Car Sharing – An Overview of Benefits, Costs, and its Role in the Mobility System of the Future

Keywords: carsharing, rental cars, free floating, sustainability, mobility system, transportation, ownership, usership

Introduction

Carsharing has been introduced and marketed as an emergent solution to traffic congestions, pollution, high consumer costs and scarcity of resources, particularly in urban areas.[i] It provides a solid solution to issues that emerge when the number of inhabitants grows, space is scarce, and sustainability challenges pressing, hence reflecting the transition from ownership to usership[ii]. Carsharing is part of a broad set of mobility solutions among other means of transport such as public transport, e-scooters, bikes, or rental cars may solve the issues at hand. Carsharing has many proponents and is pushed by automakers and cities struggling with traffic-related problems alike. Shared mobility users are likely to reside in central, denser, transit-oriented locations.[iii]

The aim of this article is to investigare how carsharing can contribute to consumer and societal welfare through providing convenient and sustainable mobility solutions. Sustainability will here be defined based on environmental, social, and financial sustainability.

Does Carsharing Diminish Car Ownership?

A main driver behind carsharing, for both regulators and users, is the benefits of reducing car ownership.[iv] Numerous studies have shown that carsharing is a viable alternative to widespread ownership of private cars[v]. Early studies promise 11.7[vi], 12[vii], or even 24[viii] private cars to be replaced by a shared car based on the following line of argument: "…the average private car is only used approximately one hour per day across countries… Thus, one shared car being used consecutively could replace 24 private vehicles as an approximation, even if all other parameters except 'ownership' remained unchanged.[ix] A literature review of existing forecasts found that on average a shared car replaces 4 to 13 personal cars[x]. Demand peaks in the morning and in the late afternoon, and is close to zero during night time, so utilization is limited. These studies build on user surveys, which overstate the positive side of carsharing for two reasons: replies tend to echo marketing messages about carsharing, and users who are happy with carsharing tend to answer surveys.

Studies based on data from shared cars show very different results. A study from ADEME suggests 3[xi], another study 3.3 private cars to be replaced by a shared car.[xii] Over time, evidence has grown that carsharing can replace car ownership to an extent, but not as much as earlier stated. An early study found that 26% of carsharing users sold their private cars and 53% withheld the purchase of a new vehicle.[xiii] A study of Car2Go and DriveNow suggest 2.1 to 5.3 percent of users sold their cars, 7.7 to 18.6 percent suppressed purchase of a vehicle (see table X).[xiv] The former is more reliable than the latter – somebody will know that the car has been sold, whereas plans to buy, or not to buy, a vehicle is hypothetical.

Carsharing availability is crucial,[xv] but not even extremely convenient carsharing services do necessarily lead to a stoppage of car ownership.[xvi] Not even ride-hailing has proven to reduce car ownership significantly. According to a study of seven major US cities, only 9% of ride-haling users affected car ownership.[xvii] [xviii] A California study found that carsharing users have a significantly lower vehicle ownership than non-users, and that while carsharing in some urban areas has effectively reduced vehicle ownership, this pattern does not extend to non-urban areas.[xix] It's self-evident that users of carsharing have fewer cars than nonusers – the reason to share is significantly lower if you have a car waiting to be used.

Recent Evidence Show Mixed Results on the Driving Forces Behind Carsharing

Recent studies analyzing carsharing usage records confirm that carsharing reduces private car ownership, and also the use of other means of transport. Over time, the existing body of knowledge has evolved from early, survey-based studies on what *users state* to evaluating *real patterns* of behaviour, in many cases based on real traffic data. One study shows that as carsharing has become more widespread, the use of public transportation and taxis has declined more than the use of private cars[xx]. Another study found that carsharing is not effective in reducing greenhouse gas (GHG) emissions because the reduction is less than the increase in GHG emissions due to the use

of carsharing instead of public transport[xxi] – a typical effect of free floating. A study of carsharing in North America found that carsharing has made cars more accessible for use, and as a result, GHG emissions from cars have increased[xxii].

Numerous studies show that economic benefits is the primary factor influencing the choice of carsharing services, and the majority of users belong to younger cohorts. In a survey study, carsharing users are highly motivated by the accessibility of a car (78.8%), price (57.7%), comfort (36.5%) and possible driving distance (36.5%) while other factors are of significantly less importance.[xxiii] The environmental factor is less important. The outcome also depends on whether free floating or station-based carsharing is used. In the former case, studies show that prior to using carsharing, mobility users' transportation methods were mainly public transit, bicycles, and walking. Hence, carsharing is not as likely as expected to replace the demand for private cars, rental cars, and taxis. This explains why respondents in mobility surveys often report increased vehicle miles traveled after replacing their means of transportation with carsharing. Accordingly, carsharing might have a negative environmental effect.[xxiv]

Does Free Floating make sense?

