Can car sharing facilitate a more sustainable car purchase?

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Abstract

Car sharing is normally seen as an alternative for the car; however for many households the option of not owning a car may be unthinkable. In this study we explore the idea of combining car sharing and vehicle ownership in order to change the consumer behavior of car purchases in a way that reduces energy usage, air pollution, and greenhouse gas emissions by improving the fuel efficiency of the consumer fleet.

We consider the personal vehicle as a bundle of functional attributes (such as seating, luggage space, performance, all-wheel drive (AWD), towing, roof rack) and symbolic attributes (such as vehicle brand, new technology, environmental friendliness). In this case we look at the distinction between "daily use" and "peak use" attributes. If the vehicle attributes could be unbundled, the personal vehicle would include only those features needed on a daily basis, likely reducing capital costs and improving fuel economy, with car sharing or another service providing the occasional "peak use" features, increasing consumer welfare. However, the transaction costs of unbundling the complete "daily use plus peak use" vehicle into a "daily use" vehicle and a shared "peak use" vehicle would have to be sufficiently small for most consumers to consider this option.

In the paper we qualitatively explore what the car sharing service would need to look like for the transaction costs of the service to outweigh the capital investment and operating costs of a bundled vehicle. We also explore the readiness of car sharing or rental car companies to provide this type of service.

The study consists of three parts: the first being an overview of the related literature on car choice and car sharing. The second part consists of an inventory of available models in car sharing fleets in order to assess the availability of "peak use" vehicles. In the third part we interview experts and representatives from car sharing and rental car companies in California and Sweden.

We find that car sharing today does not cover the needs for unbundling the vehicle. Most car sharing services today have focused on providing the primary vehicle for people without a vehicle. There are not enough "peak use" vehicles available in these services to guarantee access when the consumer needs them. However, new business models, such as combining business and private members, traditional car rental companies joining the car sharing space, and the growth of peer to peer car sharing, may offer the possibility to widen the vehicle models available.

Introduction

Consumers often purchase vehicles that meet or exceed all of their needs – from the daily, commute needs to the rare peak needs. A vehicle that meets all usage cases likely has higher operating costs (higher fuel usage) and capital costs (larger vehicle, more features) than a vehicle that would meet the everyday usage cases, because it has features that are not needed daily – such as additional seating, range, cargo, all-wheel drive, etc. The extra energy usage and expenses are a burden on consumers. The extra fuel usage is detrimental for society through additional air pollution, climate change, and energy security impacts. However, consider a business model where consumers would purchase a vehicle to meet their average (daily) needs

instead of their peak needs, with the option to borrow a variety of vehicles for peak use times. This could be welfare enhancing for the consumer (lower costs) and for society (reduced externalities). Consumers would only consider this option if their welfare stays the same or is increased with this option.

Consider the vehicle as a bundle of functional attributes (such as seating, luggage space, performance, all-wheel drive (AWD), towing, roof rack) and symbolic attributes (such as vehicle brand, new technology, environmental friendliness). If the vehicle attributes could be unbundled into the features needed for daily use and the features needed for peak use, the consumer could choose to only invest capital in the "daily use" features and pay as-needed for the "peak use" features, as shown in Figure 1. "Daily use" activities are ones the consumer engages in most days – e.g., commuting, transporting children to school, and grocery/small item shopping. "Peak use" activities only occur occasionally and might include vacations to the mountains or snow, transporting large items, towing a boat or camper, and hosting visitors. The vehicle attributes, either functional or symbolic, that are essential to the consumer are present in both the consumer-owned "daily use" vehicle and the shared "peak use" vehicle, while features that are not essential to "daily use" activities are present in the "peak use" vehicle. In Figure 1, the (-) means this feature is decreased while (=) or (+) means the feature stays the same or is increased. Vehicle price, luggage space, and engine size are likely to decrease from the bundled vehicle to the "daily use" vehicle, while the number of seats could decrease or stay the same (for example, if a 5 seater is needed daily). Safety and symbolic values would likely have to at least remain the same for consumers to consider this option. With shared "peak use" vehicles, an increase in features is likely depending on the variety of models available for the consumer to borrow.

A key component to the success of this type of business model is to keep the service convenient. It is difficult to compete with the convenience of owning a vehicle and having it available all the time – so the total cost savings would have to be large enough to balance out the inconvenience of borrowing a vehicle. The business model would need to consider the convenience of getting the borrowed vehicle, the availability of particular vehicles on short notice, and the reliability and cleanliness of the vehicles. Additional perks may be necessary to offset the inconvenience, such as a large variety of "peak use" features available on the shared vehicles and access to luxury or sports vehicles that most consumers would not have the capital to purchase.

One method of unbundling the vehicle features would be to offer a car sharing service when purchasing small, fuel efficient vehicles. We will next explore what that car sharing service would need to look like for the savings of the service and "daily use" vehicle to outweigh the capital investment and operating costs of a bundled vehicle for the consumer, and whether such a service exists today.

We first describe the methods used for the analysis, then present a literature review and an overview of car sharing fleets in the U.S. and Sweden. Next our results from interviews with stakeholders and experts on car sharing are presented. The paper ends with a discussion and conclusions for ways forward both when it comes to car sharing affecting car choice as well as further research needs.

Method

The analysis consists of two parts: a literature review which includes a survey of the inventory of car sharing vehicles, and an interview study.

