and cost of insurance which allow multiple drivers to use a single vehicle on a commercial basis. Shaheen and Cohen (2013) suggest that although vehicle insurance remains a substantial car sharing operating cost, it is no longer considered unaffordable in most markets. They also noted that in Australia and Canada, car sharing insurance had been underwritten by governments through the addition of shared cars within governmental fleets (i.e. government users who have replaced vehicle fleets or augmented existing fleets with commercial car share fleets).

Data security and use

The data collected by car share schemes about personal travel behaviours may also be of concern to users. The liability aspects of privacy for personal travel remain unresolved, and the security concerns are possibly a critical barrier for some people in their use of shared mobility services (Kodransky & Lewenstein 2014).

Impacts from other policies

Many other government and business policies can complement or hinder the introduction and growth of car sharing schemes. Some of the key factors influencing the growth of local car sharing schemes include population density, the availability of alternatives to car trips, the convenience and reliability of car travel, and the availability of affordable parking (Philip Boyle and Associates 2017). For example, car-sharing schemes are more likely to be successful where policies have encouraged higher residential density, discouraged private vehicle ownership or parking, provided convenient dedicated share car parking locations, and created awareness of the environmental impact of private car use.

Business model

The business model is evolving to provide new opportunities for car sharing. No longer is car sharing about neighbourhood schemes in mostly residential areas, with schemes expanding to replace government or institutional fleets or university campus fleets, whilst also being available to scheme members. Car sharing schemes are also expanding to airport locations as an alternative to traditional 'car rental' services. This dual role of sharing assets between institutional and public members can substantially increase vehicle numbers and availability whilst serving large trip generating locations. Shaheen and Cohen (2013) provide an overview of the most common business models:

- neighbourhood residential: local vehicle access
- business fleets: reduce or eliminate private vehicle fleets typically maintained exclusively for commercial business purposes
- university fleets: vehicle access at colleges and universities or adjacent to campuses whilst also shared in a neighbourhood context
- government and institutional fleets: shared vehicles replacing dedicated governmental or institutional fleets
- public transit extension: vehicle access at a public transit station, airports or multi-modal nodes providing 'first/last mile' services

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 the door-to-door travel benefits of private ownership 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 the autonomous vehicles may be less technical and more likely economic due to high initial costs (Fagnant & Kockelman 2015). Other challenges include legal liability, security and privacy.

SAVs are likely to improve road safety, and it is claimed that AVs could reduce 90 per cent accidents (Litman 2017). However, social and moral dilemmas remain in the design of the automation algorithms. Bonnefon, Shariff and Rahwan (2016) conducted six studies on the social dilemma of an autonomous vehicle and found that participants strongly agreed that it would be more moral for SAVs to sacrifice their own passengers when this sacrifice would save a greater number of lives overall. For car-makers and regulators, this presents a dilemma securing public acceptance for SAVs.

The question of whether SAVs will reduce traffic congestion has two opposing influences. Firstly, SAVs should be able to safely travel closer together than human-driven vehicles and interact electronically to avoid collisions thus allowing a higher volume of vehicles to move smoothly through the available road system, therefore reducing congestion. But new SAV mobility services may also satisfy unmet demand for trips, particularly from those who are unable to drive, thus increasing total vehicle numbers and congestion. The Institute of Transport and Logistic Studies (ITLS) conducted a quarterly survey and claimed that road congestion in major Australian cities is unlikely to ease with the arrival of SAVs and could be worse than it is today. The Director of the ITLS, Professor David Hensher, suggests that the government may have to impose a levy on the use vehicles in order to combat increasing congestion, although such schemes are politically difficult to introduce (Institute of Transport and Logistics Studies (ITLS) 2016). SAVs and automated driving are most likely to lead to a world where individual car ownership diminishes (Ohnemus & Perl 2016). Through their potential to connect the first/last mile of trips in low-density areas, integrating SAVs with public transport systems could substantially increase synergies between automotive and rapid transit (Ohnemus & Perl 2016), and reduce the need for large-scale and costly car parks (Fagnant & Kockelman 2015).

SAVs inherit many of the car-sharing service issues, with the added challenge of public liability. Further research is necessary to address these issues and determine appropriate standards for liability, security, and data privacy (Fagnant and Kockelman, 2015). Many of the congestion saving improvements depend not only on automated driving capabilities but also on cooperative abilities through vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I) communication.

2.2 Bike sharing

The literature has discussed shared bicycles as ‘bicycle sharing’, ‘bike share’, ‘public bicycle’ or ‘public bike’. This research discusses commercial bike sharing schemes which typically target users interested in leisure-oriented or short-distance commute 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 provide 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 demand and represents an eco-friendly mobility solution (Shaheen & Chan 2016)

The development of bike sharing

Since the first bike-share programme in 1965 in the Netherlands, public and commercial share bike schemes have become a worldwide phenomenon, transforming the concept of mobility in many cities. By 2014, public bike sharing schemes, mostly docking station type, were available in 50 countries on five continents and in 712 cities and were growing in popularity. More recently the introduction of dockless share bike schemes seen a new wave of shared mobility services spread and then retract in many large cities.

The modern concept of a public bike sharing scheme is illustrated by the coin-deposit system called Bycyken (City Bike) which was launched as a large-scale urban bike sharing program in January 1995. It is has spread rapidly with over 1,100 specially designed bicycles in lockable docking stations placed throughout downtown Copenhagen, rented with a 20 DKK (Danish krone, approximates US$3) coin deposit refunded on a bicycle’s return to the same or another docking station location (Davis 2014). These schemes have evolved to use global positioning systems (GPS) to provide information about local availability (Romanillos et al. 2016). The Vélib’ system in Paris, implemented in 2007 is an example of a modern docking scheme and has quickly expanded to 20,600 bikes and 1,451 stations (Shaheen, Guzman & Zhang 2010).

The schemes continue to evolve with innovations such as ‘geo-fencing’ which uses GPS to keep bicycles within a geographic area and alerting bike-sharing operators when bicycles leave an allowable vicinity (e.g., SoBi). Differential pricing is sometimes used to encourage self-rebalancing (distribution of bikes), multi-modal access, plus billing and data integration with public transit and car sharing.

Share bike schemes provide many benefits to the local community. For example, the La Rochelle initiative in 1974 proved to be successful and continues to operate today (Davis 2014; Fishman 2016), was developed as an environmentally progressive measure. Other examples include college/university programs worldwide such as “CibiUAM” at the Universidad Autonoma de Madrid (UAM) in Spain and “Velocampus Leeds” at the University of Leeds in the United Kingdom (UK). These bicycles were introduced to reduce campus carbon emissions. Shaheen, Guzman and Zhang (2010) suggested that the most common benefits of bike sharing are private car use reduction, mode substitution, improved human health and reductions in road traffic injuries.

Recently some schemes have incorporated electric bicycles (bike with an electric motor and battery), which enable longer distance trips, encourage cycling on steeper hills and slopes, but less physical exertion requirements. These schemes are particularly popular for users who are commuting or making work trips. However, this would reduce health benefit and raise the issue of electric charging and energy consumption.

Issues confronted in bike sharing

Rebalancing

A major operational cost in bike sharing schemes is rebalancing, whereby the operators shift the bikes between docking stations to better availability to users at all locations. Geo-fencing, which uses GPS or radio frequency identification (RFID) to define geographical boundaries may help rebalancing (Cardone et al. 2014), as would the provision of financial incentives to encourage particular trips. Schuijbroek, Hampshire and Van Hoeve (2017) studied the determining service level requirements at each bike sharing station and designing (near-) optimal routes to rebalance the inventory. They proposed a new cluster-first route-second heuristic, in which a method considers the service level feasibility and approximate routing costs. In light of Romanillos et al. (2016) study utilised big data, including GPS data, live point data and journey data, to gain insights about cyclists' route choice behaviour and their preferred and disliked route characteristics. There is perhaps no alternative, but it requires the bike share operator to collect bikes that become dispersed (for example where one rides home). In the future, perhaps autonomous vehicles could be deployed to fulfil this function.

Access to suitable locations

Bike sharing schemes suffer similar barriers to that of car sharing schemes, particularly around the availability of suitable locations to provide the mobility service. Whereas car sharing schemes are limited by the number of available on-street parking places in locations of high demand, similarly bike-sharing schemes, and in particular docking station schemes, require access to crowded footpath locations at high trip generating places.

And similar to car sharing schemes, the role of government in providing ready access to suitable locations is crucial to the success of schemes. For example, in 2017 Seville, a city with a metropolitan population of approximately 1.5 million, had a bike sharing scheme with about 2,000 bicycles available from 271 stations, with stations spaced approximately 300 metres apart (Faghih-Imani et al. 2017). Through a partnership between the municipal council and private enterprise, the bike sharing scheme delivers an average of over 25,000 bike rides per day. The support from the government goes beyond the provision of docking locations, with the municipal council establishing a 120 km network of cycle lanes city, making it one of the best-served cities in Spain for this clean, green and healthy means of transport.

General bicycling issues

Bike sharing schemes face many of the same issues as general bike riding, including health and safety, and the lack of adequate bike riding infrastructure.

Bike riding comes with an unrecognised social impact with both benefits and risks. Götschi, Garrard and Giles-Corti (2016) conducted a study on two tasks: generalizable epidemiological evidence for health effects and specific impact modelling to quantify health impacts in concrete settings. The authors found substantial benefits from physical activity dominate the public health impacts of cycling, however, injuries amount to a smaller impact on the population level but affect crash victims disproportionately, and perceived risks deter potential cyclists. Risks from air pollution are possible, although there is limited evidence for cycling-specific mechanisms. On the positive side is its potential to provide emission-free transportation, cost-effectively to all potential users (Jacobsen 2003).

The barrier to safe travel is often a significant issue for the cyclist. In a public attitude research survey, Xia et al. (2017) found 'cycling safety concerns and car use comfort' and 'public transport negative emotion' factors were positively related to the annual driving distance of the participants. Both 'sustainable transport benefits awareness' and 'traffic problems awareness factors' were positively associated with the acceptance of measures for sustainable transport planners.

Across Europe and North America, the amount of walking and bicycling varies significantly, from 6% of all trips in the USA to 46% in the Netherlands. Yet the per capita fatal injury rate to people walking and bicycling is similar in the two countries: 1.9/100 000 in the Netherlands and 2.1/100 000 in the USA (Straβenwesen cited inJacobsen 2003). The likelihood that a given person walking or bicycling will be struck by a motorist varies inversely with the amount of walking or bicycling. This pattern is consistent across communities of varying size, from specific intersections to cities and countries, and across time periods (Jacobsen 2003).

The success of bike sharing is likely to be linked to community perceptions and participation in bicycling as both recreation and a mode for commuting. Yang et al. (2010) examined interventions, both social and physical, which aimed specifically at promoting cycling. The research found that community-wide promotional activities and improving infrastructure for cycling have the potential to increase cycling by modest amounts (Yang et al. 2010). Policies for increasing the numbers of people bicycling appear to be an effective route to improve the safety of people bicycling (Jacobsen 2003). Jacobsen argued that the design of bike lanes examines only the immediate area and ignores community-wide effects. Therefore a holistic approach is recommended.

Despite bike sharing's ongoing growth, obstacles and uncertainty remain, including:

- managing future demand
- safety
- sustainability of business models
- limited cycling infrastructure
- challenges of integrating bike-share with public transportation systems
- technology costs
- user convenience (e.g., limited height adjustment on bicycles, lack of cargo space, and exposure to weather conditions).

Increasing immediate access to helmets at the point of departure may help reduce the impact of accidents and in some locations address the barrier presented by mandatory helmet legislation. Current data shows that helmet use across cities was somewhat limited. Depending on the city, 43% to 62% of respondents reported never using a helmet while bike sharing (Shaheen, Guzman & Zhang 2010).

2.3 Business model

User interaction and access

The literature notes a strong relationship between the user experience of the scheme and usage. For example, Lathia, Ahmed and Capra (2012) discussed the London Barclays Cycle Hire scheme implemented in 2010, which allowed for 'casual' usage so that anyone in possession of a debit or credit card could gain access. By analysing pre- and post-policy change, the authors, found not only that quicker and easier access to the system correlates with greater weekend usage, but it also reinforces the week-day commuting trend. A key element of building a successful shared bicycle system is to understand how the designed system characteristics, implemented as policies, affect usage across different markets (Lathia, Ahmed & Capra 2012). For example, Parkes et al. (2013) commented that North American public bike sharing tends to be highly dependent on casual or short-term users (with passes ranging from 24 hours to 7 days) for its revenue. The authors suggested that in Canada, the US and Mexico, bike sharing could target employers, residential developments, and colleges/universities to increase the market share of commuters or more regular users.

Advertisement

Bikes and bike docks are highly visible to both users and non-users, providing an opportunity for a relationship between bike-sharing schemes and advertising. Parkes et al. (2013) discussed the interaction between bike sharing businesses and advertising, noting that it has become common for external operators such as advertising firms to work alongside city authorities in the implementation of bike share schemes. Organisations like JCDecaux and Clear Channel, the two biggest outdoor advertising companies, operate 23% and 16% of worldwide bike-sharing schemes, respectively in Europe. In comparison, there was only one advertising-based bike sharing program launched in North America (SmartBike by Clear Channel in 2008), and it ceased operations in January 2011. These advertisement companies have diversified into bike system provisioning, effectively exchanging advertising rights in return for the provision of bike sharing systems (Parkes et al. 2013). In a sponsorship model, sponsor-based advertising is often used to support bike sharing capital purchases rather than as a means to sell advertising as a business.