Free floating obviously offer mobility users a convenient mode of transport through – with some restricitons – offering door-to-door mobility. There are, however, challenges in terms of system design, vehicle repositioning, fleet sizing, dynamic pricing and reservation policy[xxv], not to mention severe problems making it profitable[xxvi]. Free floating is fundamentally different from station-based carsharing in terms of convenience, business model and implications for the overall functioning of the mobility system. Bold statements were made as Daimler introduced its first large-scale free floating service: 'every journey in a car2go benefits the environment'[xxvii]. More recent evidence questions free floating, suggesting station-based carsharing to replace private cars whereas free floating is an additional option for travel.[xxviii] Hence, free floating cars not only compete with car ownership, but also with other modes of transport such as public transport, walking or biking.[xxix] A meta-study that has investigated 91 carsharing research publications concludes that station-based carsharing members may follow a more efficient and sustainable lifestyle than the one-way free floating members.[xxx] Free floating offers user convenience, however, vehicles unavoidably accumulate in certain areas or stations, requiring redistribution for subsequent users. Imbalances in the spatio-temporal demand distribution require substantial efforts of vehicle relocations to ensure availability or user incentives[xxxi] A substantial share of free floating carsharing trips starts or ends at the users' homes.[xxxii] Free floating carsharing is higher in areas with lower car or public transportation use, something that emphasizes that free floating may be used as an alternative to both one's own car and public transportation.[xxxiii]

Free floating replaces public transport to an extent

Free floating carsharing is used with disproportional intensity in areas with lower accessibility, hence it could provide mobility through destinations not well served by public transportation. Accordingly, free floating could bridge gaps in the public transportation network while station-based carsharing thrives best in areas with low car-ownership levels and well-developed public transportation[xxxiv]. Users are willing to accept a substantially longer access walk to the carsharing vehicle than for public transportation. Waiting at the trip origin is perceived less burdensome than waiting at a bus stop[xxxv]. Poor weather fuels the demand for free-floating carsharing[xxxvi]

The impact of carsharing on car use varies from a reduction of car use by 56 km per user per day, to an increase of 24 km. This variability derives from the high sensitivity to the car-ownership effect, i.e. how confident one can be in the self-assessed counterfactual.[xxxvii] These results would seem to add weight to other studies[xxxviii] that have found that carsharing may not be as environmentally beneficial as previously thought. Robert Chase, founder and former CEO of Zipcar argues that carsharing can encourage driving as they often come with dedicated parking spaces in parts of town where you would never drive.[xxxix]

Value-added services come at a cost

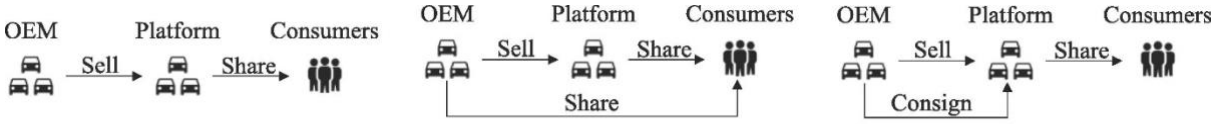
A driving force in car sharing seems to be a seamless mobility approach, including low thresholds and additional services[xl] to add value for customers, e.g. 24 hour roadside assistance, free parking, and free consumer delivery services are provided.[xli] These services make life more convenient for users and shared mobility more accessible – but they come at a cost[xlii], something that can explain why shared mobility is struggling with poor profitability. Some of these services are not only expensive, but also difficult to operate.

Increasing operating costs result in a higher rental price to cover the value-added service investment cost and leading to higher profit[xliii]. However, even though users may state, e.g. in surveys, that they are willing to pay for home-delivery, such a service comes at a high cost for the provider – at least as long as self-driving cars don't exist –, something that brings cross-elasticity of demand into the user's choice model.

Is Carsharing Profitable?

Recent evidence shows that fundamental profitability problems are inherent in carsharing, and accordingly, numerous carsharing plattforms have gone bankrupt[xliv]. There is solid evidence that carsharing, despite subsidies from e.g. municipalities in e.g. Berlin and Wien[xlv], are not profitable. One explanation is the low utilization, in a large investigation of free floating based on real data from the operator ranging from 4 to 12 percent in major cities except Madrid with 21 percent.[xlvi]

Car manufacturers have a choice between selling and sharing – the latter means being involved in one among many types of fleet services such as rental cars, taxis, police cars etc. When the manufacturer chooses to be involved in carsharing through a third pary, that's a typical outsourcing situation, something that requires cooperation[xlvii]. This is a situation similar to the choice of running own retail outlets or use franchised retailers[xlviii]. With outsourcing, entrepreneurs run most businesses more efficiently. Likewise, carsharing operations have been found to be more efficient than OEMs running carsharing[xlix].