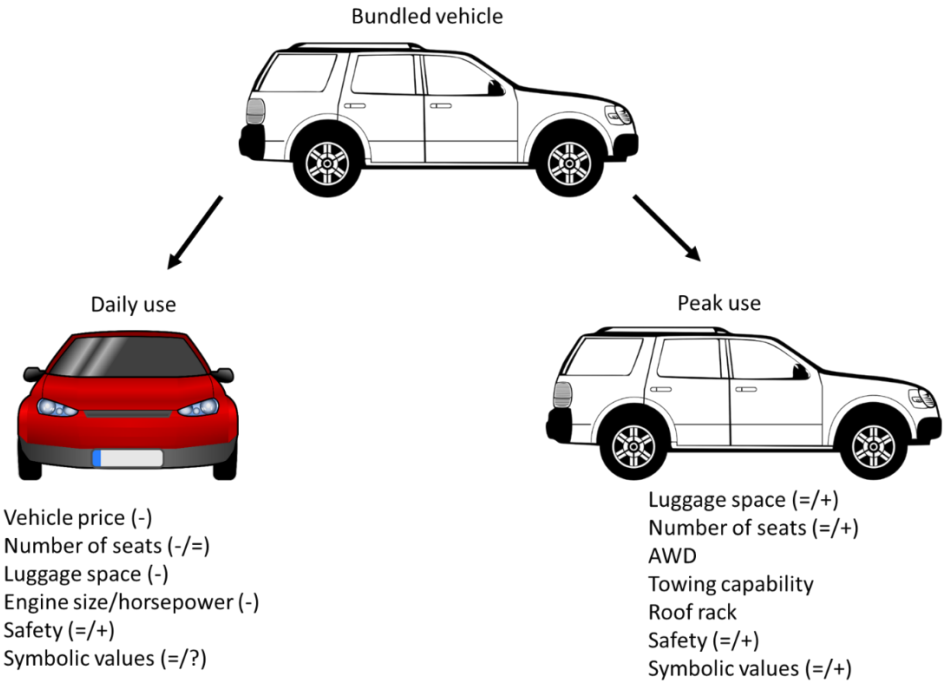

Figure 1. The Bundled Vehicle splits into a consumer-owned Daily Use vehicle and a shared Peak Use vehicle.

The literature review has two main focuses. One, to analyze to what extent the car can be considered a bundle and what can be included in this bundle. For this part three different types of studies have been included: car-choice studies and the attributes that they include in the choice models; usage centred studies that mainly look at travel patterns; and studies that include the meaning and more symbolic values of the car. The second focus has been on the car sharing space covering various forms of car sharing both in the US and in Europe. Since this space is relatively new, we included peer-reviewed papers, reports and other grey literature. The literature review is used to create a conceptual framework and understanding of how the vehicles can be unbundled and provides a context and a background for the analysis.

In order to fill the identified gaps from the literature, interviews with relevant actors were carried out in Sweden and in California, USA. California was chosen due to the presence of the major actors of car sharing as well as smaller providers. It is also were some of the major peer to peer car sharing started, providing an opportunity to gain insight on how the innovative sector might grow elsewhere. The challenges in Europe are of slightly different character given other urban structures and fuel prices. While other countries in Europe have come further when it comes to the penetration of car sharing, e.g. Switzerland, Sweden has a high adoption rate of mobile and net based application and is a car-manufacturing country with a tradition of purchasing larger vehicles (Sprei and Karlsson 2013), making it an interesting study object when it comes to changing car purchasing behavior.

In total 12 semi-structured interviews were carried out: 7 in Sweden, of which one also had experience in Switzerland, and 5 in the US. Interviewees were chosen to get a sampling of the different types of car sharing: traditional (vehicles are returned to the same place where they are picked-up), one-way (the vehicle is picked up at one location and dropped off at another), electric vehicle (EV)-only, peer-to-peer (vehicles are rented from other private individuals), for profit and non-profit, and coops (members own the car sharing), both in the US and Sweden. We also interviewed university experts and experts from city and country agencies. In Sweden four interviewees were active in car sharing companies and three were experts. In California the division was three car share practitioners and two experts.

The interviews range from 41 minutes to an hour and 10 minutes. All of the Swedish interviews were carried out in person, except one which was carried out by phone. All of them were carried out in Swedish. They took place either in the interviewee's office or, in the case of the experts and representatives, from the non-profit Chalmers University. Three of the U.S. interviews took place in person in a University office, at a café, and in a personal home. The two phone interviews were conducted in a home office.

Interviewees are anonymized through initials, such as "DG" and "JH" in the text.

Each interview was recorded and transcribed. The transcribed interviews were analyzed through recursive abstraction based on the different themes of interest for the study: customers, fleets, business strategies, thoughts on car sharing influencing car purchase behavior, how to support car sharing, and views on what future mobility looks like. The first step of abstraction was performed by each author seperatly, while further steps where done by both authors. A comparison between the interviews made in Sweden and the US was also carried out.

Literature review

THE CAR AS A BUNDLE

In this paper we conceptualize the car as a bundle of attributes and services. It is thus warranted to look at what may be included in this bundle. The answer will depend on what perspective is taken and what literature is reviewed.

Traditionally car-choice studies have mainly included attributes of technical-economic character such as vehicle price, size, number of seats, luggage space, engine size and horsepower (see Choo and Mokhtarian 2004 for a review of car-choice models). Recently car-choice studies have started to incorporate other aspects as well – mainly behavioral and attitudinal aspects of the purchasing household; some of these attributes imply that the car has some other value. Typically the attitudes to new technology are included when studying the uptake of alternative fuelled vehicles, including hybrids and electric vehicles (Bolduc et al. 2008; Eppstein et al. 2011; Ewing and Sarigöllü 2000; Hidrue et al. 2011). There is thus an implication that new technology can have a value per se for the consumer that is separate from the pure functional value of the car. Environmental attitudes are also included in some of the models (Ewing and Sarigöllü 2000; Hidrue et al. 2011).

Most traditional car choice models don't take into consideration how the vehicles are used. However in studies that look at the uptake of electric vehicles, the range of the vehicle and driving habits enter the models directly or indirectly (Mau et al. 2008; Sullivan et al. 2009). The usage can enter these models indirectly through attributes like express or HOV (High Occupancy Vehicle) lane access (Horne et al. 2005), implying that the usage of the vehicle for commuting may have importance for the purchasing decision. Another approach is the cost and time for commuting (Ewing and Sarigöllü 2000).