Entrepreneurs

Entrepreneurs have played a large role in the creation of bike share schemes. Parkes et al. (2013) commented that, in both Europe and North America, a major driver of public bike sharing is entrepreneurs, coupled with transportation planners. The bike sharing operators are policy entrepreneurs who bring expertise and knowledge to the adoption process in their cities, thereby helping to influence the public adoption decision. Rogers (2003) argued that the existence of an innovation champion could have a significant effect on the successful adoption of an innovation by an organisation. Parkes et al. (2013) interviewed innovation champions in five cities – Antwerp, Dublin, Minneapolis, Portland, and San Francisco – and found that an innovation champion has played an important role in the successful adoption of public bike sharing systems. Through the strong support of La Rochelle's urban community, Vélos Jaunes became the first successful bike-sharing program in France. Typically, as public bike sharing becomes more mainstream, it increasingly interacts with different areas of public policy (Parkes et al. 2013). Evidence suggests that policy adoption have been inspired by successful systems and the championing by entrepreneurs plays an important role in promoting bike sharing to policymakers and the greater community.

Partnership

A public-private partnership can also play a vital role in the development, funding and management of local bike sharing schemes. Shaheen, Cohen and Martin (2012) suggested a number of partnerships between government, the private sector, and bike sharing operators facilitated successful programs. Existing and planned partnerships/sponsorships include station sponsors, corporate memberships, or support for free or discounted memberships, are believed to be beneficial for public bike sharing scheme users. Shaheen, Cohen and Martin (2012) conducted interviews with 19 share bike scheme providers and 14 policymakers and found that most of them maintained some form of structured partnership to enable local schemes. The report also noted that bike sharing schemes have benefited from formalised partnerships with car-sharing organisations, public transit agencies, health insurance providers, and commercial enterprises such as hotels.

Financial support

The ongoing financial sustainability of the scheme is an important aspect of the development and expansion of bike sharing. As mentioned above, there are significant differences in the management and funding of bike sharing schemes. North American programs emphasise the use of sponsorships to support program costs rather than advertising agencies as program funders and operators. Not-for-profit schemes (e.g., BIXI Montreal, Nice Ride Minnesota) are the predominant business models, followed by publicly-owned/contractor operated models, and not-for-profit vendor operated models (e.g., DecoBike, Bike Nation, SoBi) (Parkes et al. 2013). Amongst 11 interviewed companies, Shaheen, Cohen and Martin (2012) found user fees covered between 46% to 100% of full costs, averaging 74%. Only five operators stated that their programs were close to being self-sustaining from user fees. One operator stated that its sponsors covered all the costs, and another reported that about half of its funding came from sponsors and half came from users.

2.4 Integrated multi-modal mobility

Integration

Public transport services are unable to bridge all locations, providing the opportunity for the 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 the 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).

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).

Actors may need to establish different types of relationships to enable sharing mobility services. For example, the government typically acts as a regulator or consumer of commercial services, but in the case of car sharing, the government may need to 'partner' with a commercial enterprise in the allocation of scarce parking places. Cohen & Kietzmann (2014) describe this as a merit-based business model, whereby service providers and government can achieve a common objective of environmentally sustainable mobility through shared mobility business models (Cohen & Kietzmann 2014). Without these joint responsibilities, multi-modal shared mobility will not be able to thrive.

A new business model

The evidence from successful sharing mobility schemes is that new business models consisting of new business rules, behavioural norms and success metrics may be necessary to overcome barriers and support the growth of shared transport mobility services (Boons & Lüdeke-Freund 2013). These imply that introducing a sustainable innovation requires a far-reaching approach to change business models at the company level while taking into account external barriers imposed by the wider environment of the respective production and consumption system. Three factors appear to be most important with regard to sustainable business models: technological, organisational, and social innovation as suggested by Boons and Lüdeke-Freund (2013). Their study suggests sustainable business models with a focus on technological innovation are market devices that may overcome internal and external barriers to marketing strategies. For multi-modal shared mobility, a successful business model is the ability to act as a market device that helps to create and further develop multi-modal shared mobility with improved environmental sustainability and convenient public travel as the social purpose.

Van Malderen et al. (2012) suggest that firms need to combine a value proposition, with the organisation of upstream and downstream elements in the value chain in order to bring sustainable innovations to the market. For example, the promotion of share bicycles may be more appropriate for small workplaces with short distance travel needs, while larger workplaces and those located in built-up areas or city centres are more suitable for linking sharing schemes with the promotion of public transport.

A broader policy framework may be necessary to support new sharing mobility services. For example, governments or firms that have policies to encourage walking, cycling and the use of public transport in preference to the car are more likely to make multi-modal services more successful. Policy sets that improve city and suburban transport infrastructure and a culture of supporting an open-minded public may be the key to multi-modal mobility sharing thriving. In addition, financial incentives, provision of facilities, diffusion of information and parking management all play an important role in mobility management. Looking into the future, policy settings could support two new sources of innovation: organisational advances in on-demand mobility and the technological breakthroughs of autonomous vehicles (Ohnemus & Perl 2016).

Public preference

Attractive alternatives to private cars can support existing multi-modal travel patterns and encourage a willingness to abandon, or at least reduce the use of, the private car. It is claimed that by 2030, one out of ten cars sold could be a shared vehicle (Kaas et al. 2016). Subsequently, there is expected to be a rise in the market for fit-for-purpose mobility solutions. Kaas et al., (2016) stress that consumer mobility behaviour can be changed through promoting multi-modal mobility campaigns. In addition, factors such as residential-self-selection, skills, qualifications, amenity, income, the presence of transport infrastructure and urban structure impose powerful influences on commuting behaviours (Humphreys and Ahern, 2017, Bhat, 2000). Such an automotive revolution and behaviour change are most likely to occur during rapid population growth and structural change in a suburban area (Forsey et al., 2014). People embracing multi-modal mobility behaviour are found to be more open-minded about shared mobility systems (Nobis, 2007), and highly educated and relatively wealthy people (such as millennials) are more likely to use shared mobility (Alemi et al. 2017). Other mechanisms

change accelerate a change in the public preference for transport modes. For example, common ticketing systems across all modes of transport, as well as the provision of multi-modal and inter-modal traffic information to help link-up different modes of transport, will encourage people to take advantage of the benefits of each mode (Kopp, Gerike & Axhausen 2015). Public preference is very important in promoting multi-modal shared mobility. Shirky (2011) suggested a business that creates a product for the users who would like to take care of others would be a better predictor of success than creating a new business model.

2.5 Advanced technologies for shared mobility

Four main technological advances are enabling the growth of sharing economy 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).

Big data and Internet of Things

Big data relates to massive data sets that have a large, varied and complex structure with the difficulties of storing, analysing and visualising for further processes or results (Sagiroglu & Sinanc 2013). Big data requires tools to collect information and facilitate utilisation. The IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction (Atzori, Iera & Morabito 2010). Big data and the IoT are destined to revolutionise the way public transport operates, will enable adaption to travellers' mobility needs and will help optimise transit planning, scheduling, and operations (Fonzone, Schmöcker & Viti 2016). For example, big data sets can be used to identify the optimal positioning of bike sharing docking stations to maximise usage (Gutev & Nenko 2016). Similarly, the IoT and social media can provide a richer end-user sharing mobility experience with instantaneous information flows about the scheme such as the number of bicycles available, the number of available docking spaces for returning bicycles, and the general traffic conditions for bicycles near that location (Piramuthu & Zhou 2016). Big data may be especially important for multi-modal shared mobility through its application to match transport demand and supply.

On the other hand, the concept and use of big data does have some limitations to the application of mobility solutions. Big data doesn't contain future scenario data and lacks suitability for network planning and design and in evaluating the impact of new services. A combination of the present (revealed preference) data and future (stated preference) data could be a new approach. Cheng and Chen (2016) combined big data from smart transit cards and combined stated preference data from choice scenarios to estimate a value of reliability. Big data also lacks qualitative descriptions of the context of people who are travelling in urban spaces for a different purpose by using shared mobility (Lathia, Ahmed & Capra 2012). Nevertheless, big data has the potential when managed with appropriate programming (perhaps aided with Artificial Intelligence), to revolutionise future mobility, helping to coordinate the growing number of transport modes, enabling the system to be much more responsive to community travel needs.

Cybersecurity

When big data and the IoT are playing prevailing roles in shared mobility, cybersecurity will become very important. As digital citizens are more and more instrumented, and streams of data describe their location and activities, privacy may become a bigger issue. Von Dollen (2009) suggests that cybersecurity is a critical issue due to the increasing potential of cyber-attacks and incidents against this critical sector as it becomes more and more interconnected. Intelligent transportation, public and private, will likely access a web of interconnected data from GPS locations to weather and traffic updates (Von Dollen 2009). Integrated systems should aid public safety, support emergency responders, and help in disaster recovery. Cybersecurity will also be important to prevent illegal access to information and to prevent attacks causing physical disruptions in service availability. Privacy protection systems that gather data and trigger an emergency response when needed are required technological challenges for ensuring cybersecurity.

Blockchains and other transfer mechanisms

Commercial shared mobility services are sustained by the timely and secure transfer of financial resources, mostly between users and operators. When multi-modal shared mobility becomes commonplace, it is likely to be accompanied by improved payment or ticketing systems that make use of big data and IoT. This may lead to a reduction in transaction costs, and the need to facilitate direct peer-to-peer transactions that eliminate the need for a middle operator (i.e. banks). Blockchain is one mechanism that may provide a viable method of peer-to-peer funds transfer between parties that do not trust each other, and without the need for a central financial authority with associated costs. It is envisaged that advances in funds transfer mechanisms will complement Mobility as a Service (MaaS) through simplified secure and direct payments without a financial institution as an intermediary (Andersson & Torstensson 2017). The mechanism of a new IoT E-business model can be found with more details in Zhang and Wen (2017). A blockchain or similar method could be an important tool that enables the convenience of shared mobility services for new transport adopters. Blockchain has already been applied in the financial industry, but its adoption in transport mobility might be constrained by the need for legislation, infrastructure, and other services (Andersson & Torstensson 2017).

2.6 Government

There are many barriers to the disruption of the incumbent paradigm of private car use as the dominant mobility service for many cities (Kent & Dowling 2018). As we have seen in the discussion above, Government policy makers may play an important role in the development of sharing economy mobility services through a range of initiatives from providing access to suitable locations, promotional support, and event partnership. In deciding to champion new mobility services, Kent & Dowling (2018) argue that urban policymakers may

need to accept that the new service is imperfect and in development and that policies might, therefore, be needed to support new systems through periods of the establishment. But what is the basis for policymakers to support disruptive mobility services? This section explores shared mobility services as a 'merit good' that warrants policy innovation.

Policy intervention

Shared mobility services represent merit good. Ver Eecke (2003) explained merit goods are tools that institutional policies impose on the free market to interfere with the wishes of at least some consumers. Although similar in many ways, the differentiation between public good and merit good is based on three criteria, that a merit good:

- has the intention to interfere with consumer behaviour
- is justified on moral grounds
- is financed in a different form

Cohen and Kietzmann (2014) claimed that most public transit systems could be classified as a merit good. Even though fees are charged to transport users, the majority of transit systems are subsidised by the government to allow individuals with a range of income levels to have access to the system. Cohen and Kietzmann suggested that existing shared mobility business models can be seen as a merit good and could be supported as a mode of public transport. The merit good concept can help achieve the common objective of environmentally sustainable mobility and a strengthened relationship between service providers and the local governments. Besley (1988) concurs, mentioning three main arguments which are typically used to justify government intervention:

- distributional arguments
- market failure arguments
- merit good arguments

Here merit good arguments could allow governments to apply a specific form of intervention to consumers' preferences, such as converting some residents' travel preferences to shared mobility services. Cohen and Kietzmann (2014) claim that many private sharing scheme operators, to date, have opted to avoid interaction with local governments, and equally, government has chosen not to interfere and let the businesses run as a private business. Consequently, private and public shared mobility models encounter difficulties as they have ignored that this conflicts with the value a merit model can provide.

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 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 merit good.

Cohen and Kietzmann (2014) recommended moving towards merit-based business models as those which may offer a more optimal alignment between the service provider and government objectives. Shared mobility service providers may benefit from collaborations with governments to achieve long-term viability. Any direct financial support or incentives or the application of big data into transit applications, could result in a reduction in private car use and reduce the costs for public transport users. Other business models such as non-profit, publicly owned, and sponsorship-based bike sharing programs commonly rely on public funding to support all or a portion of the capital acquisition and operational costs. Similarly, public on-road car parks are provided by the council for a shared car. When the public or government fund shared mobility, it gains a better image and higher acceptance by residents.