There are various types of carsharing, as shown in the figure, implying that the manufacturer could act as an upstream cooperator, but may also as a downstream competitor. Gou et al 2022.

Taking the marginal cost of production into account, assuming overcapacity in manufacturing, means the contribution margins of an increased production might give manufacturers the opportunity to provide products at a low cost. The reasons for overcapacity are basically two. First, car manufacturers normally overstate their future sales volumes. Second, high development and manufacturing setup costs in combination with relatively low marginal costs ends up in a battle on sales volume in the marketplace.[l] By tradition, rental cars have benefitted from low marginal costs in production through attractive purchase and/or leasing terms.

Cross-elasticity of demand has a strong influence on mobility user choices

It has been noted that mobility service increased the number of trips and caused a "mode shift" from public transportation[li], something that particularly holds for free floating services. Here, it's important to understand the power of cross-elasticity of demand. For instance, if a taxi costs EUR 40 one way and the less convenient and time-efficient public transport EUR 3, the demand for both will be strongly influenced if new services such as hailriding (Uber etc.) EUR 20 one way and the opportunity to use carsharing for EUR 5,5 an hour. At the end, both taxi and public transport will lose demand and users. Not having access to a private car is strongly linked with carsharing use[lii]. On the contrary, having access to a private car has been found to be weakly associated with a higher probability of using shared e-scooters as they require less effort compared to e.g. walking or cycling. Bike-sharing and Uber do not substantially impact car ownership[liii].

Rental cars vs. carsharing is an example of similar, although not identical, services that competes on the same mobility needs, and the same traveler purchase power. According to a research report: "It is similar to a rental car, but the biggest difference is that it can be rented and returned in hours or minutes rather than daily"[liv]. Rental cars have been available at least for a century[lv], and German Sixt, founded in 1912, is still one of the major companies in the industry. Neither is carsharing a new phenomenon[lvi]. It can be traced back to 1948 in Zürich, when a carsharing cooperative was formed by a group of consumers, soon followed by similar initiatives in France and the Netherlands.[lvii]

Methodological Issues in Collecting Data About the Effects of Carsharing

Numerous studies are based on user surveys, a method that has inherent problems both in terms of who's answering the surveys – the average customer are normally under-represented –, and the extent to which what the respondent states is correct.[lviii] To a large extent, well-known arguments for carsharing such as less

congestion, no need for individual car ownership, and environmental benefits are well-known among users, and hence well-represented in survey answers.[lix] Numerous studies conclude that car ownership is suspended as carsharing gets available[lx]. The results from one study suggest that 30% of the respondents have changed or potentially would change their car ownership.[lxi] However, when reading the results of the survey more carefully, only 3 % of respondents state they "will give up" or "have disposed" car ownership. The other 27% have postponed the decision.

Conclusions

The transition to fewer cars is urgent – but difficult

There is an enormous potential in carsharing and research is advancing. From a societal perspective, there is an alternative use of public space and other stakeholders have an interest in using it. Station-based carsharing has the potential to reduce the total number of cars in urban areas, but it has proven difficult to accomplish without the city council's support. Rental car companies provide carsharing without dependency on support from public resources or any other type of subsidies, and they have been consistently profitable over time with exception of the early Corona pandemic, i.e. year 2020[lxii]. Yet the services provided by car rental companies are not as user-friendly as leading carsharing services.

Integrating carsharing it into the mobility system is a complex endeavour. Is that best use of these scarce public resources to invest them in carsharing? Resources could be invested in public transport, recreational areas, park-and-rides, a light rail network – or taxes could be lowered. A competition exists both regarding use of land, and on public resources. Supporting carsharing or changing taxing policies involves different levels of government (federal, regional and city/municipal) and different actors (carsharing firms, company car fleet operators, businesses, employees, consumers) that make a coordinated policy mix a complex multi-level governance problem.[lxiii] By manipulating the incentives offered, car ownership may be reduced at the expense of a more multi-modal lifestyle that includes occasional car use through carsharing. For example, incentives such as public transport passes, or bike sharing and carsharing memberships may lead to residents choosing to forgo the replacement of their cars. Cash incentives, however, risk residents offsetting the cost of a new car purchase instead.[lxiv]

In order to match supply and demand, flexible pricing might be necessary. When there is a high demand, some users may not gain access to a vehicle. A service based on 'willingness-to-pay' at peak times may be necessary to give priority to the vehicle system. Pricing techniques can solve this issue, by shifting vehicles to off-peak hours – the same underlying idea as with congestion charges.[lxv]

Rental cars have a long tradition of matching supply and demand, hire parking space for a limited time when needed, adjusting the number of vehicles available depending on the season at hand etc.. The service provided is similar to, yet not identical with, carsharing and the two ways of sharing cars both have a place in the mobility of the future. Carsharing obviously is not only important for society and the transition towards sustainable mobility with high customer value. It's also important to the automotive industry. Hence, widening their customer base and maximizing utilization and profits is important.[lxvi] Sustainable societies need sustainable business that create jobs and innovations while being financially sustainable.