Driving patterns and car usage have come to the attention of studies that are trying to evaluate how to dimension EVs and PHEVs (Plug-In Hybrid Electric Vehicles) (Gonder J. 2007; Pearre et al. 2011). In these studies the driving pattern and the range of the EVs are the main focus and driving point for assessing the feasibility of the vehicle. Kullingsjo and Karlsson (2013) also look at the economic aspects of the vehicles. These types of studies are very useful to determine how one can unbundle the vehicle purely on a usage base: by identifying the usage pattern the average use can easily be identified as well as the peak need for which a car sharing service might be needed. However they might miss other dimensions such as the size of the vehicles since they don't register the occupancy of the vehicle or the purpose of the trip, as well as the more symbolic value of car ownership.

Following the ideas of Dittmar (1992) on material possessions, cars can be seen as having both an instrumental and symbolic meaning. The instrumental is mainly concerning the functional uses of the possession. In the case of the car it's a means of transportation that can take you from A to B, but even the use-related features can have symbolic elements since they make certain activities possible. The car makes it possible to

visit friends and family and to go on leisure trips. The symbolic meaning is connected to the owner expressing who he or she is. From an economic point of view a car can symbolize wealth and status. Vehicles are a prime example of a positional good and thus conspicuous consumption (Veblen 1899). This is a limiting way of looking at the symbolic value of the car since it only captures one aspect - that the car can communicate wealth (and possibly status) (Heffner et al. 2006). The type of vehicle owned can signal identity, beliefs and values as well (Heffner et al. 2006). The symbolic value of a car is not only a part of an expression of the self but also plays a role in the consumer's social position or membership in a group (Dittmar 1992). To be able to show off the symbolic value there must be awareness from others on the symbolic values. New technology in new vehicles can embody new meanings that have not existed earlier as Heffner et al (2007) find among the early adopters of hybrid vehicles in California. E.g. more than communicating an environmental awareness the ownership of hybrid vehicle also showed off intelligence and moral considerations for other people (Heffner et al. 2007).

Car manufactures are aware of this and at times strive to take it even one step further when their brand or product becomes a signifier, i.e., when the product itself can communicate certain concepts without needing any assistance from other sources. Volvo and its connection to safety is a prime example (Heffner et al. 2006).

When studying car use motivations Steg (2005), beside instrumental and symbolic motives, refers to the emotions related to driving a car, and how these emotions can influence travel choices. Sprei and Wickelgren (2011) also find an emotional argument beside instrumental and economic factors behind vehicle choice.

The functional/instrumental and symbolic meanings are of course not separated and can interact with each other. Fuel economy for example is a more functional aspect and might influence vehicle choice from a pure economical point of view, but may also have symbolic value such as environmental awareness and concern or in the case of the US even patriotism (Heffner et al. 2007). The role of symbolic value is highlighted in studies of EVs and the early adopters of these (Noppers et al. 2014; Schuitema et al. 2013; Skippon and Garwood 2011)

From the literature review we can conclude that if we consider the vehicle as a bundle, this bundle includes functional as well as symbolic aspects. None of the literature addresses how these would be affected by unbundling the vehicle attributes based on daily and peak usage as is done in this study. One question is how interwoven are these functions? One of the conclusions that we draw is that the daily use vehicle should to as large extent as possible keep the symbolic value of the bundled vehicle. E.g., if the bundled vehicle was a high status vehicle this should be exchanged with a smaller, more fuel efficient luxury vehicle. The younger generation, for whom smartphones and constant connection is more important, may place less emphasis on the status attributes associated with car ownership (Delbosc and Currie 2013; Kuhnimhof et al. 2012). Another example is EVs which, even when small, have the possibility to carry a high symbolic value (new technology, higher prices, environmental concern) (Noppers et al. 2014; Schuitema et al. 2013; Skippon and Garwood 2011).

THE CAR SHARING SPACE

Car sharing is a relatively new mobility option, which began to gain popularity in the early 2000s in North America (E. Martin et al. 2010) and slightly earlier in Europe (Jorge and Correia 2013). There are several different models of car sharing available today: "traditional" or A-to-A; "one-way", "free-floating" or A-to-B; and peer-to-peer or personal vehicle sharing (Note that ride sharing or ride sourcing companies, such as Uber, are not considered car sharing in the literature). There are also different business models, for example for-profit and non-profit companies, or all EV fleets. Cars are usually rented for short periods of time – minutes to hours – but can be rented for days or weeks, especially in the case of peer-to-peer rentals. Reservations can be made a short time before using the vehicle, and access to the vehicle is often provided remotely, using a special card, key fob, or through a smart phone app.

The traditional car sharing model provides members with access to a fleet of vehicles which have designated parking spots. The member can reserve the vehicle a short time before using it, use it for hours to days, then return the vehicle to its parking spot. As of January 2014, there were approximately 1.23 million car sharing members (traditional and one-way) with access to over 17,000 vehicles in the United States (S. Shaheen and Cohen 2014). Traditional round-trip car sharing has been studied more extensively than the other, newer forms of car sharing. Research in the United States found that traditional car sharing takes 9–13 cars off the road with each car sharing vehicle available (E. Martin et al. 2010). Martin et al. (2010) found that the vehicles used in car sharing were 4.3 km/L(10 mi/gal) more efficient than the average vehicle car sharing members were getting rid of. For those people who are shedding a vehicle or delaying the purchase of a vehicle, traditional car sharing increases bus and train usage while those members that were already car-free may reduce public transportation usage (E. Martin and Shaheen 2011b). Overall, a 2008 survey found that public transportation usage decreased while walking, biking, and carpooling all increased (E. Martin and Shaheen 2011b). Along those lines, greenhouse gas emissions increase for car-free households joining car sharing but decrease for households that shed a vehicle when joining car sharing, with an overall reduction in greenhouse gas emissions (E. W. Martin and Shaheen 2011a). The same study found that vehicle miles travelled went down overall, by 27 % (E. W. Martin and Shaheen 2011a), similar to an earlier small 2005 study (Cervero et al. 2007). The 2005 study had a small sample size of both car sharing members and non-members during the first four years of City Carshare's services in San Francisco. Interestingly, the study found that although the level of car shedding was similar for both members and non-members, car sharing members were less likely to increase car ownership (Cervero et al. 2007).