Policy innovation

It is argued that the development of policies can be understood much better by studying the role of actors in the system (Peck 2011). The policy transferring process must itself be understood as an institutionally produced and embedded phenomenon. The characters, causes, and consequences of such a process are more likely to be recovered in the efforts of linking specificity and network relations than in the universe of rational-actor models (Peck 2011). Peck was in alignment with other researchers, such as in Marsden et al. (2011), who stated that the notion of policy learning was a social process built around curiosity, exchange and trust. Informal networks and information sharing through professional contacts are the predominant and efficient methods of initial knowledge transfer.

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. Also, 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 emphasised, the academic research 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.

A recent study on multi-modal travel research found that only 28 % of Americans solely rely on a car during a week, and 79.8 % of weekly multi-modal users reported walking as their only other mode of transport in 2009, with the results also showing that about one in four American car users make at least 7 trips by walking, cycling, or public transportation during the week (Buehler & Hamre 2015). This demonstrates the concept of a continuum of mobility services ranging from mono-modal car users to those that exclusively walk, bicycle, or use public transportation for their main trips, with multi-modal users positioned in-between and perhaps being the majority. This suggests that multi-modal mobility sharing may be a type that fits comfortably into the continuum of mobility situations. This is important for transportation planners and policymakers because providing infrastructure for walking, cycling and public transportation, affects a larger share of the population than what is suggested by trip based analysis. These findings may be useful in generating policies to achieve an increased shift to shared mobility options.

Policy communications

The adoption of policies is linked to the success of communicating the benefits. Social media has been perceived as one medium to assist in reducing the knowledge translation gap, creating communities of practice and reducing traditional hierarchical divisions (Roland 2018). By exploiting the peer-to-peer nature of the medium, policymakers may benefit from utilising social media as a means of transferring their vision and goals for this new transport option, and to engage new audiences. Other policy ideas have been successfully communicated via social media. For example, in a campaign to reduce drinking and driving, an economic effects analysis indicated that social media, as a means of policy implementation, 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 policymakers and other stakeholders. Social media has the power to dramatically increase our ability to share, cooperate and take collective action without traditional institutions and organisations (Rheingold, 2003; Shirky, 2008).

Many different forms of media have led to dramatically increased social visibility and to profound consequences from commerce and government to media and religion (Shirky 2008). Media can also have negative effects on freedom that impose damage to relations between the media and the government, for example, media impact in the run-up elections (Shirky 2008). Campaigns in media to convince a potential shared mobility user to become an actual user would receive both negative and positive effects. These phenomena act as a catalyst to motivate the public or society to decide which group to try to oppose actively. It is unavoidable to see a small group of non-shared mobility users who can impact (distort) the larger population. However, policymakers should seek the long-term benefits these tools promise, even though that involves accepting short-term complaints.

2.7 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 growth. In order to accelerate adoption, they will need to be supported by smart technologies and government policy interventions, and in turn, shared mobility services can support technology growth and improved social policy.

Through the review of the literature, the benefits and barriers of the shared car and shared bike schemes were categorised and discussed. These findings are summarised in Table 1.

Car sharing and bike sharing schemes experience few similar challenges with their business model, and in attracting more users. Both car and bike sharing schemes face the challenge of access to suitable locations that match demand. Car sharing is shown to have very specific challenges regarding insurance and liability, while bike sharing requires policy support to improve health and rider safety, rebalancing of bikes to meet demand, and financial partnership.

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

The success of commercial shared mobility services will be driven in part by the digital technological revolution and the establishment of new business models, often in partnership with various levels of government. Blockchain and cybersecurity could be technologies the transfer to the transportation field, although they would probably benefit through learning the experiences from the finance or energy sectors where peer-to-peer trading has been facilitated. 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 still a lack of richness in qualitative data demonstrating travellers' preferences with regard to forecasting demand and supply. New concepts like SAVs may further complicate forecasting by creating new demand for mobility.

Policy intervention is an important factor in the success of sharing economy mobility services, with many case studies noting the importance of government as an enabler of location access, promotion and support. 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 and maybe the most cost-effective way of accelerating uptake. SAVs may also address unmet demand for mobility creating new challenges.

In conclusion, there is a 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.

Table 1 Identified benefits and barriers to shared mobility and technology and policies

		Benefits		Barriers and difficulties	
1	**Car sharing**	• Promotes an economic transport mode • Economic gains • Improved sustainability • Enjoyment • Improved lifestyles • Time savings • Saves valuable urban space •Cost savings	• Enjoy car but unaffordable • Preference not to buy a vehicle • Open to renting their car to neighbours • Saving on annual parking costs • Reduced cost of car operation and ownership	• Lack of public policy implementation campaign in public policy • Need a suitable business model • Backdrop of a digital technology revolution, massive flows of information • Lack of online security • Fragmented politics and government inexperience	• Requires car parking, on-street parking spaces are not easily obtained • Car-sharing insurance requires approval by governmental policies • Lack of privacy for personal travel • Challenge in achieving synergies between autos and transit
	Shared Autonomous Vehicles		• Reduced traffic congestion (by imposing a levy on the use of private cars) • Improved traffic safety • Reduced parking demands • Reduced rates of individual car ownership		• Social and moral dilemmas presents a challenge in automation programming • Absence of vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I) communication • difficulties in insurance liability • Substantially increase synergies between autos and transit
2	**Bike sharing**		• Complements the first/last mile of urban travel • Provides 'green' transportation • Reduces private car use •Transit mode substitution • Health benefits • Reductions in road traffic accidents if combined with cycling oriented measures		• Data on the health impact of bike-sharing lacking • Rebalancing bikes across the network over time • Lack of optimal routes that facilitate rebalance • Lack of big data support, including GPS data, live point data and journey data • Risks from air pollution • Limited cycling infrastructure • Challenges in integrating bike sharing with public transportation systems • High costs to apply smart technologies • Difficulties in fulfil user's convenience in scaling up services to wider areas • Challenge of rider safety and poor safety perceptions • Limited advertising budget • Requirement for strong entrepreneurs •Requirement for a strong organisational strategy that is innovative • Lack of joint partnership • Lack of financial funding • Poor implementation approaches for emission-free transportation
	Shared electric bicycles		• Encourage cycling in hilly areas • Lessen physical exertion requirements • Enhanced commuting convenience • Encourages wider cycling participation amongst elderly and other less physicsally active groups		• Electric charging infrastructure in public places is lacking
3	**First/last mile multimodal sharing**	• Improve attractiveness and efficiency of public transport • Create an integrated and attractive sustainable transportation system • Serve transport with lower density • Achieve sustainable and low carbon urbanisation • Enlarge public transit capacity with low cost and time-consuming • Offer an alternative to the single occupant auto • Enhance travel efficiency		•Poor implementation of policies and strategies • Require support to promote consumer mobility behaviour • Low quality of transport infrastructure • Require an integrated ticketing systems across all modes • Lack of intermodal traffic information • Require an improved collaborative relationship between service providers and the local governments • Lack of educational material • Difficulty in changing business models • Lack of a focus on technological innovation and marketing • Need a precise value proposition • Lack development in an organization's value chain and a financial model • Lack of appropriate city and suburban structures • Limited public perception	
4	**Technology of IoT, Big Data, Cybersecurity and Blockchain**	• Enable a ticketing system for a transport network without requiring human-to-human or human-to-computer interaction • Lower transaction costs • Enables peer to peer transactions		• Loss of privacy • Past data lacked capacity to explore scenarios and limited in its application to network planning, design and evaluation • Big data lacked qualitative descriptions of people's needs • Constraints posed by legislation, infrastructure, and sufficient supply of transport services	
5	**Policies**	• Powerful and direct market intervention • Improving social equity in transport provisioning • Providing financial support or incentives • Facilitating the application of big data to transit applications • Reduction in private car usage • Reduced transport costs • Building the necessary network relations between the private and public sectors to deliver Mobility as a Service (MaaS) outcomes		• Ignore conflicts of a merit model for shared mobility • Lack of information necessary to optimise income distribution • Taxation challenges • Lack of quality and trustworthiness in current evidence based research • Difficult in establishing peer-peer exchange networks • Difficulties and challenges in establishing appropriate digital platforms • Difficulties in utilising social media tools	

3. Data collection and analysis

Based on the findings of the literature review by looking at all the major issues worldwide, four sets of literature review questionnaires (see Appendant A1-4) are plotted for four types of respondents, these being the large organisations, service providers, lobby groups and policymaking bodies. These questions were sent via email to each invitee. From April – July 2018, 17 participants from industry were interviewed, and the majority of interviews were conducted face-to-face while online discussions were held with interstate and international participants. In which, there are two large organisations; three lobby groups representing of car, bike and autonomous vehicle; nine policymakers from different levels of governments and three service providers for car and bike. Also, five academics were interviewed, and they presented their opinions in this discussion of shared mobility issues.

The interview data was recorded in a voice recorder and transcribed in the text. The in-depth interview transcriptions were analysed using NVivo software. The data was coded with nodes, and the results were extracted from various charts, maps or clusters. The software produced a number of maps (few maps are listed in Appendix B) which helped in understanding various barriers and their severity informed by the several stakeholders in their interviews.

3.1 Shared mobility perceived barriers

The barriers for shared mobility are many and varied, creating quite a complicated diagram (See Figure 1). Many of these barriers are cultural, social or psychological. These are more challenging and take more time to overcome than technological barriers and involve changing the behaviour of populations. The Barrier of acceptance is a major one. The public has accepted cars as the ideal form of transport for a long time now, and few are prepared to sacrifice 'convenience' to move to a lower environmental impact.

Shared cars

Shared cars have many advantages for reducing car ownership, reduced cost on car registration, insurance, maintenance and parking spaces. The unrecognised cost of owning a car might be the depreciation of vehicles, and this is something more people need to be aware of. Shared cars can save household expenses. If people use car sharing, a good outcome will be increased community connections. Car sharing needs support with certain initiatives, for example, carpooling and restrictions on driver's licenses. Car sharing is a future trend especially when autonomous vehicles are coming into use, so car sharing needs better management with reference to parking, liabilities and insurance.

Shared bikes

Shared bikes have been promoted as having a strong environmental benefit where there are fewer carbon emissions. Bike riding can improve people's health, but on the other hand, there is the danger of riding safety risks in a low bicycle riding environment where car drivers perceive the road is predominantly for them. Riding a bicycle has its motivations that can be related to individual financial gain, overall cultural change to a sustainable environment, and resolving the high-density population transport problem. Communication with the general public to increase awareness of a bike's benefit would help promote this activity. Safety bicycle riding advertisements and social media play an essential part to help inform the public to build cycling habit.

At present, bike sharing is experiencing difficulties in terms of infrastructure (parking dock) or reallocating (balancing) bikes at convenient locations, which normally requires a high management fee issued by the service provider. It is also reported the bikes are often stolen, and their maintenance is somehow a handicap. For a large proportion of the population, wearing a helmet is not accepted for riding a bike.

Shared bikes require a partnership with many different stakeholders including commercial partners, entrepreneurs, government departments, health organisations, local schools, mapping partnership, service providers and volunteer organisations. The government is the most important partner, and its endorsement of bike riding would be especially useful. Currently, because there is a fear of bicycle docking disasters in public areas and pedestrian spaces, the state government does not permit more bikes to be released in the urban area. The government also has the power to regulate shared zones for a separated bicycle lane.

Improving bike sharing should cover cycling infrastructure which means a bike cage, separate bike facilities and reduced vehicle speed. The community engagement, consultation platform, and educating the public about cycling benefits should also be considered. The last is financial support (rebates and tax rebates) to promote bike riding.

Shared bike barriers

Bike sharing's biggest problem is the cause of its biggest issue of safety. For example, if people complain a bicycle is not safe this means a bicycle is not being ridden, he/she might perceive this to be due to the lack of bike lane facilities. Is it possible to improve the bike lanes? Policymakers argued that it is too costly to redesign bike lanes, as they are not the major road users and they should not be funded. This means there are even fewer people (or memberships) riding bikes. In addition, transport policymakers have not put in place a seamless integration of safe bike docks. As a result, there is a snowball effect with more private cars, larger cars on the road, less physical fitness, higher possibility of being exposed to vandalism and poor availability of shared bikes. Wearing a helmet has been discussed as a handicap that stops people from riding bikes. It should be a freedom of choice matter, and insurance companies should change their claim their policies relating to helmet wearing.

If the government plays a leadership role, this means promoting physical fitness by using more bikes (or shared bike). In this way, government policy would need to allocate more funding for a street redesign, to join a partnership, to improve the quality of public transport for seamless transport modes integration, to provide separate bicycle lanes, and to establish bicycle docks at public transport stations.

