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Social benefits of shared mobility: metrics and methodologies

26th ACEA SAG REPORT

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EXECUTIVE SUMMARY

The European Automobile Manufacturers' Association (ACEA) has commissioned this 26th Scientific Advisory Group (SAG) report to examine the social impacts of shared mobility. Through reviewing existing studies and evaluation frameworks, the report provides clear recommendations on how to capture the social impacts of shared mobility and how this can be delivered through the collaboration of the various public and private actors in the system.

This SAG report by Professor Greg Marsden (Institute for Transport Studies, University of Leeds) focuses on what is understood about the social benefits of newer forms of shared mobility such as pooled ride-hailing, e-scooters and carsharing. However, it does so from the perspective that these innovations are just a further part of the mobility eco-system. Their role and their impacts need to be understood alongside the existing mobility options such as bus and rail or active travel. Much sharing goes on informally, through family or social groups and often now organised via chat platforms such as WhatsApp. We know already that a large part of the population is multi-modal across the week and so these new options will most likely form part of a new blend of mobility for users. Sometimes new services will act as complements to and sometimes as competitors with existing modes. If new forms of shared mobility are to be treated fairly in terms of regulation and support then it is important to understand what role they fulfil.

There is also a huge diversity of shared mobility innovations being developed. Some are about sharing of assets such as cars, bikes or e-scooters which can be through private companies, local governments or peer to peer. Other sharing is about sharing on the go, such as demand responsive services, pooled ridehailing or liftsharing. That too can take diverse forms. In discussing the social impacts of shared mobility it is essential to recognise that this is not one thing – but many – and the purpose, target markets, barriers and use cases will potentially be quite different.

Shared mobility provides additional options into the transport mix for the areas in which they operate. There are four main ways in which shared mobility could impact on individuals:

1. They can provide greater spatial accessibility for people who are within a reasonable walking distance of the system. They also offer the potential for first and last-mile trips which connect to mainline public transport services thus widening the spatial opportunities reachable within a reasonable time frame.
2. They can be made available 24/7 in many instances and thus offer a wider temporal accessibility than existing public transport services. Whilst, in theory, such services could be provided by public transport, limited demand often makes this too expensive to subsidise through traditional services.
3. Sharing assets may be able to lower the unit costs of journeys through more efficient use. Shared ridehailing services for example offer discounted fares, although with a small trade off in extra detour journey times.
4. Over and above journey time (spatial accessibility) and cost savings there may be other aspects of journey quality which shared mobility augments such as greater

exercise, social benefits from coordinating journeys with colleagues or friends and family and feelings of satisfaction and well-being.

To understand how the individual potential impacts of shared mobility translate into social impacts it is necessary to examine impact pathways. Changes to the transport system mix result in changes to travel patterns which in turn produce both directly measurable and second order social impacts. An example of a direct benefit would be the greater temporal accessibility offered by subsidised ridehailing services. This might make people in a disadvantaged area report being more able to participate in jobs in the nighttime economy, which in turn reduces unemployment and improves standards of living for the most needy. Second order impacts are more complex to track but include how the wider system adapts as a result of changing travel patterns such as the growth of retail around mobility hubs or reductions in parking requirements for new development which lower housing costs.

Whilst the review has identified a range of studies which suggest the potential for shared mobility to have positive social impacts, the evidence base is surprisingly weak. The majority of systems have not been designed to tackle specific social impacts or promote social goals and studies of impacts have only tangentially considered social impacts. Evidence is available on the profile of members and users, with new shared mobility services generally being more likely to be used by parts of the population who are male, younger than average and educated to university level. In general, the central areas of larger cities is where early market demand has been greatest and where supply has focussed. It should not be presumed that shared mobility services will deliver social benefits in the way that maximises public policy benefits. Indeed, one of the benefits of developing a better understanding of the impacts of shared mobility will be the ability to make more informed and proportionate regulatory interventions and to justify the targeting of subsidy to support outcomes which the market would not deliver by itself.

This review has not been able to establish a single source which provides a comprehensive and usable framework for the social impact assessment of shared mobility and this lack of coherence is perhaps a contributory factor to the weak evidence base. To help overcome the limited evidence base an indicator framework is proposed which directly connects to the impact pathways collecting data on:

- Accessibility impacts;
- Transport system impacts;
- Wider impacts; and
- Equity impacts, which include distributional concerns.

There is little consensus across cities and between different research studies on how many indicators is enough or what the right indicators are (and this is true beyond social impact assessment). Even with some simplification 35 indicators were identified across six studies which could potentially be applied. There are other important areas such as the consumption of space and well-being that are yet to feature in the indicator sets.

Four case studies are reviewed which have elements of a state-of-art or robust approach to evaluation. They demonstrate that social impact assessment requires an understanding of

who is being served (and who is not) and whether the change in behaviour has unlocked something new or shifted use from one form of mobility to another. Given that shared mobility services are still used by a minority of users, normally for a minority of trips it is essential to see how the new services perform within the total set of mobility decisions people make. This means, for most cases, attempting to establish the travel patterns of a representative sample of all citizens in an area and looking at differences between groups with access to or using shared mobility services with those who do not have access or do not use them. This means, therefore, that to truly understand the social benefits of shared mobility and to enable them to be delivered in a wide scale requires collaboration across the different actors in the mobility eco-system. The report concludes with seven recommendations which, therefore, reflect this collaborative imperative.

BUILD THE EVIDENCE BASE

These are necessary to understand the role of new shared mobility services and to inform approaches to subsidy and regulation where this is important to steering different social outcomes to those which the market alone would provide.

1. The European Commission's DG MOVE should establish a handbook of social benefits which provides a guiding framework for the metrics and assessment methods for social impacts which local authorities and shared mobility providers can use in the planning of new mobility services. This should cover different mobility services in different geographic settings. Such a resource will significantly enhance the ability of the subsequent recommendations to build a rapid and robust evidence base.
2. City authorities and shared mobility providers should work together to develop trials which are specifically designed to deliver improvements to specific social issues. More bespoke evaluations should aim to learn about where the balance of subsidy, risk and reward in seeking to roll out shared mobility services which work for everyone and deliver greater social benefits.
3. Shared mobility providers and academics need to work to develop new metrics of multi-modal accessibility that allow joined up assessments of how users interact with an increasingly multi-modal set of options. This may also need to be extended to better understand how consumers use packages of services and how this impacts on their satisfaction.

DEVELOP A COMMON DATA STRATEGY

The second set of recommendations is about harnessing the strength of different actors with respect to the data they bring, building on the approaches which are already in play in cities and companies.

4. City authorities should set aside funding for regular household travel surveys which provide a baseline for how and why people travel in their areas;

5. City authorities and shared mobility providers should partner to fund additional survey costs required to more robustly demonstrate the social value of shared-mobility innovations. Rather than treating this on an innovation by innovation basis, all providers should contribute funding to a common pool. The data suggests that people use each shared mobility option as part of a mix of mobility uses and so only looking at single innovations is limiting;
6. Shared mobility providers should contribute to the survey effort by soliciting responses from within their user base, which will otherwise risk being under-represented in the data collected;
7. Shared mobility providers should also supplement the surveys with information which can be used to support distributional analysis, for example identifying particular.