One-way car sharing, also called A-to-B or free-floating, allows the user to pick up the vehicle in one location and drop it off in another after the reservation has concluded. Often the vehicles can be dropped off either on the street (sometimes with special street parking permits) or at designated parking lots. The energy and vehicle miles travelled impact of this mode of car sharing is not clear – it may be supporting a car-free lifestyle and reducing VMT by monetizing trips directly – or it may be providing an easy mobility option to use instead of walking/biking/public transportation. Very little peer re-

viewed research has been done on one way car sharing. One study discusses how to optimize one way car sharing (Correia and Antunes 2012), but the report (SDOT 2014) from the Seattle, Washington pilot program is more relevant to our work. The pilot program with car2go, a one way car sharing organization, started in 2012. The city of Seattle approved a permit system to allow car2go to purchase free-floating parking passes for $1,330, with a true-up at the end of the year to pay the full cost of paid parking. They have analyzed vehicle and survey data to draw some conclusions about the impact of free floating car sharing in Seattle, with a single operator providing 300–500 vehicles for 40,000 members. Three to 4 % of members reported shedding a car after joining the free-floating car sharing program (700–1,100 vehicles) (SDOT 2014). However, vehicle miles travelled (VMT) may have increased, since 63 % of respondents said they did not change personal vehicle usage after joining car2go (SDOT 2014). This is a concern in other cities, like San Francisco, which excluded one way car sharing models from their on-street parking pilot for car sharing, due to limited research demonstrating their environmental and congestion impacts (SFMTA 2013). San Diego, like Seattle, has a free-floating parking pilot going on with an all-electric fleet from car2go, and are investigating the impact of this type of service (Services 2011).

Peer to peer car sharing organizations allow members to loan or rent their own personal vehicles to other drivers. It allows privately owned vehicles to increase their utilization, and is more able to penetrate areas with lower population density (Ballús-Armet et al. 2014; Hampshire and Gaites 2011; S. A. Shaheen et al. 2012). Hampshire and Gaites (2011) found peer to peer car sharing to be economically viable, but challenged by public policy and car insurance. Optimizing reservations can also increase revenue, making the peer to peer system more viable (Sinha 2011). This type of car sharing may be the best suited existing model to provide the "peak use" vehicle for several reasons: individuals own the vehicles, making low utilization less of a concern; there is no sunk capital cost on the fleet by the company, so the fleet can theoretically grow enough to handle high demand on weekends and holidays without worrying about low use during the work day; and the vehicles could be located right in members' own neighborhoods, providing a low transaction cost for acquiring the vehicle. The founder of one of the main providers of peer to peer car sharing, RelayRides, was quoted in Automotive News in 2011 mentioning the potential for peer to peer car sharing to reduce the number of SUVs on the road. A family could purchase a smaller, more fuel efficient vehicle that meets their daily needs because they have convenient access to SUVs when one is needed (Abdel-Razzaq 2011). The energy and environment impact of the peer to peer model is uncertain. It can increase the utilization of existing vehicles, perhaps reducing or delaying vehicle purchases, which has a positive impact on the environment. It may also increase consumer welfare by providing access to shared vehicles in more locations. However, these vehicles may be less efficient vehicles than traditional car sharing fleets. Also, it is unclear whether individuals would purchase an additional car or hold on to an older car because it can be used in peer to peer car sharing. More research is needed in this area.

An overview of the car sharing development in Europe is given in the final report of the EU-project momo car sharing (momo 2010) that covers the market in 14 different countries including the provider structure and the spatial distribution of the services. At the time of the report (2009) car sharing was just emerging in many countries with the exception of Switzerland, where more than 1 % of the population is members of car sharing. The report also covers a survey with 108 of the 205 car sharing providers. They find that the customer base is mainly private with 84 % of the users; the rest are business users. These are mainly male (with the exception of Mobility in Switzerland with a more equal gender distribution) and between 26 and 49 years old. Compared to the general public, car sharing members own fewer cars and are more likely to own some kind of public transportation pass. The reported number of displaced personal vehicles varies between 4 to 8 per car sharing vehicle. Compact cars are dominant in the car sharing fleet and only 4 % of the providers have vehicles with an environmentally friendly drive system.

An early assessment of car sharing in Austria was carried out in Prettenthaler and Steininger (1999). The characteristics of car sharing members are similar to what is found in other studies; they are 25–44 years old and highly educated. They calculate the market potential of car sharing and find a span between 9 % and 22 %. However of those surveyed only 1.5 % answered positive to a test-membership. What might be more surprising is that there are more households with children compared to the average. Glotz-Richter (2012) describe the car sharing situation in Bremen Germany as well as Europe and focus on the effect of freeing urban space and parking needs in this area. They find a potential of not needing to provide parking for 60,000 vehicles in Europe. Jorge and Correia (2013) present a literature review of papers that have modelled car sharing. The most common type is a modeling of how to balance vehicle stocks across stations in one-way car sharing. For two-way car sharing the main modeling is demand modeling through regression analysis.

The Swedish car sharing market has mainly been studied in a number of reports from the Swedish Road Administration (Trafikverket 2012, 2013). The market consists of one large commercial operator (Sunfleet) partially owned by Volvo Cars and a large number of smaller coops (27 of these where surveyed in Trafikverket 2013). What is specific for Sweden is that the vehicles have a high environmental and safety standard. There is a lack of studies of Swedish car sharing members. The existing reports rely on a few old studies, mainly from other countries (Trafikverket 2012).