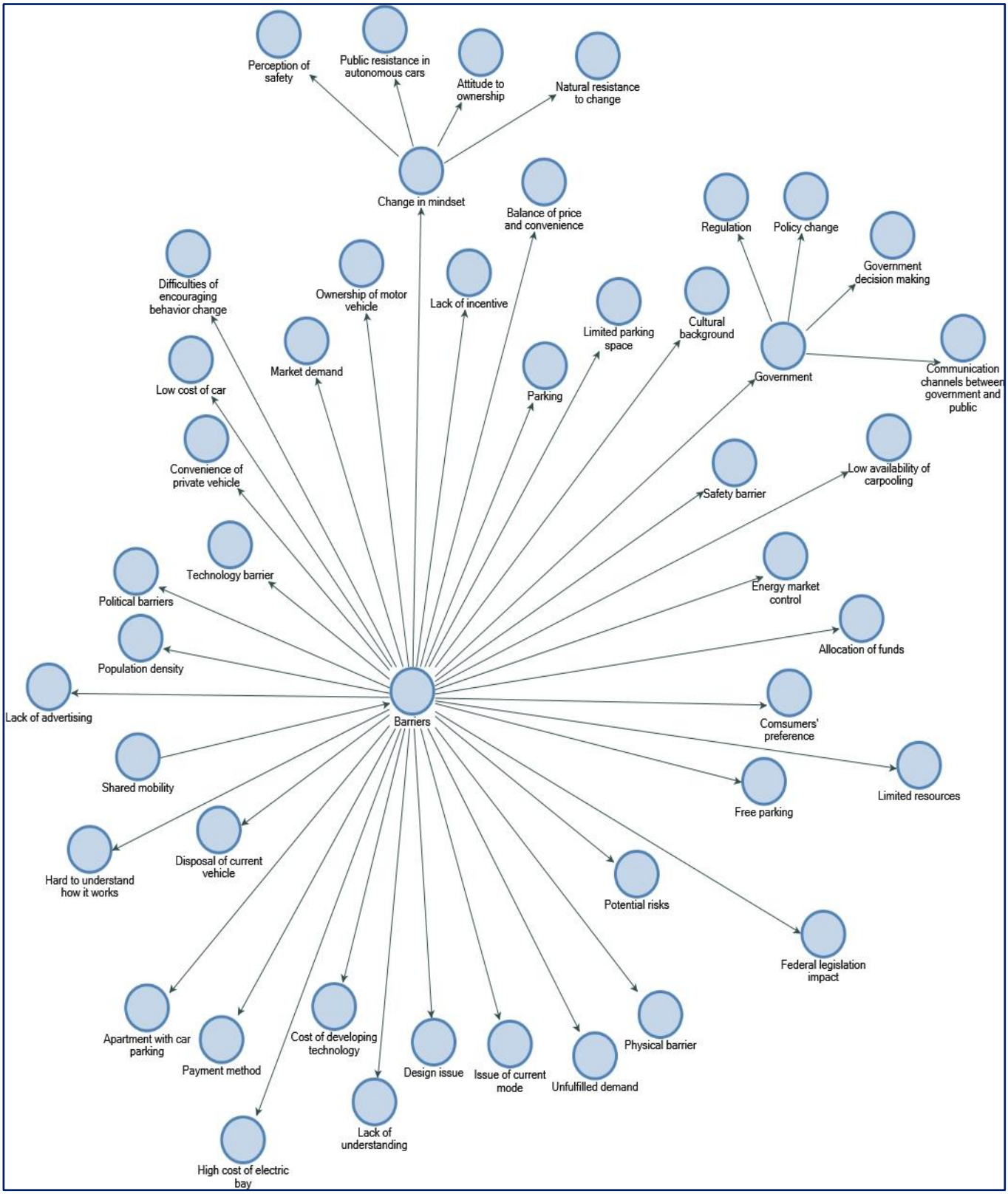

Figure 1 Shared mobility barriers hierarchy chart

Shared electric vehicles

Shared electric vehicles normally suffer high costs associated with power, service and purchase. They will utilise solar energy but still encounter problems when charging up and even though electricity can be sourced in solar panels, there is high competition with other energy resources. Despite the high benefits of low carbon emission, the public takes the view that electric cars are 'not worth investing in now' due to the current problems. The battery development needs to be further examined as do the viability of government subsidies and incentives and the creation of an electric car battery charging infrastructure.

Shared autonomous vehicles

Shared Autonomous Vehicles (AV) are still in the development stage, and there are different levels of technology involved, especially in terms of signal control. Shared AVs cause less congestion and could improve road safety given that current accidents are caused by careless driving. They could reduce car parking significantly and save more space for residential housing and for businesses. For shared AVs, to the manufacturers, owners and users had different requirements and shared AVs would require a different arrangement, where price, insurance, charging, registration and licensing need to be finalised. Currently, AVs development and activities involved a joint partnership consisted of the manufacturer, a government body, commercial partner and research organisation. It is important to conduct trials on AVs on real road conditions and collect the public feedback in order to increase the public awareness and better understanding issues relating such vehicles; which will change the mindset of people.

Multimodal sharing

Multimodal sharing mobility brings benefits to the community with both cheaper and convenient transport choices and fewer emissions being sent into the environment and would compensate for the damage done by private car driving. There are difficulties in providing shared cars and bike parking areas in public zones and transport stations. There is a better business model with joint responsibilities and partnerships where more effort can put into advertising, improving initiatives and enhancing road safety (especially for bicycle users).

3.2 Shared mobility strategies and initiatives

Shared mobility requires effective strategies and initiatives that support growth and development. It first requires strategies that can initiate a shift from conventional mobility modes to shared mobility. Education on the mode shift can be led by government, especially at the local government or city council. Tax policy has heavily supported private car driving, such as low registration fee, allowing unlimited car life span, and low cost of car parking in the CBD area. If the tax policy can be altered to solve this issue, then shared mobility will experience a different fate. Public transport strategy should be based on residents' preferences and needs, and this can be achieved through consultation with bobby groups and individual residents. The most efficient way to change the public's attitude is to generate a conversation for increased awareness of the benefits of shared mobility.

The leadership in the organisation plays an important role, especially in the policy agencies and big organisations. The propagation from company top management will impact on the strategies and policies through financial investment and action planning.

3.3 Shared mobility and existing transport

Shared mobility should merge with existing public transport systems to target multimodal shared mobility. Shared mobility can compete with private car driving and use other vehicle parking facilities. If public transport cannot provide good quality service, and people will rely on private car sharing or shift from public transport to car sharing. Better quality of public transport would help increase trip link especially for promoting first/last mile mobility sharing. Shared mobility for the first/last mile stage can increase patronage of public transport.

3.4 Policy

Shared mobility is not a new type of mobility service, but it has been introduced on a larger commercial scale. With the benefit of low carbon policy that has endorsed and researched on the importance in the reduction of low carbon purpose, however, the policies on legislation and regulation, promotion and incentives have not yet established. In such as new policymaking area, there needs more support to accept and support policy failure. Policymakers require successful implementation cases as an example but also needs courage to adventure beyond that. Evidence-based research output should play an important role when policies are being developed.

3.5 Technology

Technology that supports shared mobility can focus on the development of hardware for big data collection and analysing the feasibility of internet apps through tools such as GPS, Bluetooth, metromate and sensible metrocard etc. Technology can also be utilised to help avoid road accidents involving for the autonomous vehicles. Cybersecurity and blockchain payment system are new areas that can be investigated further in the transport context. New technology for shared mobility will expand on and replace the current system eventually and can create more jobs.

3.6 Different views from stakeholders

Toolkits for shared mobility

With regards to shared mobility, all stakeholders including large companies, service providers, lobby groups and policymakers are seeking to promote this new transport mode. Some tools now support shared mobility development between the stakeholders and these involve technology, strategies and incentives, policies and promotions, legislation and regulations, partnerships etc., which are listed in Table 1.

There are many differences in identified areas. For example, in technology, all four interviewed stakeholders think that big data, GPS systems, internet apps and blockchain and cyber security are important, while service providers and lobby groups want to link technology to cars and infrastructure, and policymakers focus on better utilisation of the metro card.

In strategies and incentives, companies suggest there should be strategies to reduce cars going into the CBD, and they will promote shared mobility while service providers consider strategies about increasing the awareness of shared mobility benefit and competitive price. Lobby groups try to influence the government's strategies on speed limits, tax interventions and partnerships with shared mobility service providers. Policymakers promote leadership, improving the quality of public transport, consult with the public and conversation with the community from many directions. They also mentioned the City council's education, insurance and mindset, informing shared mobility advantages and the benefit for the community are very important.

On the subject of policies and promotions, organisations suggest that there is a need for stronger policy direction in promoting shared mobility and providing incentives, while service providers suggested that policy makers are slow in making changes and that brings difficulties to commercial businesses. Lobby groups called for state government policies in innovation and incentives on shared mobility, and the need for research output and studies on similar cases. Policymakers said that there are difficulties in filling policy orientation and vacancies, and providing incentives need more information.

In the development scheme area, all interviewed stakeholders want SAVs to be further developed in all aspects, including the public's perception of SAVs, policy change, on SAV ownership and their impact on specific communities.

Regarding regulations and legislation, the organisations expect low carbon-related regulations to reduce private car use, while all other three stakeholder groups did note that the car speed limit should be lower. In addition to those, policymakers advocated more regulated shared mobility services.

On the willingness to start a shared mobility partnership, organisations are keen to join with commercial service providers and relevant bodies for shared mobility development. Commercial service providers look for the chance to align with government as partners. Lobby groups look for partners such as manufacturers, research, government bodies and other commercial businesses. All the stakeholders have raised the importance of partnership.

To improve the current situation regarding support for shared mobility, large organisations want to focus on company mobility service, while service providers called for improved separate bike facilities and reduced vehicle speed. Lobby groups called for community engagement, more car-pooling, and tax rebates for using shared mobility. Policymakers want the public to be educated on the value of bike riding and better cycle infrastructure.

Stakeholders views on shared mobility

There are common features shared by the stakeholders with regard to shared mobility. Table 2 summarises the specific views of each stakeholder on shared cars, shared electric vehicle, SAVs, shared bike and multimodal shared mobility.

Large organisations

Large organisations want more shared mobility, including carpooling on incentives and impact on parking. Electric cars are a possibility, but there are energy difficulties for charging them, such as the cost of electrical power batteries. On the subject of environmental sustainability, large organisations have many employees who prefer to drive a car, so changing their mindset to shared mobility will be challenging. Given that resources are limited large organisation needs look at the administration side of things with free parking, disposal of current vehicle and fund allocation to avoid potential risks. Shared mobility also presents synergies with existing transportation modes, such as public transport.

Service providers

Service providers promote multimodal shared mobility especially for the first mile and encourage preferences on public transport rather than private cars. Service providers suggested that if people don't hold driver's licence, then he is more likely to share a car with others. SAVs have issues with safe parking and market what market demands. Therefore, there is a need to run a program that can investigate the public's preference. Trial and feedback is a great way of changing the public mindset. Because powering and charging infrastructure is essential for electric cars, it is perceived that it is not this is not worth the investment now. For bike sharing, there are issues of lack of safety; people consider weather suitability or unsuitability, lack of parking spaces and vandalism. Bike sharing needs to be promoted on the issue obtaining more parking permission at public transit nodes, better bike logistics and collection and smarter management. Maintenance is another barrier to bike sharing and is difficult to overcome. Shared mobility needs a peer to peer sharing model to be put in place and a higher utilisation rate. Service providers ought to overcome share riding safety barrier, unmatched demand and understand better public's balance point of cost and convenient.

Lobby groups

Lobby groups look for supported initiatives and suitable insurance policies for shared cars, and they have addressed the current policy on depreciation of vehicles is a hidden advantage of car sharing. SAVs has a benefit on reduced future parking provision. Different levels of technology are being tested with the public through trials and feedback, with increased awareness of AVs and enhanced public confidence. Lobby groups have discussed the benefits of shared electric cars, but their current poor availability plus that of charging facilities means that more incentives have to be put in place to support the cost of these cars and services. Lobby groups perceive shared mobility as saving travel expenses and improved health and contributing to a sustainable urban environment. A new bicycle business model is urgently needed to change the current situation, for example, e-bike and peer-to-peer sharing.