Carsharing and Rental Cars Merge

Carsharing and rental cars are technically almost the same service – although there is an *image difference* – the former is being portrayed as a key solution in smart cities of the future, represented by contemporary busy mobility users who enjoy the flexibility and environmental friendliness, while the latter to a significant extent is associated with airport offices, tourists, countryside locations, and far from seamless car returns. In addition, there is an *interface difference*. Carsharing has an advantage through its more convenient setup and customer interface. Rental car companies are catching up, but it will take same time. The former difference is *perceived*, whereas the latter is *real*, maybe it's a cost of being available everywhere, not only in cool cities but anywhere inhabitants, businesses or tourists require mobility. A similar pattern could be found when it comes to taxi vs. ride-sharing – the former is not mentioned in leading research papers[lxvii], although taxi is much bigger a business than ride-sharing across the world. By 2028, taxi is still forecasted to be a larger business than ride-sharing in the US[lxviii], and only 26 % of Chinese mobility users book transport over a ridesharing app[lxix].

Through the passage of time, the difference between rental car and carsharing fades away. The advantages of both models become increasingly known through market forces, municipalities' and other public actors' attempts to organize carsharing, and through research. Traditionally, and still to an extent, there have been some differences between the two regimes.

First, the customer interface of carsharing is more user-friendly by typically offering temporary access through membership and subscription instead of rental cars, which require a contractual agreement each time one rents a car, something that has become much easier with digital solutions. It's changing, although at a rather slow pace. Car rental companies offer apps, keyless pickup etc. which makes the pick-up and return more convenient. Hertz introduced the ExpressRent kiosks in 2010 and car rental is undergoing a rapid digitization, implying an orientation towards seamless customer interfaces.

Second, carsharing locations are closer to city centers, mobility hubs, and residential areas whereas rental cars are located where it has traditionally been appropriate for the provider's logistics and where demand is high. It has a far better coverage in rural areas, where carsharing hardly exists. This difference is likely to remain to an extent. We'll still see more car rental stations at airports, car dealerships etc. while carsharing will have locations typically more suited to customers' mobility needs on the one hand, but entail significantly higher parking and logistics costs on the other. Station-based carsharing often offers one park slot per car, or close to, reflecting low utilization, while car rental companies typically have far more park slots than cars, something that gives a double cost advantage: cheaper locations and higher park space utilization. Regardless of provider, it's very difficult to provide cars exactly where it makes most sense to consumers. On the contrary, the location of hubs is very complex and involves many considerations.[lxx]

Thirdly, pricing models differ with more opportunities for shorter rentals through carsharing. This is now changing. U.S. carsharing provider Link offers three pricing models: rental fee per minute (minimum 15), 3 hour city sprint, and 5 hour break-away. A monthly membership fee always applies[lxxi]. Rental car companies typically charge minimum 24 hours and even offer monthly rates under a separate long-term rental program. Some carsharing providers try to grasp both markets, e.g. Toyota's Kinto Share and Volvo on Demand offer rental by hour, 24 hours, 72 hours, week or month[lxxii]. Accordinlgy, the widespread definitory difference between carsharing (minimum 15 minutes or one hour) and rental cars (minimum 24 hours) gradually disappears through the convergence of the two models: rental cars being increasingly being offered for short rentals of an hour, and carsharing being offered based on monthly rates.

The majority of major car rental companies are transforming their business models to become part of the carsharing business, hence drawing advantages from fleet management and logistics model that handle large volumes of cars efficiently while at the same time offering convenient and competitive carsharing, primarily to urban mobility users, hence contributing to more competition and a faster transition to sustainable solutions. One example is Europcar's carsharing unit Ubeeqo. Even small car rental operators are undergoing a transition. Sweden's second largest gas station chain OKQ8, with 770 stations, offer rental cars at more than 100 locations, and now also app-based hourly rental in three central locations in Stockholm.

Demand for mobility is an exogenous factor and mobility providers have to make sure that what they offer in the marketplace contributes to the overall mobility system. In accordance with shareholder expectations to be sustainable, manufacturers argue they engage in carsharing to contribute to protecting the environment. Here, public actors have to be clear on what they want and they should set up clear goals for the overall mobility system of the future. Market forces cannot secure well-functioning mobility for everybody, nor can public authorities be the primary driving force in this development.