The fleet of car sharing

To understand how car sharing today may be able to provide for peak activities for a household, we surveyed the types of models in different car sharing fleets (Table 1). Although this table does not show the number of vehicles available in each category, it does provide insight to the type of vehicles each company emphasizes. It is easy to see that the smaller coops don't have that much variation, but even the larger traditional car sharing firms are mainly dominated by regular 5 seat vehicles. This is not surprising since most of the demand is in this segment. However, this might make it harder for car sharing to cover peak use needs. Peer-to-peer companies in the United States have perhaps the best potential to cover peak use needs with the largest variety of vehicle attributes available to members.

Table 1. Number of models of different types of vehicles in car sharing companies in Sweden and United States.

Country	Company	Type of Service	Regular cars	7+ seaters	Transport vehicles	AWD	Total	Source
Sweden	Sunfleet	Traditional	12	1	3		15	Sunfleet.com
	Göteborg Bilkoop	Traditional Non-Profit	7	0	1		8	www.goteborgsbilkoop.se
	Stockholm bilpool	Traditional Non-Profit	6	0	0		6	www.stockholmsbilpool.nu
	Bilpoolen.nu	Traditional Non-Profit	2	0	0		2	www.bilpoolen.nu
	Lunds bilpool	Traditional Non-Profit	5	0	0		5	www.lundsbilpool.nu
USA	Zipcar	Traditional	18	3	7	3	28	www.zipcar.com
	City Carshare	Traditional Non-Profit	19	0	4	2	25	citycarshare.org
	DriveNow	One way, all electric	1	0	0	0	1	us.drive-now.com
	RelayRides	Peer-to-Peer	286	23	155	215	464	relayrides.com
	car2go	One way	2	0	0	0	2	www.car2go.com

Note: Some vehicle models are both transport vehicles and all-wheel drive (AWD), but are not double counted in the total. Also, US numbers are approximate – Zipcar depends on the location, and peer-to-peer RelayRides and Getaround may change frequently.

The literature available gives us some insights to car purchase behavior and car sharing today, but only separately – this new area of how car sharing influences the type of vehicles purchased has limited to no peer review and report literature. Therefore we gathered further information through interviews with practitioners and experts.

Results of Interviews

CUSTOMERS

United States

According to the interviewees, the customers were similar across the different types of car sharing, with a few notable differences. Members tend to be "tech savvy", well educated, out of college young people, ages 21–40, peaking between 25 and 35. According to interviewee "DG", an all EV fleet's typical customer is slightly older, at 36. The split between male and female is approximately even. Some interviewees mentioned that car sharing is more popular among singles or couples without children, while others were not sure about their customers' family status.

These car sharing services are offered in urban areas and on university campuses, and the corresponding members are urban dwellers or students. These are areas that have limited or challenging parking, something that seems to be a key component for car sharing to be successful today. Many of the users do not own a vehicle (1/3 of survey respondents from one car sharing company, mentioned by "DG") and they have some other method of commuting to work or school. Urban areas and university campuses also provide critical density of people to support the car sharing service, and possibly a culture of sharing instead of owning, observed interviewee "AB". "AB" also mentions that peer-to-peer car sharing, for example, was a good fit for college campuses, where many students do not own vehicles but may have occasional need to use one. Students that did own vehicles did not tend to be as attached to their vehicles and therefore were more willing to share them. The campus environment provided a trusted circle of people where students could rent their vehicles to other students. Students were also motivated by the chance to earn extra money.

The uses for the different car sharing services overlapped, but there were some differences. Traditional car sharing tends to be used for 1) grocery shopping, 2) recreation, 3) airport pickups and 4) errands and appointments. Driving to the airport was the top use for one way car sharing, followed by shopping and recreation.

The non-profit model of car sharing has lower pricing and targeted efforts to include lower socioeconomic groups – but generally speaking, most customers are middle class. The non-profit also focused on environmental responsibility and therefore attracted environmentally conscious customers. Members of the other car sharing services tended to join for the convenience of the service, not for environmental reasons.

The car sharing companies in the U.S. began service with personal customers, but are starting to include commercial or government groups as well. The two main traditional car

sharing companies in the San Francisco Bay Area, Zipcar (for-profit) and City Carshare (non-profit), both provide vehicle services in addition to or in replacement of city government fleets. Government employees may have priority use of the vehicles, like in an emergency, or they can use them for work related travel during the day and have discounted membership and use of the vehicles outside of work.

Sweden

While the commercial car sharing companies would say that there is no typical customer ("our oldest member is 90 years old") through the interviews an image emerged of an average Swedish car sharing member being well-educated, middle class, between 25 and 45 years old and living in an urban area. There is a general consensus among the interviewees that car sharing in its different forms is typically an urban phenomena, even in a cultural sense; i.e., even if you live in a smaller town, but feel that you belong to a modern urban life-style you could be or want to be a member. Another common feature was living in an area where parking was a hassle and/or expensive. Access to other transportation modes, such as public transport, was also seen as a key factor since members have to have an alternative for everyday travel. According to interviewee "MK" with experience from Switzerland and who had studied other car sharing options in Europe, car sharing in Sweden still had an environmental, alternative image, even the commercial one, i.e. being a member was signaling a different life-style and you would find typically the same group of people buying organic and fair-trade. While in Switzerland people join car sharing because it is the easiest, most comfortable option.

There is a balance needed between company and private members to be able to have demand during day time as well as evenings and weekends. The main Swedish car sharing company, Sunfleet, has, contrary to many other car sharing companies, started on the commercial side, giving them, according to some experts, an advantage. Today the largest growing group are the private customers. The coops have a slightly broader member-base because they also include some people with lower income that can't afford to have a car, since their pricing schemes are lower.

One thing that differentiates Sweden from the US is that it seems like more families become car sharing members.

From one perspective all groups are hard to reach out about car sharing, after all the penetration rate is still low in most countries, except Switzerland. The concept is still new and unknown to many people and if they don't perceive car ownership as something troublesome, explaining the advantages of car sharing might be a challenge. Still there are some groups that are particularly hard to get and that's those for which the car still has a high status factor: such as retired people, younger working class and high income people.