CONTENTS

1. WHAT IS SHARED MOBILITY?

Shared mobility is not new. Up until the 1960s across Europe bus and rail were used for the majority of miles travelled and remain the major forms of shared mobility. Even beyond the 1960s car ownership was relatively low and, whilst this continued to rise, a far greater percentage of car use was shared than is the case today, with average car ownership levels in Europe in 2020 at around 524 per 1000 population.[1] Even today, most sharing is conducted peer to peer and through informal networks.[2] However, there is a major revolution and a new suite of shared mobility options which are already impacting mobility patterns.

This paper will focus on what is understood about the social benefits of these newer forms of shared mobility such as pooled ride-hailing, e-scooters and carsharing. However, it does so from the perspective that these innovations are just a further part of the mobility eco-system. Their role and their impacts need to be understood alongside the existing mobility options such as bus and rail or active travel. A large part of the population is multi-modal across the week and so these new options will most likely form part of a new blend of mobility for users.[3] Sometimes new services will act as complements to and sometimes as competitors with existing modes. If new forms of shared mobility are to be treated fairly in terms of regulation and support then it is important to understand what role they fulfil.

The rise of car ownership has brought considerable individual benefits in terms of convenience. The opportunity to move people and goods over large differences to a range of destinations has been very important to economic growth in the last century, although these links are weakening.[4] This individualised convenience has also brought with it significant social and environmental costs as well as rising congestion levels. It makes participation in society harder for many of those who do not have access to a car and is also wasteful of resources:

- The average car is stationary for 95% of the day[5];
- The largest proportion of the car fleet moving at one point in time has been estimated as 14%[6];
- A third of all cars do not move at all on any given day[6]; and
- The average occupancy of cars is around 1.2 for the peak and 1.6 overall[7].

[1] https://www.statista.com/statistics/452243/european-countries-number-of-cars-per-1-000-inhabitants/

[2] Golightly, D., Houghton, R., Hughes, N. and Sharples, S. (2019) Human Factors in Exclusive and Shared Use in the UK Transport System, Foresight Future of Mobility Review, https://www.gov.uk/government/publications/future-of-mobility-human-factors-of-exclusive-and-shared-travel

[3] Nobis, C. (2007) Multimodality – facets and causes of sustainable mobility behaviour, *Transport. Res. Rec.*, 2010, pp. 35-44

[4] Loo, B.P.Y. and Banister, D. (2016) Decoupling transport from economic growth: Extending the debate to include environmental and social externalities, *Journal of Transport Geography*, 57, 134-144, doi: 10.1016/j.trangeo.2016.10.006

[5] Leibling, D. and Bayliss, D. (2012) Spaced Out: Perspectives on Parking Policy, RAC Foundation

[6] Mattioli, G., Anable, J. and Goodwin, P. (2019) A week in the life of a car: a nuanced view of possible EV charging regimes, European Council for an Energy Efficient Economy (ECEEE) Summer Study 2019 Proceedings:. ECEEE 2019 Summer Study, 03-07 Jun 2019, Hyères France, pp. 1105-1116

[7] Marsden, G., Anable, J., Bray, J., Seagriff, E. and Spurling, N. (2019) Shared Mobility: Where now? Where next? The second report of the Commission on Travel Demand, Centre for Research into Energy Demand Solutions, Oxford, ISBN 978-1-913299-01-9

There is therefore a huge opportunity to provide the mobility needs of the population by making much more efficient use of fewer assets.[8,9] Mobility on-demand, which creates opportunities to access cars as part of a wider package of mobility options as an alternative to car ownership, is a growing prospect. This could help to improve the accessibility of those who cannot afford a car or for other reasons do not want to own a car or use it and it could tackle affordability issues which see some people owning cars when they cannot even afford holidays or home heating.[10] It is in this context that the rapidly developing combination of internet enabled sharing platforms offers a wide range of new shared mobility opportunities.

Machado et al. define shared mobility as "trip alternatives that aim to maximize the utilization of the mobility resources that a society can pragmatically afford, disconnecting their usage from ownership" (p1).[8] Shaheen et al define shared mobility as "short-term access to shared-vehicles according to the user's needs and convenience, instead of requiring vehicle ownership".[11]

Golightly et al. (2019) note that what is included under the umbrella of shared mobility is very diverse in terms of modes of transport, what is shared and the extent to which technology is important to sharing, concluding that "Any attempt to understand or manage shared travel through policy must take this diversity into account, rather than treating it as a single phenomenon or mode"[2] In particular, Golightly et al suggest that it is important to distinguish between assets which are shared asynchronously (eg carshare or bikeshare) where if one user has the asset others cannot access it and synchronous collaboration in use (eg liftshare) where the asset is shared as it moves through the network.[2] Dill and McNeill further identify the importance of the business models and basis for sharing – this can be business to consumer (B2C) or peer to peer (P2P) where the assets are owned by individuals rather than companies. Motivations for sharing can be purely altruistic, reciprocated, monetised or brokered according to Dill and McNeill and so the social benefits derived and who they fall to will in turn be different.[12]

Figures 1 and 2 below show two different depictions of the shared mobility ecosystem reflecting this diversity. This report focuses on the newer innovations in share mobility but, as with Golightly et al., includes public transport and informal lift giving as critical (and currently dominant) forms of shared mobility. The report also does not foreground the distinction between who owns and operates a system as different models can be in used for the same system (eg docked bikes). There may, of course, be important implications of the ownership model for issues such as regulatory influence, trust and where financial flows go. However, this report focuses on understanding the impacts of the systems on the basis of how they are operating, not who is operating them.

[8] Machado, C.A.S., de Salles Hue, N.P.M., Bersanetti, F.T., Quintanhila, J.A. (2018) An Overview of Shared Mobility, *Sustainability*, 10, 4342, doi:10.3390/su10124342
[9] International Transport Forum (2017) Transition to shared mobility: How large cities can deliver inclusive transport services, Report to Corporate Partnership Board, https://www.itf-oecd.org/transition-shared-mobility
[10] Mattioli, G. (2017) 'Forced Car Ownership' in the UK and Germany: Socio-Spatial Patterns and Potential Economic Stress Impacts, *Social Inclusion*, 5(4), doi.org/10.17645/si.v5i4.1081
[11] Shaheen, S., Bell, C., Cohen, A., Yelchuru, B. (2017) Travel behaviour, shared mobility and transportation equity, Report to Federal Highways Administration, PL-18-007
[12] Dill, J. and McNeil, N. (2021) Are shared vehicles shared by all? A review of equity and vehicle sharing, *Journal of Planning Literature*, 36(1), 5-30, doi:

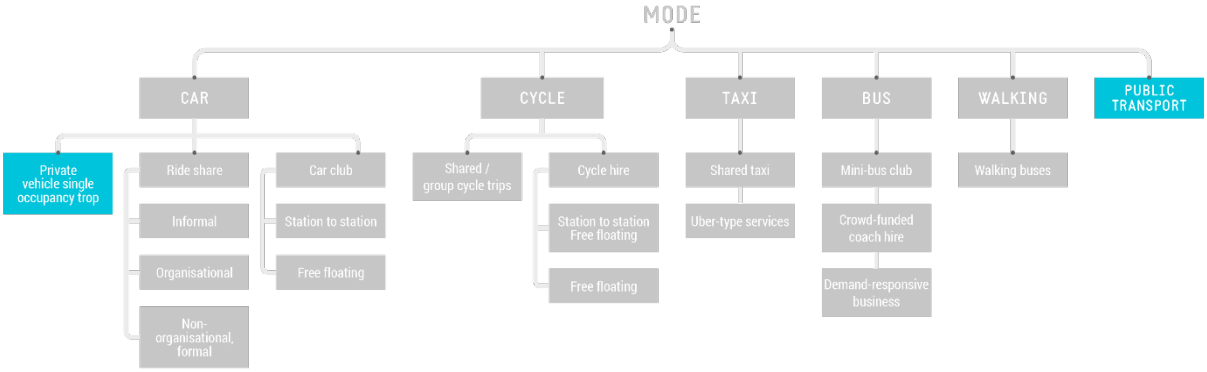

Figure 1: The range of shared mobility innovations – adapted from the classification by Golightly et al[2]