Finally, a threshold, how poor it may sound, for using a product is not purely negative. It means the user has to make an effort or give up something to reach what is wanted. Providing every citizen in every city with the mobility they want exactly when they need it would mean an enormous strain on public resources. There is always a scarcity of resources at hand, hence, all mobility efforts have to be examined in relation to their contribution to a common good, which is defined by those who design the mobility system, e.g. politicians and authorities. From a societal perspective and from the perspective of not overusing our limited resources, it's necessary to think in down-to-earth terms and not let vague concepts such as seamless mobility, hassle-free customer experience and ultra-smart cities dominate the debate. The aim is clear: to make sure citizens get the mobility they need, when they need it, but not necessarily always exactly the way they want it.

References

Acheampong, R.A., Siiba, A., 2020, Modelling the determinants of car-sharing adoption intentions among young adults: the role of attitude, perceived benefits, travel expectations and socio-demographic factors. Transportation , 47, 2557–2580

ADEME (Agence de l'Environnement et de la Maitrise de l'Energie), 2014, "L'autopartage en trace directe: quelle alternative à la voiture particulière? [Direct-track carsharing: what alternative to the private car?]" Retrieved from https://transportsdufutur.ademe.fr/wp-content/uploads/sites/6/2014/08/AD_6pages_140512.pdf

Agrawal, B.B. & BEllos, I., 2016, The Potential of Servicizing as a Green Business Model, Management Science, 63(5), 1545-1562.

Amatuni, L.; Ottelin, J.; Steubing, B. & Mogollón, J.M., 2020, Does Car Sharing Reduce Greenhouse Gas Emissions? Assessing the Modal Shift and Lifetime Shift Rebound Effects from a Life Cycle Perspective. J. Clean. Prod. 266.

Amirnazmiafshar, E. & Diana, M., 2022, A review of the socio-demographic characteristics affecting the demand for different car-sharing operational schemes, Transportation Research Interdisciplinary Perspectives, 14.

Arruñada, B. & Vázquez, G.Z., 2009, Institutional constraints on organizations: the case of Spanish car dealerships, Managerial and Decision Economics, 30(1), 15-26.

Automotive Fleet, 1962, Car Renting… Its Development… And Futurehttps://www.automotive-fleet.com/147063/car-renting-its-development-and-future, downloaded Sept. 17th 2023.

Autorental News, 2023, HyreCar Files for Bankruptcy, Prepares for Sale, March 14th, https://www.autorentalnews.com/10194707/hyrecar-files-for-bankruptcy-prepares-for-sale, downloaded Sept. 17th 2023.

Autorentalnews, 2019-2023, various issues.

Balac, M., Becker, H., Ciari, F. and Axhausen, K.W. (2019), "Modeling competing free-floating carsharing operators–A case study for Zurich, Switzerland", Transportation Research Part C: Emerging Technologies, Vol. 98, pp. 101-117.

Bardhi, F. & Eckhardt, G.M., 2012, Access-Based Consumption: The Case of Car Sharing, *Journal of Consumer Research*, 39(4), 1 December 2012, 881–898.

Becker, H., Ciari, F. and Axhausen, K.W. (2017), "Comparing car-sharing schemes in Switzerland: user groups and usage patterns", Transportation Research Part A: Policy and Practice, 97, 17-29.

Bellos, M. Ferguson, L.B. Toktay, 2017, The car sharing economy: Interaction of business model choice and product line design Manufacturing and Service Operations Management, 19 (2), 185-201.

Changaival B, Lavangnananda K, Danoy G, Kliazovich D, Guinand F, Brust M, Musial J, Bouvry P. Optimization of Carsharing Fleet Placement in Round-Trip Carsharing Service. *Applied Sciences*. 2021; 11(23)

Chapman DA, Eyckmans J, Van Acker K. Does Car-Sharing Reduce Car-Use? An Impact Evaluation of Car-Sharing in Flanders, Belgium. *Sustainability*. 2020; 12(19):8155

Chase, R., 2012, Thoughts on Carsharing, https://sustainabledevelopment.un.org/content/documents/23730411Cars.pdf.

Csonka, B. & Csiszar, C. (2016), "Service quality analysis and assessment method for European carsharing systems", Periodica Polytechnica Transportation Engineering, 44(2), 80-88.

Dowling, K., Manchanda, P. & Spann, M., 2020, The existence and persistence of the pay-per-use bias in car sharing services, International Journal of Research in Marketing 38(2)

Elad, B., 2023, Ridesharing Industry Statistics By Market Size, Industry, Age, Country, Demographics, Education and Annual Income, Enterprise Apps Today, Aug. 22nd, https://www.enterpriseappstoday.com/stats/ridesharing-industry-statistics.html?utm_content=cmp-true, downloaded 18. Sept. 2023.