FLEET

United States

The fleet of the car sharing companies depends largely on their business model and their company goals. The non-profit traditional car sharing company City Carshare focuses on having the greenest fleet, including EVs, plug-in hybrids, and small fuel efficient vehicles. They also prioritize access, and therefore include wheel chair accessible vans in their fleet. Another company, DriveNow, is owned by BMW and the fleet in the U.S. is all BMW EVs. The peer-to-peer companies have the largest variety of vehicles in their network.

The vehicles that are most popular also differ between business models. For everyday use, as interviewee "AD" mentioned, money talks – people look for the cheapest car that is closest to them, and may be willing to walk a few blocks for a cheaper vehicle. Interviewee "AB" mentions that for peer-to-peer, the luxury vehicles were always in demand. These are vehicles that members likely can't afford on their own, or be able to rent elsewhere. The utility vehicles, with the larger cargo space, were also in high demand.

Unlike Sweden, reliability and safety were not highlighted as key attributes for the vehicle fleet, although quality was mentioned by "AD" in association with the non-profit car sharing fleet.

Sweden

From the commercial car-fleet side the fleet is dominated by Volvo since Sunfleet is a subsidiary of the OEM. This implies that the vehicles are slightly larger, heavier and more expensive compared to other car sharing fleets. Sunfleet has a green profile and thus you will find the least fuel-consuming models and those with alternative fuels in the fleet. Lately the V60 plug-in hybrid has been added to the car-fleet, a model that may be seen as too expensive for other car sharing companies.

For the coops reliability is a key-issue since regular services and a large need for maintenance are cumbersome and expensive. They also have a larger share of smaller, cheaper vehicles since they have a group of low-income members that want a cheaper option. Even coops have an emphasis in green vehicles and prefer alternative fuelled models. However EVs have been seen as slightly problematic in traditional car sharing, both because of the handling of re-charging time and because of the newness of the technology. Car share members are occasional users of vehicles and may find new technology harder to handle, especially if there are different solutions of charging at different places. Of course the EV car sharing MoveAbout considered these things to be less relevant and found telematics and business models that can handle the situation. It should also be said that they do attract more "tech-savvy" and environmental concerned members. Generally the experts believed that many of the problems with EVs were easier to overcome today and thus incorporating them into the fleet would be less problematic compared to a few years ago.

Safety is a key issue in Sweden: 4 stars on the Euro NCAP test (and preferably 5 stars) is the minimum for any kind of vehicle to be part of any fleet. This feature was at first limiting for the EV car sharing MoveAbout. It wasn't until the Nissan Leaf appeared on the market that they were able to establish themselves. As a comparison, they were able to start much earlier in Norway using the smaller Think City EV.

While smaller vehicles might still be more popular in general in car sharing, the companies also find demand for slightly bigger vehicles with more luggage space. Typically a car needed to drive to e.g. IKEA. Interviewee "NS" also mentions that maybe car sharing companies need to increase the size of their vehicles to facilitate private owners having a smaller vehicle and using car sharing for those special occasions instead.

Generally it can be said for both Sweden and the U.S. that the larger the car sharing company, the easier it is to have a diversity of models such as Mobility in Switzerland and Zipcar in the US that include more specific models such as sport and luxury vehicles.

CAN CAR SHARING AFFECT CAR CHOICE?

United States

When car sharing practitioners and experts were asked if car sharing can affect car purchase choice, the answer was likely yes – people are more likely to purchase the same type of vehicle they typically use in car sharing. Although the interviewees did not have quantitative evidence of this phenomenon, they all invariably had anecdotal evidence to support this claim. "AD" mentions one customer telling her she bought a Scion because she really liked it when she used it in the car sharing service. This type of affinity to a vehicle may be one of the motivating factors for car manufacturers to provide car sharing services, but it is too early to say for sure if this works.

The aim of most of these car sharing companies is to support a car-free lifestyle. They focus on the benefits of not having a car and all the hassle and money associated with it – parking, insurance, maintenance, upfront costs, sunk capital and low utilization, etc. They generally seem to believe that if someone is purchasing a vehicle, they are stopping their car sharing membership. When asked about car purchase behavior, the interviewees often began the response with 'when the customer decides to leave car sharing and purchase a vehicle'. Purchasing a vehicle while in car sharing did not seem common in their experience. There are households that utilize car sharing while owning a vehicle, but there is no evidence that the availability of the car sharing service encouraged or allowed households to purchase a more fuel efficient vehicle.

When the idea of grouping together car sharing with the purchase of a fuel efficient commuter vehicle was presented to the car sharing practitioners and experts, the reaction was cautious – they generally agreed it was a great idea in theory, but really hard to implement, and not being done today. Several people mentioned that if such a service existed, the dealers would be in the ideal position to run such a program. The dealers could utilize excess capacity on their lots while supporting the sale of more fuel efficient vehicles. This type of service is already being tried by some automobile manufacturers, such as BMW offering use of an X3 with the purchase of their all electric i3.

One idea brought up by "SS" was fractional ownership. This would be one way to share vehicles in less dense areas like the suburbs while maintaining the convenience of the service. This could support more fuel efficient vehicle purchases if the shared vehicle provided other mobility attributes like cargo or all-wheel drive.

Sweden

Even in Sweden there seems to be anecdotal evidence that driving a vehicle in car sharing will increase the chances that you would want to buy that type of vehicle. EV car sharing is often mentioned as an example: if somebody gets the opportunity to drive an EV through car sharing they will be more positive on buying one. Basically it is a risk-free and cheaper way of trying out new technologies and models.