Table 1 Tools for improving shared mobility mentioned by difference stakeholders

	Large organisations	Service providers	Lobby groups	Policymakers
1. Technologies	Big data, GPS system, internet apps and blockchain and cybersecurity	Big data, GPS system, internet apps and blockchain and cybersecurity, linked to cars and facilities	Big data, GPS system, internet apps and blockchain and cybersecurity, linked to cars and facilities, crash avoidance, turning system	Big data, GPS system, internet apps and blockchain and cybersecurity, smart metro card
2. Strategies and incentives	Increased strategies for shared mobility	Awareness of benefit, competitive price	Speed limit, tax policies, commercial partner, and government strategies	Leadership in organisation, public transport, consultant, conversation with the community from many directions, council level's education, Government's Insurance strategies, Gradual changes in mindset, Benefit for community, Advantages
3. Policy and promotion	Policy direction, and incentives	Policy is too slow, policy brings difficulties, need policy change	Policy incentives, policy innovation, e government policies, research ut and similar cases	Policy vacancies, policy incentives, policy difficulties, and policy orientation
4. Development	Share mobility impact on road,	public lack of confidence in SAVs	Public lack of confidence in SAVs	SAVs future development: specific community, ownership, policy change, negative future, run as frequent service, ownership, positive future
5. Legislations and regulations	Low carbon related legislation		Speed limit	Regulated service, speed limit
6. Partnership	C commercial service providers or adjacent organisation	Government, public partnership	Manufacturer, research organisations, government body Commercial partners	Recognised partnership
7. Improvement	Company mobility service	Separate bike facilities Vehicle speed Bike path More facilities	Community engagement Tax rebate Other rebate Total of car pool	Education benefit to public, bike cage, Provide bike cage, vehicle speed, cycling infrastructure, bike path

Table 2. Stakeholders' perceptions of shared mobility

	Large organizations	Service provider	Lobby group	Policymaker
1. Shared car	Parking, incentives, carpooling	Driver's license, future development	Insurance, supported initiatives, depreciation of the vehicle	carpooling, charging , parking, insurance
2. SAVs	Lack of confidence	Safety, parking, market demand, public's preference, trial and feedback, insurance, change the public mindset	Parking, trial and feedback, safety Increase awareness, inform public, different levels of technology, Benefit, lack of confidence	Parking, registration and license, SAVs improvement: Impact of SAV
3 Shared electric cars	Business model Battery Cost of electricity power Energy difficult in charging	Powering Not worth investing now Charging infrastructure	Incentives, benefit, cost of service cost of electric car, Low availability of electric car, difficulties in charging	Policy orientation, benefit, cost, charging infrastructure
4. Shared bike	health and safety, shared road, improvement	Parking, maintenance, logistics, communicate with general public, bike collection	Urban environment, e-bike, platform, business model: current situation, peer-to-peer, benefit: income, environment, health, argument: Government view and lobby group's view	Death and safety, provide facilities, bike lane and Parking of bike
5. Multi-Modal shared mobility	barriers, benefit, improvement, promotions	first mile, preference on transit	Benefit, joint responsibilities	Promotion: road safety, advertising, first mile, last mile, partnership

There is an argument for free or sharing of costs regarding shared mobility by the government and lobby groups. One local council stated ‘well, we don’t need a free bike program because OBike and OFO are here and we’re not paying them for that service’. According to one lobby group ‘firstly nothing’s free, and secondly, what we’re missing out on here, you’re aggregating responsibility of managing and looking for community benefit through what is the fundamental lifeblood in our community, which is transport, on the assumption you get something for free’.

Policymakers

Policymakers advocate carpooling and wanting more plans for car parking, and well-defined charge and insurance for car sharing. Concerning SAVs, they are keen to monitor improvements and identify the impact of SAVs, for example, registration and license, and management of parking. Policymakers commented on the benefits of sharing electric vehicles benefit, and seek a new policy on cost and improving charging infrastructure. For shared bikes, policymakers mentioned cycling deaths and safety are serious issues and seek ways to provide better facilities, such as separate bike lanes and parking of bikes. Policymakers want to improve the safety of shared mobility and help with advertising and partnerships with other preferred stakeholders. The first mile has been recognised as a more difficult part of multimodal sharing compared with the last mile (such as at CBD areas).

4. Discussion

4.1 Value proposition canvas of government policy and shared mobility

Based on the literature review, government policy and shared mobility form a good partnership with regard to their functions and aims. The value proposition canvas is shown in Figure 2. Better shared mobility could benefit from being treated as a good thing and obtain greater support from government policy funding (at least in its nascent stages). The notion of second-best policy support shared mobility will enable a government to make decisions regarding intervention, innovation and communication without fear of failure. Shared mobility and government policies can form a well-suited business proposition canvas, as demonstrated in Figure 2. Shared mobility has its benefits (customer jobs) of improving sustainable travel modes that can meet with the product (government policy) of key performance indicators such as reducing private car ownership and promoting MaaS. Shared mobility has its problems (pains) for example lack of policy support, business model and reliance on technology, which can be largely overcome by government's establishment of a technology network and better targeted social media. The government's abilities to influence the market and providing better quality public transport will help shared mobility's mission of reducing personal travel cost and time.

Concerning the argument between government policymakers and lobby groups' view on whether there should be free on shared mobility, it is deemed to be a good outcome, as discussed in Besley (1988) and Ver Eecke (2003). Shared mobility should be treated as a merit good of public transport, and for this reason, policymakers can use monetary intervention such as tax or rebate to support its early growth. Because policymakers lack information about the shared mobility market, they are unable to adjust their policy and the method of implementation.

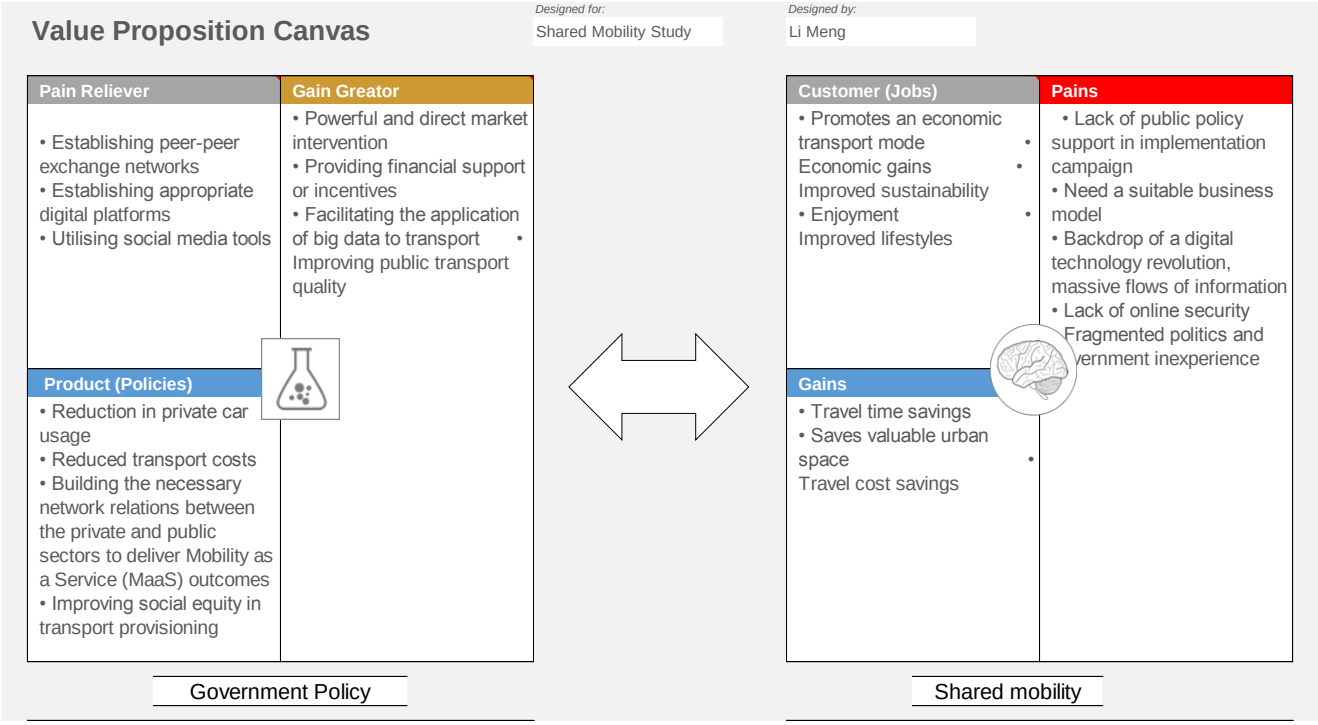

Figure 2 Government policy and shared mobility value proposition canvas

4.2 Perceived barriers in Australia and international success stories

Two significant barriers to shared mobility are the public's acceptance of it and service availability. It is found that younger people are more interested in shifting to shared mobility, which is supported a marketing and psychology study on individual preference and intercept study on modes and choices on major activity sites in the CBD. Preference and acceptance are complex terms, and the psychology preference study found cyclists are more cost sensitive, while they also found the most people would not be influenced the possibility of saving money. A recent study has found safety and comfort were related to the preference for a private car driving(Xia et al. (2017) if a behaviour change program linked to the promotion of health and environment benefits would make implementation more successful. They further suggested 'cycling safety concerns and car use comfort' and 'public

transport negative emotion' factors were positively related to the annual driving distance of participants.

Partnerships carried out by service providers, policymakers, companies (employers), lobby groups and other commercial companies for shared mobility would help change people's perceptions. For example, campaigns on increasing awareness of the benefit of shared mobility, education advertising etc. would provide incentives for people to engage in shared mobility. The most effective partnership is the one between governments and service providers, as it can reshape the image of shared mobility in the public's eyes. A partnership can also be undertaken by shared mobility service providers and manufacturers, research organisations and commercial partners who could sponsor shared mobility initiatives. What we need more is information about the concerns of the advertising firms, as mentioned by Parkes et al. (2013). Parkes et al. used the example of JCDecaux and Clear Channel, the two biggest outdoor advertising companies who helped implement bike sharing schemes in Europe and in North America (SmartBike by Clear Channel in 2008). Advertising can support bike sharing capital purchases rather than as a means to sell advertising as a business. What is also missing is the role played by social media, but one policymaker claimed that it is too expensive even if it can highlight and spread policy ideas and societal benefits, which will outweigh the costs (Elder et al. 2004; Rheingold 2003; Shirky 2008).

The service provider complained that the 'policy is too slow, brings difficulties and needs change', but policymakers claim there is a lack of strong leadership that can bring different sectors together to support shared mobility based on incentives, public transport provision (especially at first mile), road design, car parking provision price levy, behaviour change and collaborating with other institutions. This is consistent with Le Vine et al. (2014), who mentioned the frequently of privileged access to on-street parking space, in many car sharing served neighbourhoods is limited and is politically-contentious.

On the other hand, strong leadership partnered with entrepreneurs has led to the successful implementation of programs. For example, in France, the mayor of La Rochelle Vélos Jaunes started the first successful bike-sharing program through strong leadership (Davis 2014). Shared mobility has characteristics of merit good, as indicated by Ver Eecke (2003) and Besley (1988), but not so well received in Australia. A good policy needs to be initiated so that adequate permissions for shared mobility are provided, principally to use public parking and shared zones. The policy should also aim to improve smart technology that enables a seamless payment system in multimodal shared mobility, and makes possible a joint partnership for promoting shared mobility. Good policy can help to control the level of car ownership and car lifecycle.

4.3 Stakeholders' to do list

At present, shared mobility has been hampered by various issues which are presented as various scenarios in Table 3. It is critical to take action to promote shared mobility as described in scenario 2 given the original situation outlined in scenario 1. Once improvements have been made, stakeholders should move to scenario 3 in order to promote and implement smart multimodal shared mobility.

Large organisations currently provide free or cheap car parks for their employees and utilise taxis or business owned cars for business trips. For the next step they should initiate shared mobility as joint partners and introduce polices to reduce car park provision, company car ownership and taxi expenses, promote car-pooling, reallocate parking facilities for shared cars and bikes, build better information systems etc. They need to take the role in educating employees on how to approach and experience sustainable travel behaviour. For the long-term, big organisations should play a leading role in reducing unnecessary commuting trips, and plan them better enable the business to work around fewer transport requirements and make shared mobility easier to access, and to become a leader in providing friendly transport in the industry.

Shared mobility service providers are generally sole entrepreneurs due to low patronage they suffer high operation costs and also struggle to obtain more parking spaces. To maintain their place in the market, they should build partnerships with governments, large companies, lobby groups, the public, other mobility providers and commercial advertising /marketing companies. They also need to advertise service availabilities and improve communication with the public about the benefits. In future, the ideal shared mobility service will be one that is integrated with public transport for multimodal shared trips. Morden technology would enable shared information and reduced service costs.

Lobby groups currently play an important role in promoting shared mobility based on limited funds and the implementation of small schemes to promote shared mobility. They could take more action to help link service providers and governments. They represent a powerful body that can educate members and the public on sustainable travel and provide more trails and testing of shared mobility projects. In future, lobby groups can further take joint responsibility for planning shared mobility trips and an environmental friendly safe and healthy shared mobility user committee. They also stand in a good position to create a dynamic information flow system from users and service providers.

Last, not the least, policymakers, who are the most important stakeholders in the chain, are currently working on a relatively specific function without alibility to influence other sectors. Even though they have identified the benefits and problems concerning shared mobility, but because there is not enough information about the shared mobility market, they fear to make mistakes or have no power to make an actual policy change. Policymakers demonstrate a strong leadership culture to bring different partners and sectors together in a revolutionary way to redesign more modern infrastructure, promote usage of shared mobility, test new policies and adjust the results according to what the public suggests. It is essential to introduce a 'good merit' concept of shared mobility and ensure that it is well funded and subsidised. In the long term, policymakers should establish on-demand flexible route multimodal shared mobility where accumulated data on usage and patterns can make dynamic transport planning much more methodological and effective. These parties are all working towards more shared electric autonomous vehicles for future transport services.