Firnkorn, J. & Müller, M., 2011, Selling Mobility instead of Cars: New Business Strategies of Automakers and the Impact on Private Vehicle Holding, Business Strategy and the Environment, 21(4), 264-280.

Fromm, Hansjörg; Ewald, Lukas; Frankenhauser, Dominik; Ensslen, Axel; Jochem, Patrick (2019) : A study on free-floating carsharing in Europe: Impacts of car2go and DriveNow on modal shift, vehicle ownership, vehicle kilometers traveled, and CO2 emissions in 11 European cities, Working Paper Series in Production and Energy, No. 36, Karlsruhe Institute of Technology (KIT), Institute for Industrial Production (IIP), Karlsruhe

Glotz-Richter, M., 2012, Carsharing—"Car-on-call" for reclaiming street space. Procedia—Soc. Behav. Sci. 48, 1454–1463

GVR (Grand View Research), 2022, Ride-hailing And Taxi Market Size, Share & Trends Analysis Report By Type (Ride-hailing, Taxi), By Distribution Channel, By Region, and Segment Forecasts, 2022 – 2028.

Habib, K.M.N., Morency, C., Islam, M.T. & Grasset, V., 2012, Modelling users' behaviour of a carsharing program: Application of a joint hazard and zero inflated dynamic ordered probability model, Transp. Res. Part A: Policy Pract., 46 (2), 241-254.

Habibi, S., Englund, S., Voronov, A., Engdahl., H., Sprei, F., Pettersson, S. & Wedlin, J., 2017, Comparison of free-floating car sharing services in cities, ECEEE Summer Study Proceedings, European Council for an Energy-Efficient Economy, Mobility, Transport, and Smart and Sustainable Cities, s. 771-778.

Happaerts, S. Climate Governance in Federal Belgium: Modest Subnational Policies in a Complex Multi-Level Setting. J. Integr. Environ. Sci. 2015, 12, 285–301.

He, L., Mak, HY., Rong, Y. (2019). Operations Management of Vehicle Sharing Systems. In: Hu, M. (eds) Sharing Economy. Springer Series in Supply Chain Management, vol 6. Springer, Cham.

Henrik Becker, Francesco Ciari, Kay W. Axhausen, 2017, Modeling free-floating car-sharing use in Switzerland: A spatial regression and conditional logit approach, Transportation Research Part C: Emerging Technologies, 81, 286-299,

Hu, B., Zhang, Y, Feng, C. & Dong, X., 2023, Understanding the characteristics of car-sharing users and what influences their usage frequency, Information Processing & Management, 60(4).

J.M. Skjelvik, A.M. Erlandsen, O. Haavardsholm, 2017, Environmental Impacts and Potential of the Sharing Economy Nordic Council of Ministers, Denmark.

Joann, P. & Shu, S.B., 2009, "The Effect of Mere Touch on Perceived Ownership," *Journal of Consumer Research*, 36 (October), 434–47.

Joonho Ko, Hyeongyun Ki & Soojin Lee (2019) Factors affecting carsharing program participants' car ownership changes, Transportation Letters, 11:4, 208-218

Jorge, D., Barnhart, C. and de Almeida Correia, G.H. (2015), "Assessing the viability of enabling a round-trip carsharing system to accept one-way trips: application to Logan Airport in Boston", Transportation Research Part C: Emerging Technologies, Vol. 56, pp. 359-372.

Jung, J. & Koo, Y., 2018, Analyzing the Effects of Car Sharing Services on the Reduction of Greenhouse Gas (GHG) Emissions. Sustainability, 10, 539.

Juschten, M., Ohnmacht, T., Thao, V.T., Gerike, R. & Hossinger, R., 2019, "Carsharing in Switzerland: identifying new markets by predicting membership based on data on supply and demand", Transportation, 46(4), 1171-1194

Ke, H. & Mo, Y., 2022, Station-Based or Free-Floating? An Integrated Carsharing System with Dual Service Types. Service Science 15(1):58-76.

Ke, H.; Chai, S. & Cheng, R., 2019, Does Car Sharing Help Reduce the Total Number of Vehicles? Soft Comput. 2019, 23, 12461–12474.

Keigo Ikezoe, Eriko Kiriyama, Shuzo Fujimura, 2021, Analysis of car ownership motivation in Tokyo for sustainable mobility service and urban development, Transport Policy, 114, 1-14.