Overall car sharing is more aimed at replacing the first and only car. Some of the interviewees however did mention without being prompted that there is a chance that car sharing could work as the car for those special occasions. "JH" even stated a term that summarizes the idea quite well: mobility insurance. None of the interviewees however had any evidence that this was actually happening today. While it might seem as an attractive option some issues were seen as problematic. E.g. there might be a peak-demand for larger vehicles during weekends and vacation periods. Also for a longer trip, such as a one week ski vacation, car sharing becomes too expensive and the rental car is a better option.

When it comes to EVs and car sharing being a solution to range limitations, a mentioned solution even in Sweden was that the dealers would provide the service instead.

Some more social barriers were also mentioned. Power structure in families and each family member having a car that is distinctively theirs is one of them. The reluctance to share vehicles with perfect strangers was also seen as something still hindering car sharing from replacing the privately owned vehicle. "NS" brought up the idea of having different levels of openness of car sharing circles as an option for this.

HOW CAN CAR SHARING BE SUPPORTED?

United States

As "SS" summarized nicely, insurance is the main challenge for car sharing, then trust and awareness. "AB" mentions that insurance is almost prohibitively expensive for car sharing, especially peer-to-peer, because most of the industry is not big enough to negotiate competitive commercial insurance rates. Insurance was mentioned by both experts and practitioners as a major issue in the car sharing space.

Car sharing practitioners and experts stressed the need to have highly visible parking for car sharing in the urban areas to spread awareness. On-street parking is especially valuable, both for convenience and visibility. One- way car sharing would benefit from having a free floating parking permit allowing them to park anywhere in the city, while traditional and peer-to-peer would benefit from having a permanent parking location with appropriate signage. However, the policies for parking permits vary city by city, which represents a challenge to car sharing services, mentions "DG".

The San Francisco Municipal Transportation Agency (SFMTA) currently has an on-street parking pilot for car sharing services underway, where designated parking spaces are reserved for a particular car sharing company. Only A to A, or roundtrip, car sharing companies are involved in the pilot (one is peer-to-peer), because the environmental benefit of other types of car sharing services is still unknown, according to "AT". Although this should increase the visibility and convenience of these car sharing services, there are some subtle challenges they've run into. One of the main ones is the perceived "wasted" parking space. If the car sharing vehicle is parked in the reserved spot a lot of the time, neighbors complain that the service isn't being used and it's taking up valuable parking space. If the vehicle is used frequently and rarely parked in the parking space, the complaint is that no one can use a parking space that is almost always free. Either way it may be frustrating for neighbors, which is not good publicity for the car sharing services. How-

ever, if neighbors can be encouraged to become a member of the car sharing service, their viewpoint will likely change. The pilot will provide important information on the benefit of these services to VMT and neighborhood car usage (SFMTA 2013).

"AB" mentioned another area where policy makers or city governments can help support car sharing services. The first major traditional car sharing company, Zipcar, put together exclusive parking agreements with city parking garages and on college campuses. As industry leader, Zipcar set these agreements up to exclude any other car sharing service from parking in that area. Others in the car sharing industry have expressed frustration at these exclusive agreements, and think city and campus policies should push back on these agreements and allow others to park as well – increasing consumer options for car sharing and thereby potentially increasing consumer welfare.

Unlike Sweden, collaborating with public transportation is not seen as an advantage. Public transportation in the US usually has a negative image – slow, unreliable, and used primarily by lower socioeconomic groups. "SS" mentions that funding is decreasing for public transportation, reducing further the quality of the services and bringing into question the sustainability of the public transportation system. Perhaps car sharing can support existing public transportation, making the service work better and avoiding massive investment in new public transport systems, says "SS".

Sweden

There was a general consensus that parking is key for supporting car sharing. First of all private parking has to be scarcer and more expensive. When it comes to costs many times it is a question of letting parking carry its own costs. Housing companies are many times forced to provide a certain number of parking spots per housing unit: This increases construction costs but all of these are not covered in the actual price that tenants are paying for parking, which means that the remaining cost are borne by all tenants. Lenience in these regulations will imply fewer parking spots, making car sharing more attractive. There are municipalities today that allow housing companies to reduce the number of parking spots if car sharing is provided.

The other issue with parking is allowing car sharing to have parking spots in attractive places especially in city centers or other places were parking is difficult.

"JH" mentioned public procurement as a way of promoting car sharing. If a municipality uses car sharing for daily services it also opens up the chance for private members to use it evenings and weekends. Another strategy is collaboration with public transport to gain respectability and reach out to a population that is more likely to become members since they are already using an alternative transportation mode. This is happening in other European countries. For the EV car sharing a better charging infrastructure is of course important.

FUTURE MOBILITY

United States

The common theme mentioned about future mobility in the U.S. is on-demand mobility. Interviewees see the future as one with everything linked up on your phone, so you can get somewhere with the touch of a button. The unfeasibility of one car per person or per household in the future urban areas was mentioned several times, especially in growing urban areas. Car sharing will be a key component to maintaining mobility for these no-car households, and according to "SS", vehicles in the future will automatically be set up with all the necessary technology for car sharing. "AB" suggested that OEMs are likely to get into this space when they realize the car ownership model is broken, and may start to offer services instead of just vehicle sales. "SS" suggests that fractional ownership of vehicles may be the future of car sharing in less populated areas like the suburbs. Self-driving cars, says "AT", are a ways off – but maybe they'll be the shared assets of the future, picking people up and dropping them off optimally, increasing utilization and decreasing parking demand.

Sweden

When it comes to the future of mobility almost all interviewees mention the idea of integrated mobility. Where different modes are combined and can be used interchangeably, e.g. under the same scheme. MoveAbout e.g. have the ambition to include e-bikes in their sharing scheme. The hope for them and others is that car sharing and other modes can integrate with public transport as well as providing more flexibility for the users. "MK" points at the importance of making it easy and comfortable for the user and at the same time making it harder to use the personal vehicle. One basically chooses the car sharing/mobility option because it is the easiest and best option. "NS" sees the need to move beyond traditional car sharing and look at different schemes and ways to share cars.