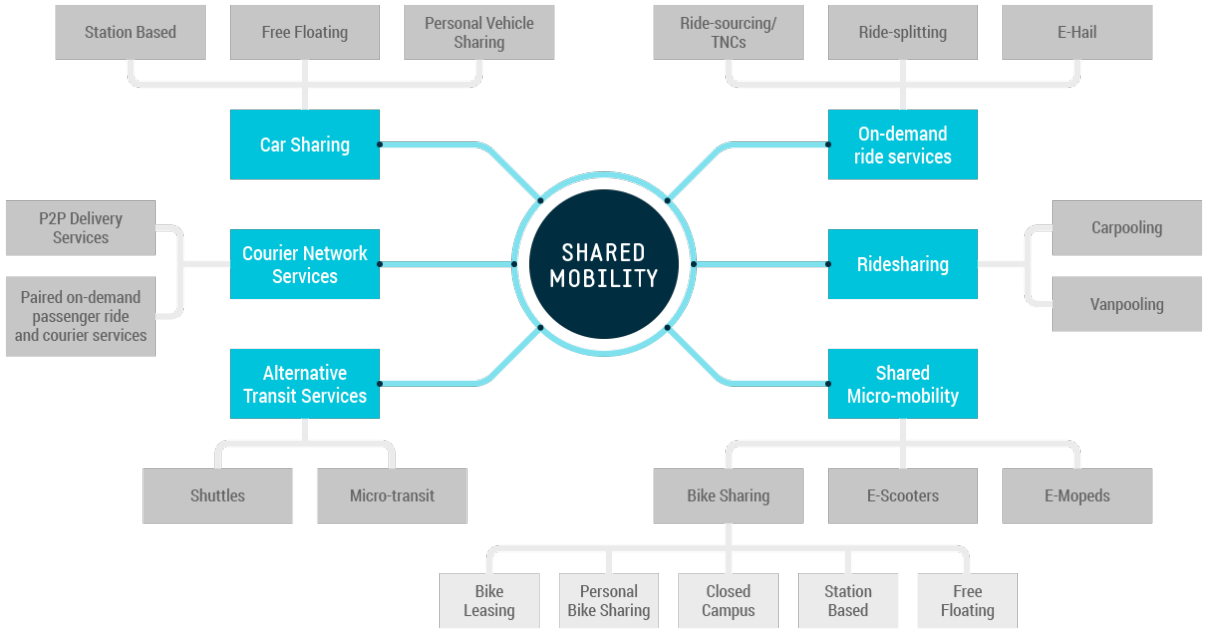

Figure 2: The range of shared mobility innovations – adapted from the classification by Roukouni and Correia[13]

Mobility as a Service (MaaS) is another innovation which connects to the shared mobility system. Pangbourne et al. see MaaS as a system where “users are purchasing mobility services via a broker (often termed a mobility operator) that provides an interface connected to multiple transport services.” P38[14] MaaS itself does not provide any new mobility services,

[13] Roukouni, A. and Correia, G.H. de Almeida (2020) Evaluation Methods for the Impacts of Shared Mobility: Classification and Critical Review, *Sustainability*, 12, 10504, doi:10.3390/su122410504
[14] Pangbourne, K., Mladenović, M.N., Stead, D. and Milakis, D. (2020) Questioning Mobility as a Service: Unanticipated implications for society and governance, *Transportation Research Part A*, 131, 35-49, doi: 10.1016/j.tra.2019.09.033

although it may enhance access to shared mobility resources by overcoming information shortfalls and enabling lower cost journeys to be identified.[15]

MaaS however is requiring transport authorities to confront the questions of integration between modes which are numerous and complex.[16] One critical question which is important to understanding the role of shared mobility in delivering social benefits is whether such services should receive subsidy to deliver desired social outcomes and, if so, how those should be assessed against existing services and how they should be channelled. Public transport has been found to provide huge social benefits through opening up access to employment, services and amenities and in combating social isolation.[17] As a result of these social benefits, in combination with congestion and pollution benefits, public transport receives significant subsidy to operate in each EU territory. This is delivered through a variety of mechanisms such as fuel or mileage rebates or through the contracting of specific services or direct payments for certain free or subsidised traveller groups. New mobility services may provide new connections to existing public transport services, replace aspects of current public transport or open up new markets. It will be necessary to treat these services on a level playing field. However, we currently lack the transparency on the social benefits of newer shared mobility options that would enable this to happen. This report goes some way to addressing that shortfall.

[15] Butler, L., Yigitcanlar, T. and Paz, A. (2020) Smart Urban Mobility Innovations: A comprehensive review and evaluation, *IEEE Access*, 8, 196034-196049, doi: 10.1109/ACCESS.2020.3034596
[16] ITF (2021) The Innovative Mobility Landscape: The Case of Mobility as a Service, International Transport Forum Policy Papers, No. 92, OECD, Paris, https://www.itf-oecd.org/innovative-mobility-landscape-maas
[17] Mott MacDonald and ITS Leeds (2013) Valuing the social impacts of public transport, Report to Department for Transport.

2. THE SOCIAL BENEFITS AND IMPACTS OF SHARED MOBILITY

2.1 Key benefits

Shared mobility provides additional options into the transport mix for the areas in which they operate. There are four main ways in which shared mobility could impact on individuals[18]:

1. The provision of new shared mobility options provides greater spatial accessibility for people who are within a reasonable walking distance of the system.[19] They also offer the potential for first and last-mile trips which connect to mainline public transport services or other assets such as carshare stations, thus widening the spatial opportunities reachable within a reasonable time frame.[20]
2. Shared assets can be made available 24/7 in many instances and thus offer a wider temporal accessibility than existing public transport services. In some cases, demand-responsive transport services or ridehailing have been specifically designed or subsidised to enable low-income workers to take up employment in the night-time economy.[21] Whilst, in theory, such services could be provided by public transport, limited demand often makes this too expensive to subsidise through traditional services.
3. Shared mobility options may be able to lower the unit costs of journeys through more efficient use of the assets. Shared ridehailing services for example offer discounted fares although with a small trade off in extra detour journey times.[22]
4. Over and above journey time (spatial accessibility) and cost savings there may be other aspects of journey quality which shared mobility augments. This could be greater exercise from using shared bikes or social benefits from co-ordinating journeys with colleagues or friends and family.[2] More recently, work has begun to focus on the relationship between the real experience of journeys and well-being and happiness and shared mobility will generate different experiences.[23]

As noted in Section 1, a large section of the literature is built around the idea that, faced with a sufficiently broad set of mobility options which includes access to car may allow people to give up owning their own car or to avoid the need to own a car.[24] There is the potential for a substantial saving in ownership costs, only some of which may transfer to spending on using mobility assets. This is important as there is now an established literature which identifies a