Khan, M. & Machemehl, R., 2016, The Impact of Land-Use Variables on Free-Floating Carsharing Vehicle Rental Choice and Parking Duration, in Thakuriah, P., Tilahun, N. & Zellner, M., Seeing Cities Through Big Data: Research, Methods and Applications in Urban Informatics, Springer Geography, Wiesbaden: Springer, 331-347.

Lamberton, C. P., & Rose, R. L. (2012). When is ours better than mine? A framework for understanding and altering participation in commercial sharing systems. Journal of marketing, 76(4), 109-125.

Le Vine, S., Polak, J. (2017) The impact of free-floating carsharing on car ownership: Early- stage findings from London. Transport Policy.

Loose, W., 2011, The State of European Car-Sharing Final Report D 2.4 Work Package 2 Bundesverband CarSharing e. V., https://www.eltis.org/sites/default/files/trainingmaterials/the_state_of_carsharing_europe.pdf

MacDuffie, J.P., 2017, Demographic Shifts: Shaping the Future of Car Ownership, Knowledge at Wharton, A business journal from the Wharton School of the University of Pennsylvania, Febr. 17th.

Mavlutova I, Kuzmina J, Uvarova I, Atstaja D, Lesinskis K, Mikelsone E, Brizga J. Does Car Sharing Contribute to Urban Sustainability from User-Motivation Perspectives? *Sustainability*. 2021; 13(19):1058

May, X.; Ermans, T.; Hooftman, N. Company Cars: Identifying the Problems and Challenges of a Tax System. Brussels Studies. [Online], Synopses, no. 133. 25 March 2019.

Meijkamp, R., 1998, Changing consumer behaviour through eco-efficient services: an empirical study of car sharing in the Netherlands, usiness Strategy and the EnvironmentVolume 7, Issue 4Sep 1998Pages179-259

Mouratidis, K., 2022, Bike-sharing, car-sharing, e-scooters, and Uber: Who are the shared mobility users and where do they live?, Sustainable Cities and Society, Volume 86,

Munzel, K., Boon, W., Frenken, K. & Vaskelainen, T., 2018, Carsharing business models in Germany: characteristics, success and future prospects, Information Systems and E-Business Management, Vol. 16(2), 271-291.

Nansubuga, B. & Kowalkowski, C., 2021, Carsharing: a systematic literature review and research agenda, Journal of Service Management, 32(6), 55-91.

Örsdemir, A., Deshpande, V. & Parlaktürk, A.K., 2019, Is servicization a win-win strategy? Profitability and environmental implications of servicization, Manufacturing and Service Operations Management, 21 (3), 674-691.

Ortega, A., Haq, G. & Tsakalidis, A., 2023, Carsharing in Europe: a critical review of policy, research, innovation, and practice, Transportation Planning and Technology, 46:4, 381-406.

Pierce, Jon L., Tatiana Kostova, and Kurt T. Dirks (2001), "Towards a Theory of Psychological Ownership in Organizations," *Academy of Management Review*, 26 (2), 298–310.

Prieto, M., Baltas, G. & Stan, V., 2017, "Car sharing adoption intention in urban areas: what are the key sociodemographic drivers?", Transportation Research Part A: Policy and Practice, Vol. 101, 218-227.

Qiuyue. S., Jun B., Xiaomei Z. Wei G. & Chaoru. L., 2023, "Joint optimization of infrastructure deployment and fleet operations for an electric car sharing system by considering multi-type vehicles, Journal of Cleaner Production, 422.

Regina R. Clewlow, 2016, Carsharing and sustainable travel behavior: Results from the San Francisco Bay Area, Transport Policy, 51, 158-164.

Seo, J. & Lee, S., 2022, Who gives up a private car for a carsharing service? An empirical case study of Incheon City, South Korea, International Journal of Sustainable Transportation, 16:10, 875-886

Sprei, F. & Ginnebaugh, D., 2018, Unbundling cars to daily use and infrequent use vehicles—the potential role of car sharing, Energy Efficiency, 11, 1433-1447.

Svennevik, E.M.C., Dijk, M. & Arnfalk, P., 2021, How do new mobility practices emerge? A comparative analysis of car-sharing in cities in Norway, Sweden and the Netherlands, Energy Research & Social Science 82(7)

Turoń K, Kubik A, Chen F. What Car for Car-Sharing? Conventional, Electric, Hybrid or Hydrogen Fleet? Analysis of the Vehicle Selection Criteria for Car-Sharing Systems. *Energies*. 2022; 15(12):4344

Turoń K. 2022, From the Classic Business Model to Open Innovation and Data Sharing—The Concept of an Open Car-Sharing Business Model. *Journal of Open Innovation: Technology, Market, and Complexity*. 8(1):36.