Summary and looking forward

Table 2 summarizes the idea of unbundling the mobility need into two different services: one for daily usage, one for peak usage. This usage will depend on a number of factors and will determine what type of mobility service might be best suited. In the paper we mainly focus on daily use being covered by a small commute vehicle or an Electric Vehicle (EV). However the concept could be extended into other mobility forms ranging from no vehicle at all to just any vehicle that is smaller and more fuel efficient than the one covering all needs.

The mobility insurance, i.e. a service that might be needed for special occasions such as visits of family members or long trips, can then be covered by a number of services. In this case we have focused on car sharing but other actors such as car dealers or ride sharing companies might also provide this service. Since the existing models don't fully cover the needs that might exist we find that there is room for completely new services or combinations of today's existing services that might provide the needed mobility gap.

If we look at car sharing companies today we find that they are not aiming at replacing the second car; they encourage replacing private owned vehicles in general in urban areas. When it comes to choosing the fleet of vehicles, there is a larger focus on profitability and thus sometimes profiling of vehicles, having one type that is easily identifiable, is more important than variety. This is especially the case for smaller car sharing companies. As they grow and the customer base increases so do the chances to incorporate a larger range of models as is the case for Mobility in Switzerland and Zipcar in the United States. Sunfleet in Sweden is another example of a car sharing

Table 2. Illustration of daily use mobility and mobility insurance.

Daily use	Mobility insurance
No vehicle (foot or public transport) Bike E-bike Micro mobility vehicle (e.g Renault Twizy) Small commuter car Regular car EV	Car sharing Peer-to-peer car sharing Ride sharing Rental car Car dealers …
Will depend on: Needs and perceptions. Infrastructure, location, access to public transport, household size and family situation (e.g. small kids, pets, …)	**Will depend on:** Frequency of need Geographic location Quality of service, ….

company with a larger range of models since they also showcase new vehicles from their main owner Volvo Cars. Peer to peer fleets, like RelayRide and Getaround, are the most diverse, with hundreds of different models of vehicles.

Our conclusion is thus that as car sharing works today it has little chance of functioning as a mobility insurance. However, considering that the mobility space is changing rapidly at the moment we can see that there is a chance for mobility insurance service to develop, either through expansion and diversification of traditional car sharing or other actors such as car dealers or car rental companies. Combinations and collaborations between the different actors is also a way forward.

For the idea of unbundling the traditional vehicle into a daily use vehicle and a mobility insurance, there are still a number of problems that have to be overcome to really make it attractive. Based on the interviews and the literature review as well as our own reflections, these are some of the main problems with possible solutions.

Pb: The personal car is not only a mobility provider but also has symbolic value.

Solution: The replaced daily use vehicle has to have equivalent or greater symbolic value.

Pb: Your personal car has all the adjustments already in place, such as radio stations, car seat, mirrors, etc.

Solution: All adjustments could be stored in e.g. the phone that plugs into the vehicle, then the vehicle quickly conforms to your preferences.

Pb: In your vehicle you might store things that you might need such as sunglasses, car-seats for kids, extra bags for shopping, etc.

Solution: Might be one of the more difficult issues to find a solution to. The solution might depend on the product that is needed, which might also determine how much of a barrier it is.

Pb: The unbundling of the vehicle can create a peak-demand on week-ends and holidays for larger vehicles and low demand during day time.

Solution: Car sharing companies can have a better balance between company and private customers. Company customers will create more of a demand during work-days. Another alternative is to cooperate more with car rental companies, who already lots of business customers. Peer to peer might also be a solution, if the fleet is big enough and diverse enough.

Pb: Some people might not be comfortable sharing vehicles with strangers.

Solution: Not just rely on traditional car sharing or peer to peer but create solution that allows for more car sharing schemes where the vehicle(s) are shared with a restricted number of people, such as your neighbours, friends or family.

Besides these specific problems it is important that the process of renting the shared vehicle is as smooth as possible. For this to happen there are a number of preconditions that have to be met:

- The process of booking the vehicle should be simple and user-friendly.
- There should be a large variety of vehicle models that can cover the different needs. This can also be something that gives extra value since it allows the individual or household to have access to vehicles that they otherwise could not afford, such as more luxury convertibles.
- Vehicles have to be close to the user. The proximity to users is often one of the advantages of car sharing over car rental today.
- The availability of needed vehicle must be high. This implies that there needs to be enough vehicles for users to be sure there is a vehicle when needed. This might be hard to fulfil if the car sharing is too small and implies a good balance between number of vehicles and number of users.

POLICY RECOMMENDATIONS

One of the prerequisites for a mobility insurance to work is that there are a variety of vehicle models in the car sharing fleet, i.e., not only mid-size vehicles, but also larger vehicles such as 7-seaters, mini-vans and AWD. According to the literature and our interview results, for car sharing companies to achieve such diversity they need to achieve a certain size and customer base. Thus supporting car sharing is an important step for enabling

the possibility for it to provide mobility insurance. From our analysis we here summarize the policy recommendations for supporting car sharing:

- Parking: this includes both restricting parking for private owned vehicles and providing car sharing companies with attractive parking spaces.
- Other modes of transportation: insuring that there are other modes of transportation (such as public transport) for daily use makes car sharing more attractive.
- Insurance: making it easy for car sharing to provide insurance.
- Density: more dense cities create more possible members near the vehicles.

FURTHER RESEARCH

In this study the consumer perspective is solely based on literature on vehicles or car sharing. There is thus a need to test the idea of unbundling the car into a daily used vehicle and a mobility insurance from a consumer perspective. Is it at all attractive for consumers? This could be researched by constructing choice experiments and stated preferences. This might also be useful to better understand what kind of services and vehicles the consumer would want and what combinations are most attractive.

For the case of Sweden it is clear that there is a lack of studies of members of car sharing.

Most studies of car sharing focus on the current members and rarely on potential members or those that have left the services. These groups would be interesting to research to better understand how car sharing can be made more productive for them and the effects on future car purchases even in this group.

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