[18] Curl, A., Watkins, A., McKerchar, C., Exeter, D. and Macmillan, A.(2020) Social Impact Assessment of ModeShift, NZ Transport Agency Research Report 666.
[19] Shaheen, S. and Cohen, A. (2018) Impacts of Shared Mobility, ITS Berekely Policy Briefs 2018 (02), doi: 10.7922/G20K26QT
[20] Abduljabbar, R.S., Lyanage, S. and Dia, H. (2021) The role of micro-mobility in shaping sustainable cities: A systematic literature review, *Transportation Research Part D*, 92, 102374, doi: 10.1016/j.trd.2021.102734
[21] Palm, M., Farder, S., Shalaby, A. and Young, M. (2021) Equity Analysis and New Mobility Technologies: Toward Meaningful Interventions, *Journal of Planning Literature*, 36(1), 31-45
[22] Eckhardt, J., Lauhkonen, A. and Aapaoja, A. (2020) Impact assessment of rural PPP MaaS pilots, *European Transport Research Review*, 12(49), doi: 10.1186/s12544-020-00443-5
[23] Olsson, L.E. and Friman, M. (2021) Steering toward happiness in sustainable travel, In: Business Transformation for a Sustainable Future (pp.97-109), DOI:10.4324/9781003188773-8
[24] Schreier, H., Grimm, C., Kurz, U., Schweiger, B., Keßler, S. and Möser, G. (2018) Analysis of the Impacts of Car Sharing in Bremen, Final Report for SHARE-North

group of the population which owns cars despite being unable to afford other basic social goods such as heating or a week of holiday.[10]

Other social impacts which have been identified through the review, although primarily as concepts rather than with empirically supporting evidence include:

- Employment benefits in the shared mobility ecosystem
- Financial benefits can accrue to individuals who generate revenue from underused resources
- The consumption of space in urban areas. A recent ITF discussion paper identified that a car occupies 5 times more space than a pedestrian and 10 times more space than a bus in the peak period.[25] Sharing access to cars enables wider reforms to land-use policy such as reduced car parking provision for new development which in turn impacts on density and the quality of spaces.
- Lower emissions where shared mobility options results in greater vehicle occupancy or opens up the opportunity for those who cannot afford electric cars to access car share vehicles with higher environmental standards (for the purposes of this report the emission benefits would relate to health improvements rather than wider environmental goals although these are also clearly important).

2.2 Distributional and justice concerns

Shared mobility services will have direct social impacts on users of the systems. An important question from a public policy perspective is who do these benefits fall to and who misses out? Distributional assessments of social impact focus on the difference in characteristics of either or both the areas served by shared mobility services and the characteristics of the users of the system.[26] The distinction between access to and use of services is important. One could have proximity to shared mobility but not, for financial, physical or mental capabilities or cultural norms be able to use such a system. Much of the literature focusses on the differences between levels of uptake or membership or access on the basis of characteristics such as race, gender, employment status or income. Dill and McNeill (2020, p5) provide a review of the literature on equity and vehicle sharing.[12] Their assessment of the evidence to date, at least in many developed countries, has found that these services are used disproportionately by more privileged populations, such as people with higher incomes and more education and people who are male, nondisabled, white and/or younger".

Martens (2016) argues that the accessibility gap between the best served in the population and the worst served should be limited.[27] Within this though it is important to focus on providing a "sufficient" level of accessibility to a set of key services. In such a framing, so long as shared mobility services provided new accessibility opportunities to disadvantaged

[25] Crozet, Y. (2020) Cars and Space Consumption: Rethinking the Regulation of Urban Mobility, International Transport Forum Discussion Paper, No 2020/13, OECD Publishing, Paris, https://www.oecd-ilibrary.org/transport/cars-and-space-consumption_8abaa384-en
[26] Singh, J. (2020) Is Smart mobility also gender smart, *Journal of Gender Studies*, 29(7), 832-846, doi: 10.1080/09589236.2019.1650728
[27] Martens, K. (2016) Transport Justice: Designing Fair Transportation Systems, Routledge

populations there may still be wider social policy benefits even if already well served areas also receive an accessibility uplift.

Curl et al. (2020, p42), in a review of the social impact assessment of mode shift, argues that distributional analysis of accessibility should form "part, but not all of a broader social impact assessment."[18] They argue that "social, economic and environmental impacts are connected in a complex system. Impact pathways need to be articulated and second and higher order, wider impacts, considered.". So, for example, if ridehailing services add to accessibility for an area but result in the reduction of the viability and service frequency of public transport then this would need to be included in an impact assessment. They also note that social impact assessments would benefit significantly from engaging with the target communities rather than starting from traditional transport appraisal approaches which remain dominated by monetisable metrics such as travel time.

2.3 Impact pathways

As it is important to distinguish between the provision of new shared mobility assets or services (access to) and the use of those services, the social impacts of shared mobility assets can only really be understood by tracking: how they are used; who is using them; whether what they are doing is new travel or transferred from other modes; and what it is enabling people to do. The process of understanding changing impacts is shown below in Figure 3. It is necessary to understand shared mobility services not just in terms of the performance of the specific service but in relation to other transport options. Cohen and Shaheen, for example, found that only about 9% of 6000 carpool riders in morning used the car pooling trip for the reverse trip in the evening, the remainder used public transportation.[19] In Lyon, 9% of the population are members of the Velo'v system and so it forms just one part of the wider mobility ecosystem.[28]

Teixeira et al. reviewed the impacts of bike share schemes across 77 studies and made an assessment of the main benefits and the wider limitations and risks which can counter those benefits.[29] They note that the benefits of such schemes are contingent on replacing trips by motorised modes. Health gains may not occur for all groups and this will depend on the wider transport safety and air quality context. Whilst the systems seem to offer the theoretical potential to decrease the accessibility gap between car-owning and car-less groups socially disadvantaged groups are systematically underrepresented in the use of the systems.

Whilst on one level, the provision of additional shared mobility services, which make efficient use of assets, feels intuitively likely to generate positive social impacts there are very few simple cause and effect relationships. The next section addresses how to establish a framework to connect shared mobility to social impacts.