Table 3. Scenarios for future action for shared mobility

	Scenario 1	Scenario 2	Scenario 3
	Do nothing	**Promoting shared mobility**	**Promoting smart multimodal shared mobility**
Large companies	providing free or cheap car parks for employees, providing taxi or business owned car for business trip	partnering with shared mobility providers to introduce shared facilities, reducing car park provision, company car ownership and taxi expenses, restricting business cost for services, promoting carpooling, providing more facilities for shared cars and bikes, building better information system for shared mobility, and educating employee with sustainable travel behaviour	reducing unnecessary commuting trips, assisting commuting transport planning, enabling business work around with low transport and easy access to shared mobility, and becoming a leader in travel-friendly business in the industry
Service providers	being a sole entrepreneur, providing shared mobility with high operation cost, and struggling to obtain more parking spaces to enlarge business	building a partnership with government, large companies, lobby groups, other mobility providers, public and commercial advertisement companies, advertising service availabilities and communicating the benefit with public	linking shared mobility with public transport for multimodal shared trip, enabling shared information, and developing better technology for reduce service cost
Lobby groups	working on shared mobility based on limited funds and implementing small schemes to promote shared mobility	helping link service provider and government, educating members and public for sustainable travel and providing more trail and test for public	taking joint responsibilities for planning shared mobility trip, establishing a green, safe and healthy shared mobility committee and enabling a dynamic information flow system from users and service providers
Policymakers	focusing on specific areas, identified benefits and barriers of shared mobility, but holding minimum less information or power to change	elaborating a strong leadership to joint different partners and sectors to redesign infrastructure, promote the use of shared mobility, test new policies and adjust accordingly, and introduce merit good concept on shared mobility	enabling on-demand flexible route multimodal shared mobility, establishing big data for dynamic transport planning, introducing more shared electrical autonomous vehicles

4.4 Bowden case study

Bowden is a suburb in Adelaide currently undergoing major redevelopment in terms of high-density living. It is part of the City of Charles Sturt local council and is located 4 km away from CBD, and much of the housing is being transformed from former workers' cottages and warehouses to gentrified living arrangements. Bowden is a flagship development led by Renewal SA, with the cooperation of the City of Charles Sturt, for higher density urban renewal development. It also presents a pioneer project in encouraging shared mobility in Australia.

Bowden is the site for developing shared car schemes with priority parking spaces in appropriate locations. The project has paid up to $1000 per month to keep 2 GoGet cars in Bowden while they become established. The cars are now self-funding, and GoGet has decided to leave the cars here without that top up money for parking. Renewal SA has an agreement with GoGet that it will waive the new membership fees for all residents in Bowden. Renewal SA also offers a number of vouchers for residents when they attend the cycling workshops, training/safety workshops, people can receive the $100 voucher from Bicycle Express, and free Metro cards (worth $5) and $5 of credit is put on these cards.

For urban development a target of 0.75 car parking spaces has been set; i.e. car park space was not provided in some apartments due to housing sales pressure. The investor buys an apartment without a carpark, and this allows the person to save $30,000 and $35,000 on the property. Temporary all weather car parks (rubble and gravel surfaces) in various locations exist around the Bowden development close to the centre of building activity. These car parks will service visitors to Bowden residents during the construction of nearby buildings until shared parking in retail or commercial buildings is provided. This will be backed up by alternatives such as accessible and high-quality public transport. However, there was no adequate demand for those apartments with no car park, and from real estate sales consultant pressure, the new apartments are being planned with at least one car park per dwelling.

According to UniSA's Low Carbon Living research on green travel survey the small number of participants of 17 led to the following conclusions: no car ownership is 7%, one car ownership is 67%, two car ownership is 17%, more than two car ownership is 9%, and even though 59% of people have used a shared car, car ownership is still too high for a shift to shared mobility to occur. At the suburban level, Bowden has achieved a lower level of car ownership where 9% of households had access to two or more motor vehicles when compared to 50% on an average in Greater Adelaide. For car sharing preferences in Bowden, there is a large interest (54% in favour) in utilising 'GoGet' service to get to work. However, this might not rise further due to current car ownership and the costs of using GoGet cars.

The situation in Bowden demonstrates a government-led scheme for shared mobility development. Shared mobility is currently being subsidised as a merit good, and it is a partnership involving various government bodies, service providers who are working on delivering different schemes to promote shared mobility. What residents will prefer in the future is still a major issue, and there is possibly insufficient advertising and marketing to inform residents about the benefits of shared mobility.

The service provider is still a sole entrepreneur; even the provision of share cars have been subsidised at the location. It is likely that the service provider will need build awareness to convince residents that shared mobility is a viable alternative to car ownership and complements public funded transport services. A more extensive joint partnership is possible, which could interact with the transport department and other agencies to promote lower car ownership. More development is required integrate smart multimodal shared mobility with other transport services, making information available and introducing a seamless payment system across all public transport modes. Further research needs to explore higher density residential mobility demands to understand the decision making processes and preferences of specific residential groups.

Table 4. Bowden development in shared mobility

	Scenario 1	Scenario 2	Scenario 3
	Do nothing	**Promoting shared mobility**	**Promoting smart multimodal shared mobility**
Businesses	Office worker parking will be limited by the building owner through parking and travel plans for worker to encourage use of public transport, commercial visitor parking is required and will be provided at predetermined rates, opportunity exists to share car parking between commercial, retail and residential uses dependent upon the times of day that car parking is required for the specific use	partnering with shared mobility providers to introduce shared facilities, providing more facilities for shared cars and bikes, building better information system for shared mobility, and educating employee with sustainable travel behaviour	reducing unnecessary commuting trips, assisting commuting transport planning, enabling business work around with low transport, and becoming a leader in travel-friendly business in the industry
Service providers	being a sole entrepreneur, providing shared mobility with high operation cost, and struggling to obtain more parking spaces to enlarge business	building a partnership with government, large companies, lobby groups, other mobility providers, public and commercial advertisement companies, advertising service availabilities and communicating the benefit with public	linking shared mobility with public transport for multimodal shared trip, enabling shared information, and developing better technology for reduce service cost
Goget, Ofo (ceased in July, 2018)	being a sole entrepreneur, providing shared mobility with high operation cost, and struggling to obtain more parking spaces to enlarge business, oFo needed (while they are in business) to demonstrate that they are doing regular patrols and removing damaged or missing bikes	building a partnership with government, large companies, lobby groups, other mobility providers, public and commercial advertisement companies, advertising service availabilities and communicating the benefit with public	linking shared mobility with public transport for multimodal shared trip, enabling shared information, and developing better technology for reduce service cost
Resident committee	13% of using shared cars, with relative good support from Renewal SA	Influencing neighbours for sustainable travel and providing more trail and test for public	taking more roles for planning shared mobility trip, establishing a green, safe and healthy shared mobility committee and actively engaging to use a dynamic information flow system from users and service providers
Renewal SA, Charles Sturt Council	Reduction of total car parking spaces to be offset against shared car scheme; Investigation into residential housing car parks and electric car recharge sites; Reduce number of car parks across development to target less than one per households; Use of share car schemes including Go-Get have enabled residents of developments such as Christies Walk to live without a car, exploit shared car parking areas between uses based upon compatible hours of peak operation; introduce merit good concept on shared mobility introduce merit good concept on shared mobility	redesign infrastructure: the speed limits perhaps around local areas, to again make more of the cycling infrastructure, such as separated bike lanes and designate, test new policies and adjust accordingly, advertising the schemes in promoting high-density development and shared mobility	enabling on-demand flexible route multimodal shared mobility, establishing big data for dynamic transport planning, introducing more shared electrical autonomous vehicles

5. Conclusions

This project has reviewed the literature on shared mobility and practices, and added to that literature with new knowledge gained by an in-depth investigation of shared mobility issues in Adelaide. The similarity in problems in many cities is not a surprise. Car sharing and bike sharing schemes experience issues with matching demand and supply. A key challenge is providing shared mobility infrastructure in suitable locations to match demand (that is, for cars, access to sufficient parking locations, while for bikes it is rebalancing). Shared autonomous vehicles encounter very specific challenges regarding insurance and liability, and the provision of sufficient electric vehicle charging stations. In the case of bike sharing scheme, it requires government policy support to provide access to pavements for docking stations, promotional and infrastructure support to improve people's health and rider safety, rebalancing of bikes to meet demand, and financial partnership.

First/last mile shared mobility can be met to some degree by shared mobility services, but further effort is required to integrate car sharing, bike sharing and other shared mobility services with existing public transport systems, to provide a seamless service platform and integrated trip experience from start to finish. Doing so will require new business models, often in partnership with various levels of government.

Last but not least, the success of commercial shared mobility services require an up-to-date digital technological such as IoT, blockchain and cybersecurity to fulfil on-demand services, whilst providing confidence to users that their information is secure.

Cities such as Adelaide face the challenge of high levels of private car ownership and driving a culture that impacts and is impacted by population density, public transport service quality and mobility demand. It has to be noted that the first/last-mile transit sharing stands out as one the most significant problems in Adelaide, reducing the popularity of public transport. Therefore collaboration and co-operation between public transit services, regulators, and sharing mobility providers to improve multi-modal shared mobility could support a transition to decreased reliance on private transport.

The interviews with experts from large companies, service providers, policy agencies and lobby groups show the potential for increased collaboration and mutual benefit. To establish new partnerships policymakers will play a leading role to enable sufficient infrastructure, support and resources to facilitate first/last mile shared mobility. The evidence shows that large companies and other organisations that are generating commuting trips can play an important role promoting and co-ordinating shared mobility. Lobby groups have an opportunity to use their expertise in developing shared mobility services and helping to change people's behaviour and mindset.

There appears to be opportunities for new and innovative business models to address the identified barriers. Recognition of the benefits of shared mobility services is still relatively low in many situations, and seeking new ways to establish a positive public image of shared mobility will go a long way to addressing barriers to popular use. This challenge is increased by our relatively low density car-oriented urban structure that exists in many parts of Australia.

The study identifies the importance of policy in the availability and effectiveness of shared mobility. Leadership in policy making can bring related sectors together with a sense of 'one mission' to address mobility from a multi-modal perspective. For example, the Bowden development has presented a perfect example of policy makers from Renewal SA partnering with commercial operators to reduce car ownership and enhanced the acceptance of shared mobility.

Schemes that increase the density of residential development, enhance public transport provision, and provide monetary and other support for shared mobility services, can help transition residents away from high levels of public ownership. Residents' preference is still a big issue to address to increase shared mobility services, but this is not an unusual challenge to disruptive technologies or services. This may be addressed to some degree by combining the promotional power of the state and commercial operators by delivering shared mobility as part of an integrated multimodal transport system. Bowden demonstrates some success in creating a TOD development integrated with shared mobility. However, Bowden's success is limited with many residents still wanting to own and use private transport to meet much of their mobility demand. These remain substantial barriers for shared mobility.

In summary, increased penetration of shared mobility is linked to many factors including the adoption of new IoT and secure transaction technologies, and the ability to better match demand with supply. Shared mobility could benefit from being characterised as a merit good, and possibly be subsidised like other forms of public transport, or at least promoted as a form of public transport. By doing so, government bodies may be better placed to develop joint partnerships with shared mobility service providers and organisations who generate substantial commuting trips. This study finds that policy leadership may be the necessary catalyst to enable and promote shared mobility, increasing its penetration and effectiveness, and therefore reducing our reliance on private car ownership and use.

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Appendices

Appendix A1 Interview Questions for Organisations and Businesses

1. Shared mobility barriers, benefits and promotion methods

a. What are the benefits that shared economy mobility can bring to your organisation?

b. What are the barriers that hamper your employees using shared mobility?

c. What kind of program do you think can efficiently help to promote shared mobility?

d. Do you support any of the following measures to encourage shared mobility: providing incentives to economy carpool and bike share, campaign posters or broadcast media advertising, facilitating pick up or drop off for shared cars or managing car parking and traffic control to give shared cars priority?

2. First/last-mile shared mobility development, barriers and promotion

a. What do you believe are the barriers to use of first/last-mile travel by economy carpooling, bike hiring or shuttle bus as on-demand services?

b. Which policies do you think could be most effective to promote first/last-mile travel?

c. What are your thoughts on employers engaging in the following: economy carpool matching, company shuttle buses and providing preferential parking at work, office hours, compressed work week for casuals?

3. Shared autonomous electrical vehicle and concerns

a. When autonomous vehicles are introduced what supporting programs can be made to motivate employee car sharing?

b. What insurance and legal decisions are required to be made to enable autonomous vehicle to be utilised in a shared scheme for duty care/work safety to your employees?

c. What changes are likely to occur to company employee travel to work trips and car parking management?

d. Are there any plans for increasing electrical car charging stations?

4. Bike riding safety and sharing promotion

a. How can we improve bike riders' safety in traffic? E.g., reduced car speed, more separation of cycling facilities

b. Do you think the behaviour of drivers and cyclists can be changed, e.g. by education?

c. Could a relaxation of mandatory Helmet Legislation help promote bike sharing?

d. Do you have any other suggestions to improve bike sharing, for example, information availability, convenience, availability after hours?

e. How could your organisation facilitate shared bike scheme designs that can reduce bicycle theft and vandalism?

f. How about bicycle redistribution (or rebalancing)?

5. Big data and the internet of things for shared mobility

a. How can your organisation promote travel data information collection or provide information on your website to better facilitate demand-responsive, multi-modal sharing systems?

b. How can your organization incorporate website information for shared travel schemes into your organisation (with trip plan Apps on mobile phones and GPS on the devices)?

c. Do you have any comments regarding Cybersecurity or blockchain?