W. Liu, X. Yan, W. Wei, D. Xie, 2019, Pricing decisions for service platform with provider's threshold participating quantity, value-added service and matching ability, Transp. Res. Pt. E-Logist. Transp. Rev., 122 (2019), pp. 410-432

Wang, Y, Wang, Z., Hu, X., Xue, G. & Guan, X., 2022, Truck–drone hybrid routing problem with time-dependent road travel time, Transportation Research Part C: Emerging Technologies, 144.

Yuhan Guo, Yu Zhang, Youssef Boulaksil, Yaguan Qian, Hamid Allaoui, 2023, Modelling and analysis of online ride-sharing platforms – A sustainability perspective, European Journal of Operational Research, 304(2), 577-595,

---

[i] Parment 2014
[ii] Lamberton and Rose 2012
[iii] Mouratidis 2022
[iv] Kahn & Machemehl, 2016
[v] Becker et al., 2018; Cai et al., 2019; Clewlow, 2016; Katzev, 2003; Nijland & van Meerkerk, 2017; Park & Moon, 2013
[vi] Park and Moon (2013)
[vii] Meijkamp 1998
[viii] Sprei, F. & Ginnebaugh, D., 2018; Firnkorn & Müller, 2011
[ix] Firnkorn & Müller, 2011

[x] Sjelsvik et al 2017
[xi] Ademe (Agence de l'Environnement et de la Maitrise de l'Energie) 2014
[xii] Ko et al, 2019
[xiii] Katzev (2003)
[xiv] Fromm et al 2019
[xv] Kim et al, 2017
[xvi] Ikezoe et al, 2020; Le Vine & Polack, 2019
[xvii] Clewlow et al 2017
[xviii] Moreover, studies have found that ride-hailing increases motorized traffic and causes traffic congestion, accordingly, there are areas where ride-hailing is not approved by the municipality (Tirachini, 2019).
[xix] Clewlow (2016)
[xx] Seo et al., 2018)
[xxi] Jung and Koo (2018)
[xxii] Martin and Shaheen (2011)
[xxiii] Mavlutova et al 2021
[xxiv] Seo and Lee
[xxv] He et al 2020
[xxvi] See e.g. autorentalnews.com, various issues.
[xxvii] Car2go, 2011
[xxviii] Namazu and Dowlatabadi (2018)

[xxix] Becker et al 2017
[xxx] Amirnazmiafshar & Diana 2022
[xxxi] Balac et al 2019; Jorge et al 2015; Nansubaga & Kowalkowski 2021
[xxxii] Schmöller et al., 2015, se även de Lorimier and El-Geneidy, 2013
[xxxiii] Becker et al 2017; Balac et al 2019
[xxxiv] Celsor and Millard-Ball, 2007, Stillwater et al., 2009
[xxxv] Frei et al., 2017
[xxxvi] Frei et al., 2017, Schmöller et al., 2015
[xxxvii] Chapman et al 2020
[xxxviii] Amatuni et al 2020; Jung and Koo 2018; Ke et al 2019
[xxxix] Chase 2012
[xl] Liut et al 2019
[xli] Liu et al 2019
[xlii] Liu et al (2019), Zhang et al (2019).
[xliii] Sou et al 2022
[xliv] Autorentalnews 2023
[xlv] Numerous other cities support carsharing, e.g. through offering park place for free.
[xlvi] Habibi 2017
[xlvii] Gou et al 2022
[xlviii] Arruñada & Vazquéz 2009

[xlix] Sou et al 2022
[l] Parment, 2009, 2016
[li] Datson 2016)
[lii] Hjorteset & Böcker, 2020; Martin et al., 2010; ter Schure et al., 2012; Ye et al., 2019
[liii] Blazanin et al. (2022) Tirachini & del Río, 2019; Mouratidis et al 2022
[liv] Seo and Lee, p. 878
[lv] Automotive Fleet, 1962
[lvi] Nansubuga & Kowalkowski, 2021
[lvii] Shaheen et al., 1998
[lviii] Parment & Söderlund, 2010
[lix] Acheampong & Siba, 2020
[lx] Ko et al 2019
[lxi] Ko et al 2019
[lxii] Autorentalnews, 2019-2023, various issues.
[lxiii] Happaerts et al 2015
[lxiv] Chapman et al 2020
[lxv] Dowling et al 2021; Ortega et al 2023
[lxvi] Cf. Nansubaga et al 2021t
[lxvii] See e.g. Guo et al, 2023
[lxviii] GVR Report, 2021
[lxix] Elad, 2023
[lxx] Changaival, 2021
[lxxi] https://blinkmobility.com/rental-rates/
[lxxii] https://www.kinto-mobility.se/kinto-share/priser; https://www.volvocars.com/se/on-demand/priser