[28] Raux, C., Zoubir, A., and Geyik, M. (2017) Who are bike sharing schemes members and do they travel differently? The case of Lyon's "Velo'v" scheme, *Transportation Research Part A*, 106, 350-363
[29] Teixeira, J.F., Silva, C. and Moura e Sá (2021) Empirical evidence on the impacts of bikesharing: a literature review, *Transport Reviews*, 21(3) 329-351, doi: 10.1080/01441647.2020.1841328

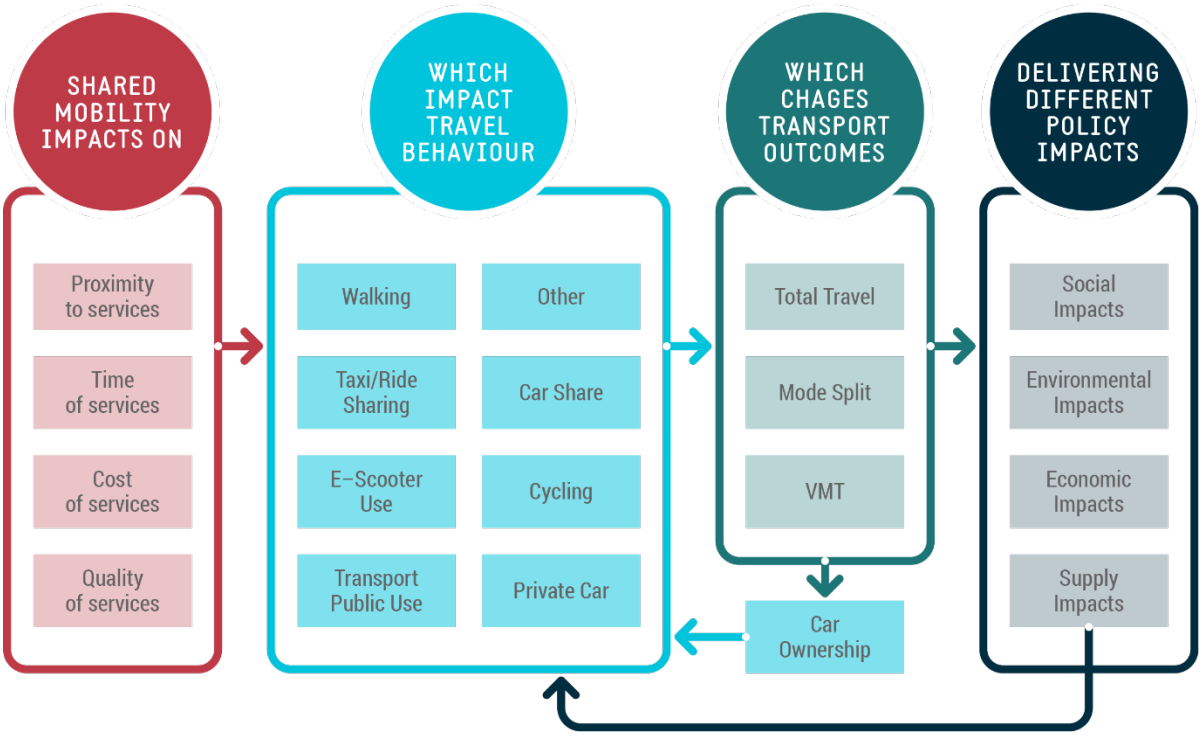

Figure 3: Shared mobility and the connection to social, environmental and economic impacts

3. A FRAMEWORK FOR ASSESSING SOCIAL IMPACTS

This report focuses on social benefits and impacts of shared mobility. It is, of course, impossible to separate out social, environmental and economic impacts in real life as they are mutually connected through the changes to patterns of use. This section begins by setting out the principles of indicator frameworks for assessing impacts before focussing more specifically on the social impacts which are the focus of this report.

3.1 Indicator frameworks

There are two core concerns in assembling an indicator framework:

1. The establishment of a clear set of outcomes or policy goals which the indicators are to inform
2. The establishment of a process which connects what can be measured with the outcomes or goals

The first of these two concerns is addressed by understanding the local policy context. They are driven by decision-makers who are ultimately responsible for the vision for their area. Different policy goals or outcomes have priority in different places and these can change over time. For example, currently in Sweden the 17 United Nations sustainable development goals[30] are shaping the selection of outcomes. In the UK, there has been a shift from very tightly specified key outcomes around a range of policy objectives connected to safety, air quality, congestion and inclusion to no central guidance[31], although this is moving again with requirements for climate targets. It is not possible here to specify the 'outcomes', but, in any indicator framework, it should be known why something is being monitoring something and what it contributes towards.

The second concern relates to the mechanics of assembling an indicator framework. This involves finding the right balance of comprehensive and simple to understand but, importantly, it must also connect what is measured to the outcomes through reasonable impact pathways as set out in Section 2. There should not be indicators in a framework that do not serve a purpose or have clear ownership. Many different guides to assembling indicator frameworks have been developed and interested parties can find further details in the reference list at the end of the document[32].

3.2 Social impact indicators in current practice

The review has not been able to establish a single source which provides a comprehensive and usable framework for social impact assessment. All studies which examine shared mobility in some way have something to contribute in that they utilise some metrics to

[30] https://sdgs.un.org/goals
[31] https://doi.org/ 10.1016/j.tranpol.2009.03.003
[32] Marsden, G., Kelly, C.E., Snell, C. (2006) Selecting indicators for strategic performance management, Transportation Research Record, 1956(1), 21-29; Gudmundsson, H., Hall, R., Marsden, G. and Zeitsman, J. (2016) Sustainable transportation: Indicators, frameworks, and performance management, Springer, 10.1007/978-3-662-46924-8; Guidelines for developing and implementing a Sustainable Urban Mobility Plan, https://www.eltis.org/mobility-plans/sump-online-guidelines

demonstrate the impacts or, if modelled, the potential impacts of the innovation in question. Table 1 below attempts to list the topics for which indicators are suggested from six of the most relevant and comprehensive sources.

Table 1: Potential Social Impact Indicators

Topic	Roukouni & Correia[11]	Transform[33]	Eckhardt et al.[19]	Curl et al.[15]	Pakkanen[34]	WBCSD[35]
Accessibility Impacts						
Access to key services		x	x	x	x	x
Access to mobility services						x
Connectivity				x		
First/last-mile connections	X					
Perceived accessibility			x	x	x	
Transport System Impacts						
Active travel	X			x	x	x
Attitudes towards public transport/sharing			x			
Journey quality/intrinsic value				x	x	x
Multi-modality	X		x	x		x
Reliability				x		
Resilience				x		
Total transport service provision		x		x		
Travel time	X			x		x
Travel Costs	X	x	x	x	x	
Trip generation	X		x	x	x	
Vehicle ownership	X					
VMT	X					

[33] Transform (2017) A Framework for equity in new mobility, TRANSFORM, transformca.org, California
[34] Pakkanen, T. (2020) The social and distributional impacts of transport in the Helsinki region: What how and whom to access? Masters Dissertation, Aalto University.
[35] WBCSD (2020) Methodology and indicator calculation method for sustainable urban mobility, report to the World Business Council on Sustainable Development, Paris.

Wider Impacts						
Economic opportunity						x
Economic Activity Near Hubs	X					
Employment	X	x		x		
Net public finance						x
Air quality	X	x	x	x	x	x
Accidents	X	x		x	x	x
Health	X			x		
Noise				x	x	x
Social cohesion					x	
Security				x		x
Forced relocation/gentrification				x	x	
Land-use	X			x		x
Parking supply	X					
Urban aesthetics	X			x	x	x
Equity Impacts						
Diversity of user		x	x	x		
Distribution of benefits to disadvantaged groups		x	x	x	x	x
Equity	X	x		x		
Fairness in conditions for shared mobility workers		x				

Some 35 different indicator topic areas are identified across the studies (even after allowing for some amalgamation of very similar but different topics). Other indicators such as greenhouse gas emissions or energy efficiency have been excluded as these would fall more squarely under the environmental impact category and the direct social impact link is unclear. By contrast, air quality is included here as the actions within a city will directly impact on the distribution of air quality to its residents. 12 of the indicators are only identified in one of the papers. Even were those 12 to be excluded, there is still a very diverse and substantial list of different metrics that could potentially be collected under the broad umbrella of social impacts.