6. Multimodal sharing systems

a. How can your organisation support multi-modal sharing systems (first/last mile shared services +public transport)?

b. Which stakeholders do you think should be included in partnerships?

c. What strategies can be introduced in the operating system?

d. What are the significant barriers policy will encounter?

e. How can multimodal sharing systems be made popular in your employee group?

Is there anything I didn't ask you that you want to add?

Appendix A2 Interview Questions for Policy Makers

1. **Shared economy mobility service programs, strategies and legislation**

a. What initiatives relating to shared mobility align with your low carbon policy? E.g. providing Obike rack

b. What strategies do you think can support shared mobility? E.g. subsidies

c. Which programs do you think can help promote shared mobility?

d. What legislation and legal decisions are required for shared services? E.g. road safety

2. **First/last-mile shared mobility development, barriers and policy**

a. What barriers do you perceive for first- and last-mile travel by carpooling, bike hiring or shuttle bus as on-demand services?

b. Which policies do you think could be most effective to promote first-/last- mile shared mobility travel?

3. **Shared autonomous electrical vehicle policy change, infrastructure, insurance and legal for safety**

a. When autonomous vehicles are introduced what policy changes can be made to support car sharing?

b. What insurance and legal decisions are required to be made to enable autonomous vehicles to be utilised in a shared scheme?

c. Are there any plans for increasing electrical car charging stations?

d. What kind of regulation is necessary to ensure autonomous vehicle's signal control?

4. **Bike riding safety and sharing promotion**

a. How can we improve bike riders' safety in traffic? E.g., reduced car speed, more separation of cycling facilities

b. Do you think the behaviour of drivers and cyclists can be changed, e.g. by education?

c. Could a relaxation of mandatory Helmet Legislation help promote bike sharing?

d. Do you have any other suggestions to improve bike sharing, for example, information availability, convenience, availability after hours?

e. Do you have any suggestions for shared bike scheme designs that can reduce bicycle theft and vandalism?

f. What are your suggestions for better bicycle redistribution (or rebalancing)? E.g. at the railway station

5. **Big data and the internet of things for shared mobility**

a. How can big data or the internet of things be better used to facilitate demand-responsive, multi-modal sharing systems?

b. What elements do you think can be included in the pre-launch program? Such as trip plan Apps on mobile phones and GPS on devices

c. Do you think other alternative traditional information inquiry methods are still necessary?

d. Do you have any comments regarding Cybersecurity or blockchain?

6. Multi-modal sharing systems development

a. In multi-modal sharing systems (first/last mile shared services +public transport), which stakeholders do you think should be included in partnerships?

b. What strategies can be introduced in the operating system?

c. What are the significant barriers will be encountered against a multi-model sharing system policy?

d. How do you think multi-modal sharing systems could be made popular?

Is there anything I didn't ask you that you want to add?

Appendix A3 Interview Questions for Service Providers

1. Shared economy mobility service barriers, benefits and promotion methods

a. Can you suggest any government policy changes that will support your business more effectively?

b. What are the barriers that hamper shared mobility?

c. What kind of program or campaign can efficiently help promote shared mobility?

d. How about providing incentives to economy carpool and bike share, campaign posters or broadcast media advertising, facilitating pick up or drop off for shared cars and managing car parking and traffic control to give shared car priority?

2. First/last-mile shared mobility development, barriers and promotion

a. Can you list the barriers in efficient implementation of first/last mile shared mobility schemes?

b. Which government policies do you think could be most effective to promote such travel?

c. What are your thoughts on employers engaging economy carpool matching, and providing preferential parking at work?

3. Shared autonomous electrical vehicle and concerns and safety

a. When autonomous vehicles are introduced, do you need to make or have you already made policy changes can be made to support car sharing?

b. What insurance and legal decisions are required to enable autonomous vehicles to be utilised in a shared scheme?

c. What car parking management changes do you propose?

d. What new legislation changes do you recommend for protecting road user and passenger's safety?

e. Are there any plans for increasing electrical car charging stations?

4. Bike riding safety and sharing promotion

a. How can we improve bike riders' safety in traffic? E.g., reduced car speed, more separation of cycling facilities

b. Do you think the behaviour of drivers and cyclists can be changed, e.g. by education?

c. Could a relaxation of mandatory Helmet Legislation help promote bike sharing?

d. Do you have any other suggestions to improve bike sharing, for example, information availability, convenience, availability after hours?

e. What can you propose to help reduce bicycle theft/vandalism?

5. Big data and the internet of things for shared mobility

a. What can your organisation do to utilise data or the internet of things to be better used to facilitate demand-responsive, multi-modal sharing systems?

b. What technical development can support shared facilities schemes (add on to the trip plan Apps on mobile phones and GPS on the devices)?

c. How about shared facilities redistribution (or rebalancing) between different park (dock) stations?

d. Do you have any comments regarding Cybersecurity or blockchain?

6. Multi-modal sharing systems

a. How can your organisation support future multi-modal sharing systems (first/last mile shared services +public transport)

b. Which stakeholders do you think should be included in partnerships?

c. What strategies can be introduced in the proposed multi-modal sharing system?

d. What barriers do you foresee in effective implementation of this policy?

e. How can multi-modal sharing systems be made more popular?

Is there anything I didn't ask you that you want to add?

Appendix A4 Interview Questions for Lobby Group and Community

1. Shared mobility barriers, benefits and promotion methods

a. What are the benefits that shared mobility can bring to individuals in your community?

b. What are the barriers that hamper shared mobility?

c. What kind of program do you think can efficiently help promote your community to use shared mobility?

d. What other programs could promote your community to participate in shared mobility? For example, providing incentives to economy carpool and bike share, campaign posters or broadcast media advertising, facilitating pick up or drop off for shared cars and managing car parking and traffic control to give shared cars priority?

2. First/last-mile shared mobility development, barriers and promotion

a. What barriers does your community perceive in first- and last-mile travel by economy carpooling, bike hiring or shuttle bus as on-demand services?

b. Which policies do you think could be most effective to promote such travel?

c. What are your thoughts on employers engaging carpool matching, providing preferential parking or work shuttle buses?

3. Shared autonomous electrical vehicle and concerns

a. When autonomous vehicle are introduced what organisation policy changes can be made to support car sharing?

b. What insurance and legal issues are required to be known to enable autonomous vehicles to be utilised in a shared scheme?

c. What changes would be brought to your community's travel behaviour and car parking management by using autonomous vehicles?

d. Are there any expectations for increasing electrical car charging stations?

4. Bike riding safety and sharing promotion

a. How can we improve bike riders' safety in traffic? E.g., reduced car speed, more separation of cycling facilities

b. Do you think the behaviour of drivers and cyclists can be changed, e.g. by education?

c. Could a relaxation of mandatory Helmet Legislation help promote bike sharing?

d. Do you have any other suggestions to improve bike sharing, for example, information availability, convenience, availability after hours?

e. How could the community be better supported to prevent shared bike theft or vandalism?

f. How about bicycle redistribution (or rebalancing)?

5. Big data and the internet of things for future shared mobility services

a. How do think mobile APPs and internet information can assist people's travel plans and using combined modes for one trip?

b. How can internet and mass data contribute better for travelling?

c. How can traditional information system services be better targeted to required travel groups?

d. Do you have any comments regarding Cybersecurity or blockchain?

6. Multimodal sharing systems development, barriers, policy and promotion

a. How could the community be promoted to use the newly designed multimodal sharing systems (first/last mile shared services +public transport)?

b. Which stakeholders do you think should be included in multimodal sharing partnerships?

c. What strategies can be introduced to the operation of a multimodal sharing system?

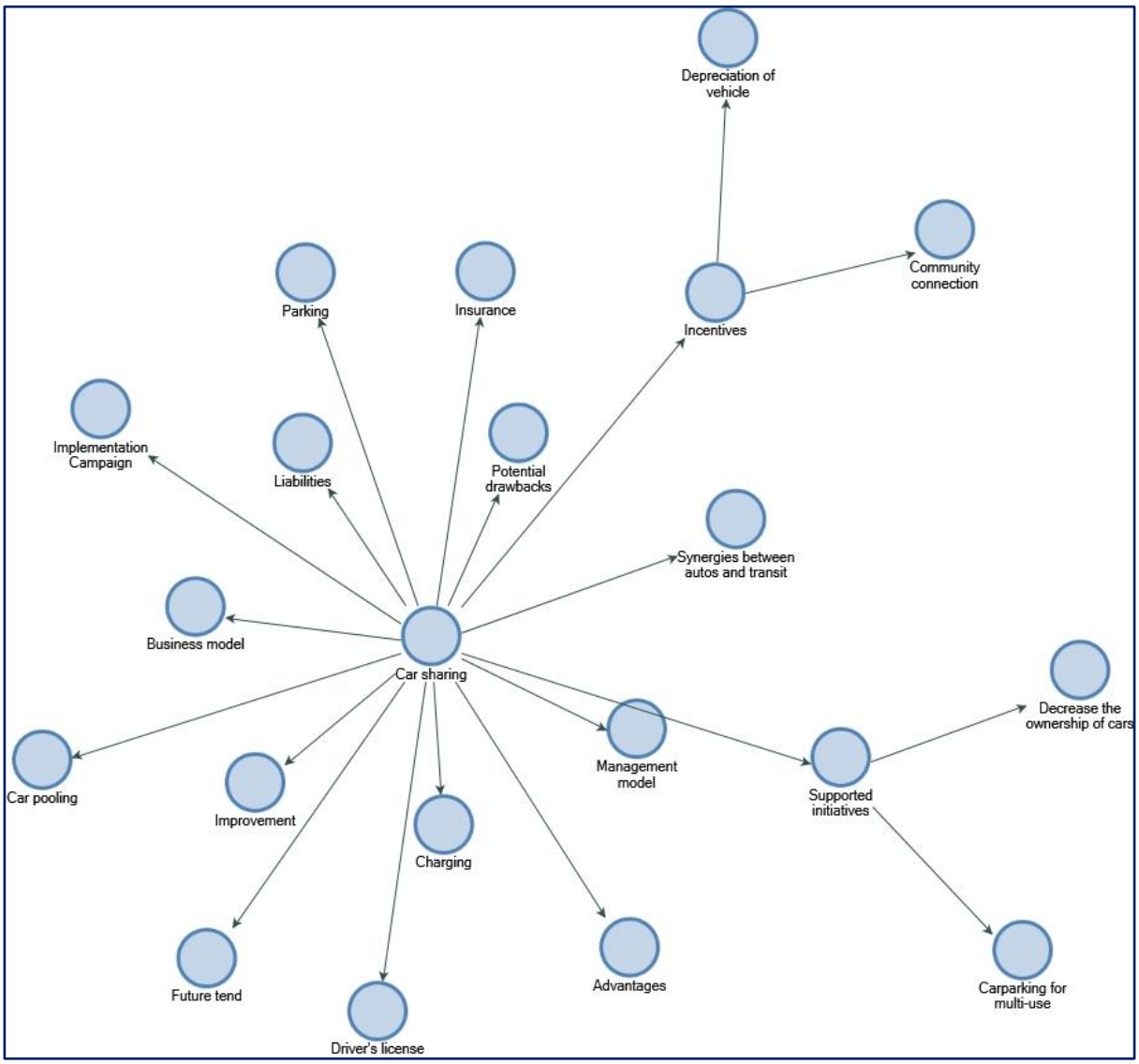
d. What are the significant barriers policy will encounter in multimodal sharing system?

e. How can multimodal sharing systems be made more popular in your community?

Is there anything I didn't ask you that you want to add?