The table provides a comprehensive list of different social impacts which shared mobility could have. It is not though, exhaustive, for example it does not feature indicators on happiness and subjective well-being nor is there a consistent focus on the use of space (although aspects of land-use are covered).

In order to convert these (or other indicators which stakeholders value), it is essential to connect this into a framework which links indicators to outcomes as noted in Section 3.1. The review of social impacts in Section 2 suggested that this is best done by thinking through the causal impact chains. This helps both to structure the type of information that can be collected and by who and the extent to which the data requirements are proportionate to the scale of the mobility innovation concerned. A carshare scheme with 10 stations in a city could be anticipated to have a much smaller sphere of influence than one with 100 stations in another similar city and so the visibility of second order impacts may be much harder to trace.

3.3 Assembling an indicator framework

In order to connect the policy outcomes to the range of potential indicators then the impact chain is organised as set out in Figure 3. This focuses on what is changed in the transport options for the users, then it examines how this impacts on patterns of mobility and, from that, what the net social impacts are. It is also essential to consider how these impacts are distributed across the population. Each of these elements are treated in turn below.

3.3.1 Accessibility impacts

These are metrics which set out what is available and what, in theory, this provides access to. Variables to be measured include the locations of stations/pick up points, service hours, average waiting times and service costs. There are two aspects to consider. First is access to the assets themselves – how long does it take someone to reach a carshare vehicle or to receive a ridehail to their address. The second measure would then to be to convert this knowledge into a measure of potential accessibility to key services such as employment sites, hospitals or education centres. Such calculations can be complex to produce and require integrating shared mobility services with existing public transport assets and other shared services if there is a prospect of first-mile last-mile connectivity and a belief that multi-modality will be important (eg with Mobility as a Service applications). Significant consideration of how these systems might be connected can be found through the extensive modelling exercise on shared mobility developed by the International Transport Forum[9] although further work is still needed.

3.3.2 Transport system impacts

Whilst shared mobility innovations provide the potential for new travel options to be adopted through accessibility gains, it is only in the actual choices which are made that the combination of individual capacity to use the system (financial resources, physical capacity etc.) combined with the relative convenience of the system for the journeys that need to be made are revealed. Even those who engage with a system by signing up for membership may not become regular users. In order to track the social impacts of shared mobility services it is essential to know how important they are in the overall mobility mix and, as discussed further in 3.2.4, to know for whom and for what kinds of journeys.

If one assumes that the rest of the transport system remains unaltered by the introduction of new shared mobility options (for example bus service levels remain unchanged) then, any increase in shared mobility service use can be seen as a proxy for some form of social benefit. This is because it either represents an entirely new trip which had not previously been made or it represents a shift from a previous way of travelling to a new way which, by definition, has been selected because the user finds it in some way preferable. Whilst this is a fairly narrow and utilitarian view of the social benefits of shared mobility it is nonetheless an important foundation for wider benefits which are claimed as a result.

The metrics which are used to capture travel behaviour are those which have commonly been in use in the transport sector for decades such as mode share, journey time, number of trips and costs of travel. Because of the interest in shared mobility unlocking new more intensive use of vehicles or the potential for people to shift to accessing cars on-demand rather than through ownership it is increasingly of interest to track impacts of shared mobility on levels of vehicle occupancy and on car ownership. Further extensions to understand the well-being impacts of different options would require more bespoke surveying of users[36].

3.3.3 Wider outcomes

Table 1 includes a long list of potential wider social impacts that could accrue from shared mobility. For example, important economic benefits could include enabling people to work in areas which they previously did not or it could create new and more vibrant locations for retail and catering near to mobility hubs.[37] Wider social goals such as delivering socially necessary transport services but at a lower cost per journey can also be captured.[17]

Some of the wider outcomes accrue directly from the use of the service (for example a new Demand Responsive Transit service for night time job access). Others accrue as a result of the changes in overall mode use and the balance of risk associated with the modes being used or their emissions. Here, direct causality between the presence of shared mobility and changes in local ambient air quality and accident risk become more difficult to demonstrate. These outcomes will in any case change year on year as a result of new vehicles, design changes, the introduction of cycling infrastructure or road redesign etc. For shared mobility services to have an observable impact on these outcomes the interventions would need to

[36] Friman, M., Fujii, S., Ettema, D., Gärling, T. and Olsson, L.E. (2013) Psychometric analysis of the satisfaction with travel scale, *Transportation Research Part A*, 48, 132-145.
[37] Ricci, M. (2015) Bike sharing: A review of impact on impacts and processes of implementation and operation, *Research in Transportation Business and Management*, 15, 28-38, doi: 10.1016/j.rtbm.2015.03.003

be the dominant influence and so some of these impacts are inferred from changing usage patterns instead.

There are also some direct and second order impacts on land-use. Direct impacts might be on improving (or worsening) the local environment through the provision of new mobility assets which change the consumption of space. This could depend on the design of the parking areas and whether these improve the pedestrian environment or encroach upon it, for example. Second order impacts might be from local authorities deciding to reduce parking provision in central areas or for new residencies as more people choose to reduce or eliminate car ownership. This land can then be given over to other uses which can, for example, make housing more affordable.[38]

3.3.4 Distributional concerns

Dill and McNeil (2020)'s review of the distributional impacts of carshare, bikeshare and e-scooters looked across different groups according to race/ethnicity, income, gender, age and disability.[12]

There are some frequently observed findings which suggest that attention needs to be paid to distributional impacts based on the characteristics of the early adoption of shared mobility services. For example, women are less likely to be members of carshare and bikeshare and, early evidence would suggest with e-scooters. Carsharing tends to attract wealthier and more highly educated groups and, whilst bike share schemes are also typically used by higher income people, this is perhaps the result of better spatial access to stations for these groups in privately run systems.

Older people are somewhat less likely to engage in carshare schemes but more so with bikeshare and e-scooters which have a much younger demographic. Dill and McNeil "did not find any research that provided data on the use of carshare, bikeshare or shared e-scooters by people with disabilities."[12]

Different cities have different economic and spatial geographies which dictate where higher and lower income groups are located and the degree of concentration of different ethnic groups. The evidence base to date suggests that whilst there might be some shared factors across places, the most important implication is that the impacts of shared mobility are not falling evenly across society. In addition, it appears that unless they are designed to specifically tackle pre-existing distributional issues there is a risk that they will widen gaps. Assessing the distribution of impacts across different groups is therefore crucial to any claims to be making the transport system more inclusive and fair.

4. CASE STUDIES

This section briefly reviews four case studies from the literature which provide insights into how to operationalise a framework for assessing social impacts. The four case studies were selected to cover a range of social impacts and methodological approaches which, together, enable some more robust conclusions to be drawn about the relationship between different actors around data sharing. The case studies are not intended to point to 'good

[38] Litman, T. (2021) Parking Requirement Impacts of Housing Affordability, Victoria Transport Policy Institute, www.vtpi.org

implementation practice' or to be the most contemporary studies. It is their peer reviewed quality which defined their selection. There are many more case studies available through programmes such as Horizon 2020 (eg https://h2020-momentum.eu/case-studies/ and https://www.eltis.org/resources/case-studies) or through the Shared Mobility Center (https://sharedusemobilitycenter.org/publications/).

4.1 Integrating new mobility services and public transport

Palm et al. (2021) review a range of different types of integration between new mobility services and traditional public transport in order to address social equity problems.[21] 38 agencies had provided some form of subsidy to ridehailing services. Greater Philideplhia, for example, subsidised 40% of Uber ride costs to access suburban public transport stops to widen the reach of public transport. Whilst 36 of the 38 agencies said they were subsidising ride hailing for benefit of low income, only one scheme in Tampa was clearly equity focused (subsidising between 9pm and 6am up to 23 rides per month for those at or below 150% of US poverty line). For the remainder "equity remained outside of scope…" (p36) according to the authors. No evidence was found that access for digitally disconnected people or those who are unbanked was addressed.

A second set of case studies focused on the use of Demand Responsive Transit services to extend the hours or spatial coverage of public transport. A rural scheme in Scotland was estimated to provide a benefit to cost ratio of 3:1 as a result of people who would not have been able to access jobs being able to do so. In Belleville, Ontario, a demand responsive night bus service replaced a traditional service and reported a 300% increase in ridership. The evaluation measured riders sense of well-being, safety and ability to reach activities at night. 40% of respondents reporting that they felt that this enabled them to work nights. However, examples from San Francisco and Finland also showed declines in patronage, although there was no assessment provided of the counterfactual position and whether the outcomes were better than they otherwise might have been.

The authors suggest the need for a standardised data protocol which sets out waiting times, deviation times and travel times to provide ways of comparing accessibility with more traditional public transport and also so that multi-modal accessibility can be assessed. However, they also point to the need to focus on how these schemes impact on actual activity participation through surveys. They conclude that whilst demand responsive transport and ride-hailing have "the potential to meaningfully address some disadvantaged traveller's transportation problems" they "find little rigorous evaluation of this potential." (p41)

4.2 Impacts of rural MaaS partnerships

Eckhardt et al. report on trials of MaaS in three smaller rural areas/cities in Finland Porvoo, Ylöjärvi and Sastamala.[22] Rural MaaS, in the contexts studied, is more about combining different services into a package to provide a wider suite of options rather than providing integration between services as was the case in Section 4.1. Rural MaaS includes Demand Responsive Transit, liftsharing and shared services (eg using health and social care transport). It is believed that rural MaaS can have a positive impact on accessibility and total travel cost/individual or household as well as providing savings to the service providers.

However, the trials are very clear. They operate in an environment where all services are subsidised in some way and integration of social goals into MaaS involves the public sector.

It is important to note that the nature of the cases are of greater value than the outcomes, given the very limited sample of people interviewed or surveyed. In case 1, a late night DRT was created as there was no pre-existing public transport service. 10 people (of the 15 surveyed) reported using the service for leisure and 5 for school/work trips. The study identified high levels of car ownership per household on average and informal lift giving as a key alternative, with the service being used where this was not available. In case 2 an existing taxi-based social mobility service was reconfigured with a minibus or taxi now all coordinated through one call centre. The evaluation was again limited and skewed to older females (76 years). 27% of users said they would not have made the trip without the service and some shifts in preference for how to make trips were observed. 80% of people said they used the service because the family car was not available.

In the second of the two cases, the system was replacing a pre-existing set of arrangements and so a direct before and after assessment can be made which could include the number and nature of users, the frequency and timing of trips as well as their purpose. It is particularly important with services which have few alternatives to measure quality attributes such as waiting times, how far in advance booking is required and on-vehicle journey times as the user may have just two choices which are to use or stay at home and so identifying preferences is difficult.

4.3 Impacts of bike sharing schemes

Raux et al. conducted an evaluation of who is using the Velo'v bikesharing scheme in Lyon and how it had affected their travel patterns.[28] Velo'v began in 2003 and, at the time of the research study in 2014, had 350 stations, 4500 bikes and 50,000 members (which equates to 9% of the population of Lyon/Villeurbanne). The study focuses on annual season ticket holders which costed €25 for adults and €15 for students. More than two-thirds of system users are season ticket holders.

Station supply is correlated with population density and the density of stops is significantly associated with the likelihood of being a season ticket holder. Station supply is not correlated with the wealth of an area as many factors impact on population density. Despite an apparently equitable distribution of supply, annual members were found to be more likely to be male, under 30, holders of public transport season tickets and a driving license. Higher social position and residential proximity to a station both have separate positive effects on the likelihood of being a member of Velo'v.

Velo'v is used for a variety of journey purposes like other modes. 17% of respondents used Velo'v extensively – with the remainder using it as a more occasional mode (on average less than 3 times per week). Both Velo'v and public transport appear as a substitute to car or walk suggesting the need to take a rounded view as to the mobility impacts of the system.

The study is an example of a careful comparison of the characteristics of scheme users with a wider household travel study which was available for the two areas. The study was not specifically focused on equity impacts but it was able to look at gender and occupation/employment status as well as the types of activities that it was used for. No

information on what new opportunities were opened up was obtained as the survey focused on enabling comparison with an existing data source and the scheme was area-based rather than being specifically targeted at a particular social outcome.

4.4 Impacts of carsharing schemes

Becker et al. 2017 compared users of free-floating carshare and station-based carshare in Basel Switzerland.[39] The scheme was more focussed on user profiles for the two schemes rather than questions of spatial equity as the distance to the nearest station-based scheme was only around 300m.

The study, as with that on Velo'v made a comparison of behaviour between users of the two systems and the wider population of the study area. The study was able to report on differences in patterns based on gender, age, education, license holding and car ownership. For example, 70% of free-floating members are male, 60% for station based compared with 55% for license holders in the general population. Over half of free-floating members were under 36 and this was significantly younger than either station-based users or the general population. Examination of journey purpose showed the station-based systems being used more for goods transport and leisure than the free-floating, whereas the free-floating was used significantly more for commuting. The average occupancy of station based was significantly higher than free-floating (1.8 compared to 1.4).

The two different systems also exhibited very different levels of competition/complementarity with public transport, walking and cycling. The net percentage of people using bus more rather than less was +13% for station-based users and -9% for free-floating users. The parallel figures for walking were +8% and -16%.

This study is important in that it underlines the fact that the impacts of carsharing can only really be understood by relating the characteristics of users to the general population and by understanding the detail of what the journeys are for and what they are replacing. It is not however, recommended to extrapolate these results beyond the specific case at the point of assessment.

4.5 Methodological lessons

This section looks at the methodological lessons relating to the four different elements of the indicator framework set out in Section 3.

First, for accessibility indicators it is important for service providers to consider how best to integrate their services with the existing approach to accessibility assessment in an area. For example, some countries have a defined spot location of every public transport stop and regularly update their public transport schedules which are assigned to each stop. This allows a level of service accessibility to be generated to anywhere in the city. Some shared mobility schemes operate on a station-based structure and can mirror the public transport service data by profiling availability of mobility assets, for example. For other services where the service is flexible then having a network of pick up points with expected wait times would

[39] Becker, H., Ciari, F. and Axhausen, K. (2017) Comparing car-sharing schemes in Switzerland: User groups and usage patterns, *Transportation Research Part A*, 97, 17-29, doi: 10.1016/j.tra.2017.01.004

be necessary. As Palm et al. set out, this is an area which would benefit from further research to establish meaningful metrics which represent how the user views the services so meaningful multi-modal door to door accessibility measures can be defined. In the International Transport Forum work, for example, variables related to booking time, access time to a pick up point, wait time and detour times (if shared in motion) were included.[9] It may also be helpful to standardise on a set of key activities to which accessibility will be assessed, although this may be culturally context specific (eg on what services are provided at a local medical centre or what size of employment cluster is meaningful as a measure of job access).