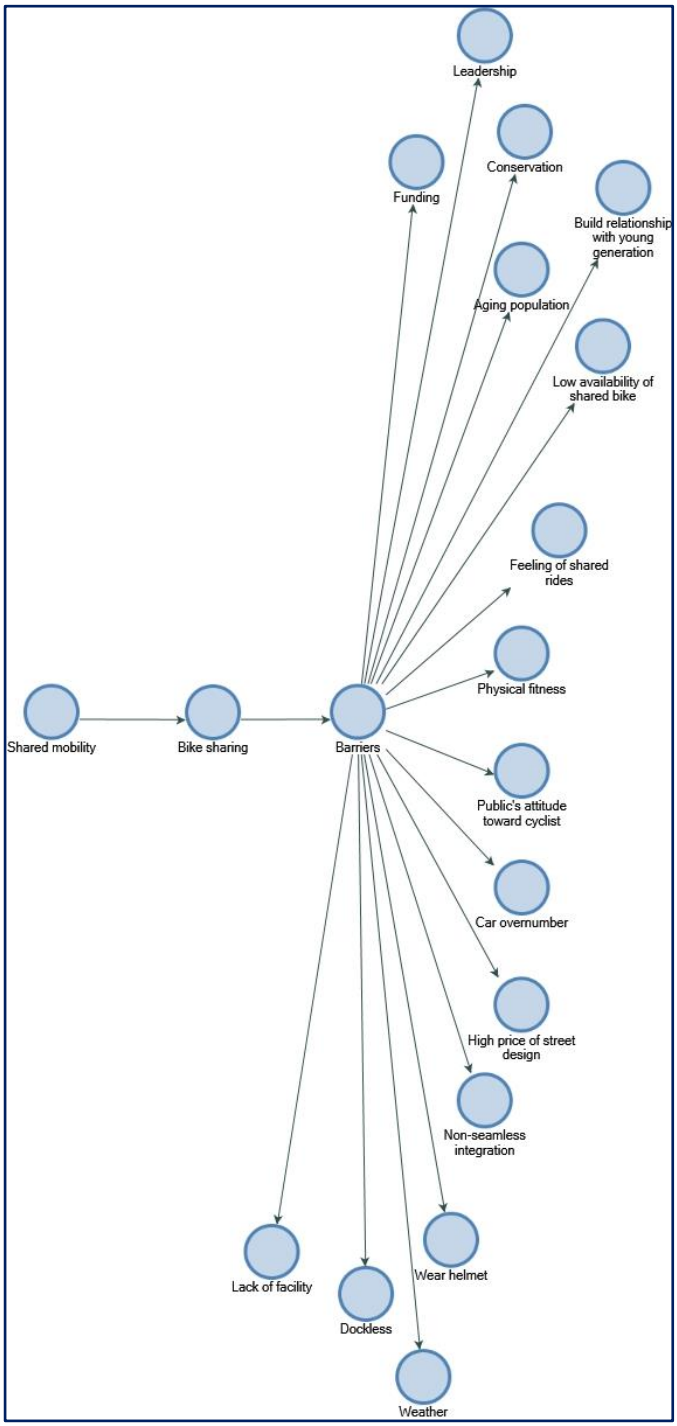
Appendix B Results from Nvivo outputs

Appendix B1- Key issues relating to car sharing



Sharing a car is difficult for the public to swallow as it is seen as an expensive option. A shared car is a business asset and must be financed and maintained as one. This brings costs that are hidden in car ownership such as depreciation into the fore. A share car must also make a profit some users will resent this.

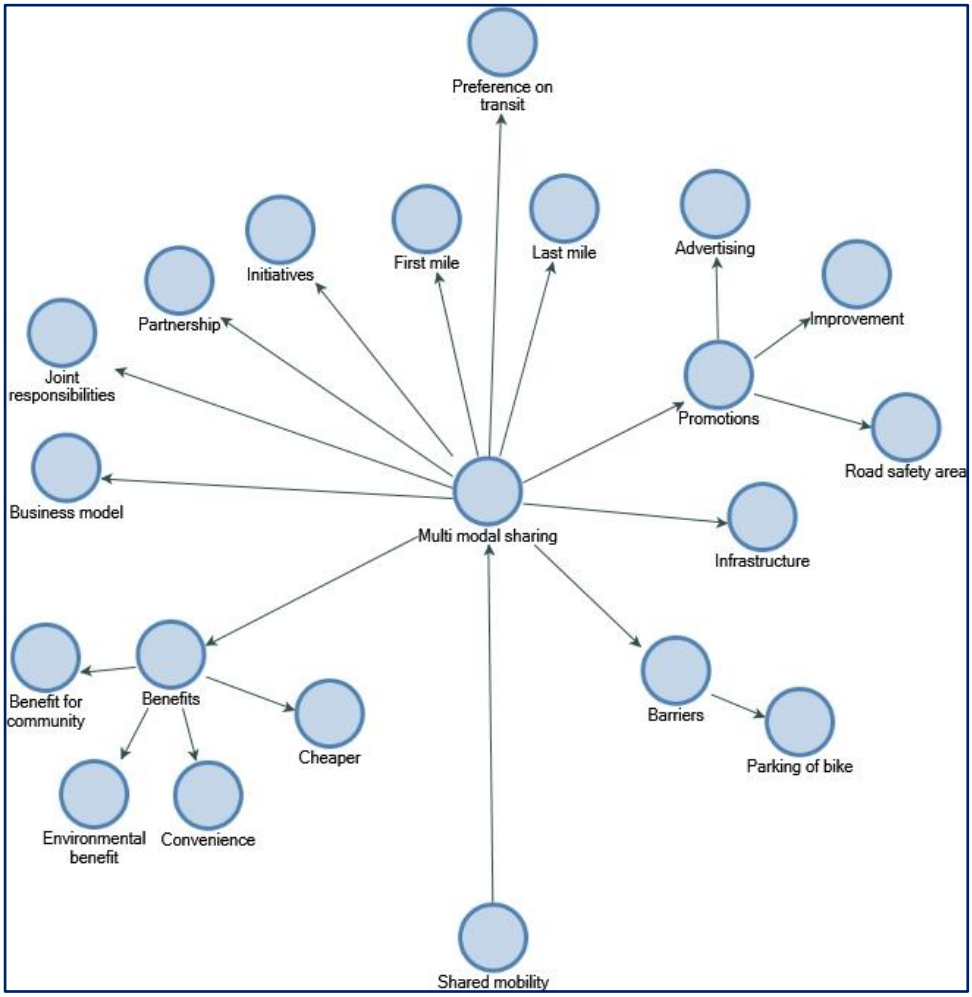
Appendix B2- Bike Sharing barriers



These barriers can be broken down by mode with different modes facing different challenges. For example, the issue of requiring a helmet is often seen as a major inhibitor of increased bicycle uptake but is unique to this mode. There are some similarities across modes with weather, for example, a barrier to both cycling and public transport.

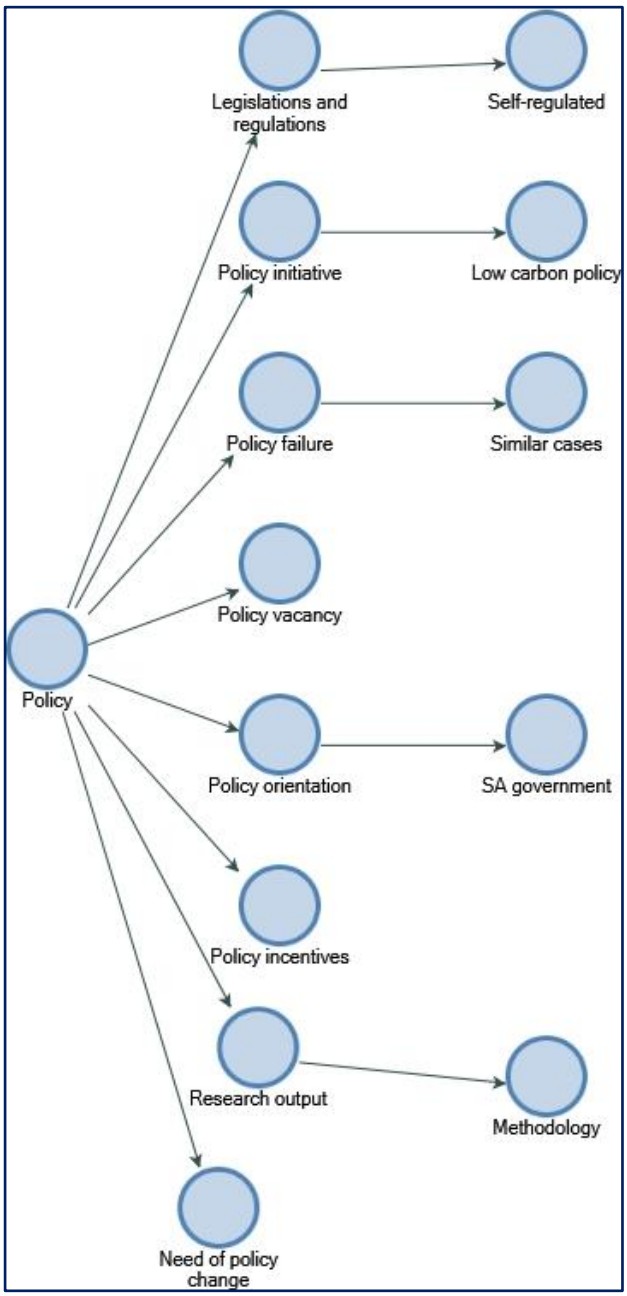
Appendix B2- Key issues relating to car sharing

Appendix B3- Issues, benefits and barriers of Multi-Modal sharing



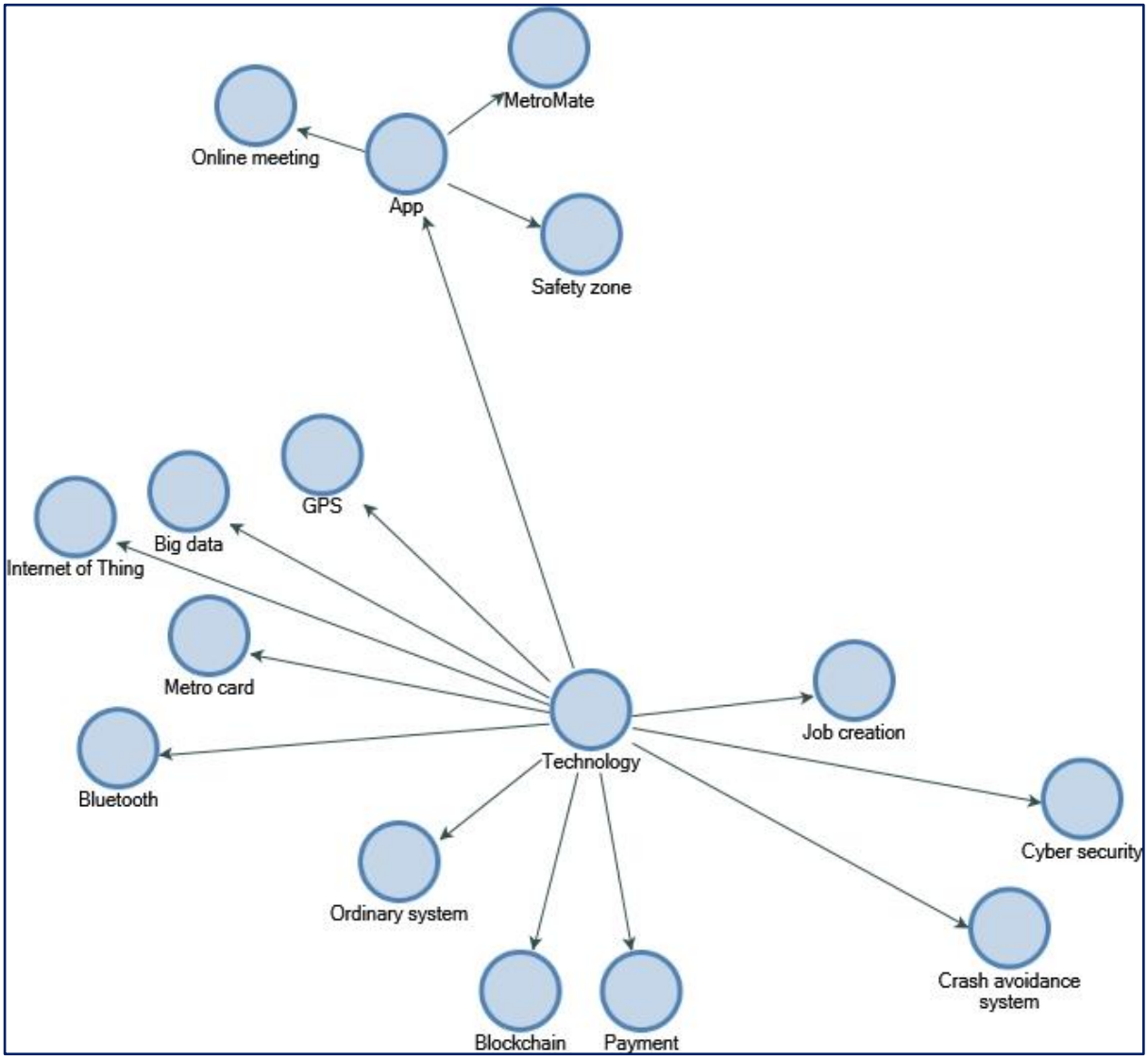
A multimodal approach has the most benefits, and the least barriers as individuals can approach this from their perspective, for example, a fitter member of society might cycle to a public transport node while another drives. Linehaul Mass transit as distinct from public transport and its wandering feeder bus services becomes important in a multimodal shared mobility solution. The promotion of a multi-modal solution is key as users will need to be convinced to change modes initially. as cycling is more prone to the barrier of weather and requires more physical effort than driving the cyclist above will need to be convinced to choose this option, and this may be achieved by advertising the health benefits.

Appendix B4- Shared Autonomous Vehicle



Policy is the area that needs most improvement. Policy makers are very conservative by necessity. Shared mobility is at the moment a new innovation and much more disruptive then reactive. Many of the words on this image have negative connotations, words like failure, vacancy or need for change. It seems neither the policymakers nor others believe the policy is where it should be in this space.

Appendix B5- Role and types of technology for success of shared mobility services



Technology is critical to the success of shared mobility. Existing technology such as the Metrocard ticketing system for public transport is as important as emerging technology such as blockchain payment systems. The integration of technologies in different stages of development is a big challenge but also the biggest catalyst for change. The public wants seamless integration of technology, then and only then might they abandon the “convenience” of their privately owned car. Interestingly all the technologies in the diagram that came from our discussion are information technologies predominantly focused around mobile phones.