For transport system impacts, if the scale of the mobility service is sufficient that it is aiming to impact on city wide mobility patterns then to understand the social impacts it is necessary to understand what journeys are entirely new and which journeys have switched from which modes. Only then can a full assessment of, for example, the health impacts of more (or less) walking be made. It feels important to assess the value of shared mobility systems in the round with other modes because in most cases, even when the system is widespread such as Velo'v in Lyon or car share in Basel, members of such schemes are still a minority in the population and for most members, shared mobility systems still form a modest part of their overall mobility patterns. To properly understand how overall mobility is impacted by shared mobility requires data from household travel survey type data collection which can explore journey purpose (important for social impact) as well as frequency. Not all cities regularly collect this data. It is also necessary to oversample from the users of the shared mobility service as otherwise it becomes difficult to get enough user responses to make differences between age groups or areas in a city statistically robust.

Fundamentally, the achievement of better social outcomes requires understanding a whole range of system properties, travel behaviours and outcomes which no one organisation has access to. Mobility providers have fantastic knowledge about who is using their system, how often, for how long and when and where they go when they do. However, without the rounded perspective of local authorities who are trying to build a whole area understanding of mobility it is difficult to infer the social impacts. Whilst there are increasingly intelligent and blended ways for local government to understand travel patterns in real-time[40] it is through more effective partnership working and data sharing that a better understanding of social impacts will be achieved and this forms part of the recommendations in Section 5.

As Curl et al. (2020, p8) state "the range of interconnected social impacts, with different timeframes and pathways can make it difficult to measure the social impacts of transport policies and to attribute outcomes to specific policies."[18] There are three aspects to consider for assessing wider social impact outcomes. For some of impacts, it will be necessary to conduct bespoke evaluations. As the first two cases showed, these are most likely to be measured through questionnaires or interviews which seek to capture information on a specific social impact which the system was targeted at (such as participation in the night-time economy) or through asking about feelings of social cohesion. Evaluations typically rely on asking what users would have done without the service unless a careful before and after survey approach has been planned. It may be possible to compare with areas where there is

[40] https://h2020-momentum.eu/resources-overview/publications/

no provision to look at differences in responses with and without the system. Next, for some of the second order impacts such as changing air quality or activity levels, these can only be inferred once a good measure of transport system impacts is derived (see above). Finally, some of the wider social impacts listed such as land-use change, gentrification or parking supply would need to be considered over longer time periods to allow time for the market to adjust. These are notoriously difficult to track because so many other economic and social variables change over time which may also impact on these outcomes.

Distributional analysis shows the importance of thinking about the difference between members, member-users and casual users of systems as they have different characteristics. It is important to control for the impacts of proximity to services in assessing the propensity to use such systems. However, even in those locations with fairly ubiquitous coverage, there are important differences in the profile of users from the general population. Most of the evidence to date has focused on income (or sometimes education as a proxy), age and gender. A number of studies have looked at race or ethnicity but there is less coverage of disability. Shared mobility services generally have a good understanding of the profiles of their members and this could help more generally to improve the treatment of distributional issues within transport planning analysis practices.

5. RECOMMENDATIONS

Whilst the potential for shared mobility to deliver social benefits is clear, the evidence base is relatively weak and, because of the nature of early scheme deployments, has more substantially benefitted those who already had multiple mobility options. This of course has a social value but, for some of the wider claims about social benefits to be recognised requires a better evidence base. In order to do this, some deliberate actions have to be taken.

5.1 Build the evidence base

The first three recommendations are targeted to ensure that an understanding is built around how shared mobility systems can be integrated into the existing mobility eco-system and deliver social benefits. It is from this understanding that better regulatory interventions and effective, transparent and fair subsidy arrangements can be developed such that the social benefits are steered in ways which best meet the policy objectives.

1. DG MOVE should establish a handbook of social benefits which provides a guiding framework for the metrics and assessment methods for social impacts which local authorities and shared mobility providers can use in the planning of new mobility services. This should cover different mobility services in different geographic settings. Such a resource will significantly enhance the ability of the subsequent recommendations to build a rapid and robust evidence base.
2. City authorities and shared mobility providers should work together to develop trials which are specifically designed to deliver improvements to specific social issues. More bespoke evaluations should aim to learn about where the balance of subsidy, risk and reward in seeking to roll out shared mobility services which work for everyone and deliver greater social benefit.
3. Shared mobility providers and academics need to work to develop new metrics of multi-modal accessibility that allow joined up assessments of how users interact with an increasingly multi-modal set of options. This may also need to be extended to better understand how consumers use packages of services and how this impacts on their satisfaction.

5.2 Develop a common data strategy

The second set of recommendations relates to finding ways of harnessing the strength of different actors with respect to the data they bring. There are ways to move beyond the reticence to share data at a micro scale for fear of data protection breaches by all parties being clear about what is needed and why. Much can be done without needing micro-level data.

4. City authorities should set aside funding for regular household travel surveys which provide a baseline for how and why people travel in their areas;
5. City authorities and shared mobility providers should partner to fund additional survey costs required to more robustly demonstrate the social value of shared-mobility innovations. Rather than treating this on an innovation by innovation basis, all providers should contribute funding to a common pool. The data suggests that people

use each shared mobility option as part of a mix of mobility uses and so only looking at single innovations is limiting;

6. Shared mobility providers should contribute to the survey effort by soliciting responses from within their user base, which will otherwise risk being under-represented in the data collected;
7. Shared mobility providers should also supplement the surveys with information which can be used to support distributional analysis, for example identifying particular times of day or particular areas or facilities which some user groups access a lot or where usage levels are lower than is expected.

None of this is to diminish the huge advances in demand forecasting and use pattern analysis which big data brings. Some of the insights available from big data which new mobility service providers have brought, and which local authorities and public transport operators are also now increasingly deploying are invaluable. However, McKenney argues that from a social equity perspective "machine learning could very easily perpetuate any equity blind assumptions that existed"[41]. To understand social impacts requires a full understanding of who is not accessing as well as who is, and this requires a broader approach than just user data.

The recommendations are quite deliberately collaborative in their nature. Local governments are responsible for trying to steer improved social outcomes but have limited influence on the provision of shared mobility services. Shared mobility service providers can deliver improved social outcomes but do not have a responsibility to identify what needs addressing or for subsidising provision where this is required (although they may sometimes do so). It appears that only through more collaborative working will the full range of social benefits of shared mobility be within reach.

[41] McKinney, E.Z. (2016) Code shift: Data, Governance and Equity in Los Angeles's shared mobility pilots, Masters Dissertation, Massachusetts Institute of Technology.

ABOUT THE EU AUTOMOBILE INDUSTRY

- 12.7 million Europeans work in the auto industry (directly and indirectly), accounting for 6.6% of all EU jobs
- 11.5% of EU manufacturing jobs – some 3.5 million – are in the automotive sector
- Motor vehicles are responsible for €398.4 billion of tax revenue for governments across key European markets
- The automobile industry generates a trade surplus of €74 billion for the European Union
- The turnover generated by the auto industry represents more than 8% of the EU's GDP
- Investing €58.8 billion in R&D per year, automotive is Europe's largest private contributor to innovation, accounting for 32% of the EU total

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