

Introduction to Special Issue: New Directions in Shared-Mobility Research

Guest Editorial

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Scott Le Vine¹
Imperial College London
Department of Civil and Environmental Engineering
Exhibition Road
South Kensington, SW7 2AZ, United Kingdom
and
SUNY New Paltz
Department of Geography
Hawk Drive
New Paltz, NY 12561, USA
slevine@imperial.ac.uk

John Polak
Imperial College London
Department of Civil and Environmental Engineering
Exhibition Road
South Kensington, SW7 2AZ, United Kingdom
j.polak@imperial.ac.uk

¹ Corresponding author

Shared-mobility sits within the broader phenomenon that has been termed the 'Sharing Economy', in which widespread usage of emerging information and communications technology, particularly smartphones, enables new forms of market interactions that can enable both new services and improved efficiency in asset utilisation. Rather than individual physical items being purchased, owned, controlled, maintained and used solely by their owner, in shared-mobility systems the physical assets (bicycles, automobiles, airplanes, etc.) are accessed by multiple users on a pay-per-use basis. This implies higher utilisation rates of assets with relatively high fixed costs; in the case of automobiles the classical high fixed cost / low marginal cost paradigm of private car ownership is reversed. Whereas shared-mobility was a niche market a decade ago, today the phenomenon has entered the mainstream, with a broad array of major automakers (BMW, Citroen, Daimler, Ford, Renault, Toyota, etc.) investing in shared-mobility services.

Terminology in this area is a vexed subject, with innovation in business models greatly outpacing the speed at which researchers, let alone the general public, have proven able to converge around a common lexicon. Indeed, it is arguable whether the term 'sharing' itself is an accurate descriptor for the interactions that take place in 'shared-mobility' markets.

There is also a lack of consensus regarding where to draw the boundaries of shared-mobility – one view of the term is broad enough to encompass traditional car rental, whereas a contrasting perspective would emphasise the importance of intermediation via contemporary ICT, thereby excluding car rental from a storefront or airport counter. The issue is not merely a pedantic one; definitional ambiguity has led, for instance, to the peculiar circumstance of public-sector entities providing subsidies to carsharing services, whilst at the same time subjecting them to legacy car rental transaction taxes with rates, as Bieszczat and Schwieterman (2012) document, that are frequently twice the magnitude of general sales taxes.

Business model innovation has outpaced not only the shared-mobility lexicon; whereas shared-mobility services remain in a state of turbulence, with rapid evolution in service features, progress in research is continually pursuing this moving target from a trailing position. Researchers are presently forging the theory, techniques and data structures that are required to satisfactorily represent shared-mobility systems. It is clear that existing methods for modelling urban transport require extension to accommodate shared-mobility systems; as this process continues, a beneficial side effect will be that methodological advances developed to better represent shared-mobility users' behaviour will lead to general improvements in urban transport analysis. For instance, the need to migrate from the individual journey (or tour) as the unit of analysis towards a multi-day representation of an activity/travel pattern in order to fully capture shared-mobility user behaviour is becoming increasingly clear; the line of enquiry to address this challenge will serve to advance the state-of-the-art in activity/needs-based modelling more broadly.

In addition to this issue, other important items on the research agenda include:

- How should shared-mobility networks be represented in regional travel demand models? What are the relevant service features and behavioural responses, and what are the implied requirements for empirical datasets (e.g. household travel surveys?)
- Which logistical strategies are available to shared-mobility operators, and how can fleet-management concepts be deployed most efficiently across differing contexts?
- Shared-mobility systems tend to attract users of a distinct demographic profile (well-educated, relatively young adults, small household sizes, above-average incomes). Will it prove possible to represent service attributes and traveller preferences (with respect to shared-mobility services) with sufficient descriptiveness that this profile can be reproduced from first principles, or will it be necessary to resort to simply observing this user profile empirically and then extrapolating it (perhaps subject to some representation of diffusion processes) into the future?

The papers in this Special Issue report recent studies undertaken by a cross-section of leading researchers, addressing a subset of relevant research questions. The first two papers present *a priori* regional-scale analyses of hypothetical shared-mobility systems. The following two papers report studies of user behaviour amongst two distinct market segments ('free-floating' or 'one-way' carsharing, and 'business-to-business' carsharing). The fifth paper presents a study of shared-mobility service operators' perspectives, with the final (sixth) paper reporting an analysis of alternative operating strategies for shared-mobility systems. We now introduce each of these papers, in sequence, highlighting both their contributions and the sets of issues they raise for the next phase of the shared-mobility research agenda.

The first paper in this Issue, by Ciari, Balac and Balmer, employs agent-based activity/travel microsimulation techniques (implemented in MATSIM) to forecast the impacts of introducing free-floating carsharing, using Zurich as a case study. The authors evaluate a range of temporally-differentiated pricing strategies on behalf of the service operator. It is encouraging that the simulation model identifies business-travel as an important segment of free-floating carsharing usage, which is consistent with empirical findings from shared-mobility systems of this type. This paper concludes by highlighting important issues for the next stage of this research, including enhancing the structure of the choice processes represented in agent-based models to better capture behavioural response to the unique service features of shared-mobility. The agent-based approach that Ciari and colleagues have pioneered to model the impacts of shared-mobility services offers great promise as it becomes, in time, more widely used amongst researchers and practitioners.

The second paper, by Morency, Verreault and Demers, poses, and then attempts to answer, a simple question: What would be the consequences of replacing all privately-owned cars in a metropolitan region with a fleet of shared cars? The authors report that participation in shared-mobility services (specifically carsharing) currently reaches as high as 11% of households in certain neighbourhoods of Montréal. In order to evaluate a hypothetical

transition away from privately-owned cars, the authors employ data from a very large-sample origin-destination survey (approximately 4% of the Montréal region's population) and subsequently iterate through a representative 24-hour day to identify the minimum fleet size to serve all car driving trips. Morency and colleagues report that, conditional on a set of assumptions that includes upper limits on 'acceptable' walking distance, the number of cars required to serve all car driving trips would be 18-34% lower if all vehicles were part of a single 'mutualised' fleet. The paper concludes by highlighting the current gap in knowledge regarding people's preferences for the qualitative differences between car *ownership* and *access*, and the importance of establishing these preferences through a future line of research.

In the third paper, Kopp, Gerike and Axhausen present a study of the activity/travel behaviour of the users of free-floating carsharing services. Whilst the impacts of round-trip carsharing are well-established, much less is known regarding free-floating systems. A generic challenge of shared-mobility has been an endogeneity issue: the difficulty of adequately disentangling between *impacts* due to shared-mobility participation (which would otherwise not exist) and the fact that the activity/travel behaviour patterns of shared-mobility users would be distinctive even in the absence of shared-mobility. Kopp et al. appeal to a similar experimental-design strategy as the seminal early work by Cervero alone (2003) and with colleagues (2004, 2007): evaluating shared-mobility users' observed activity/travel behaviour relative to the behaviour of a carefully-selected control group. However, whereas Cervero used a paper travel diary instrument, Kopp and colleagues take advantage of recent technological developments and employ a bespoke smartphone-based app. Findings reported by Kopp et al. include that free-floating carsharing users are both more *multimodal* (use of different forms of transport for different journeys) and *intermodal* (use of multiple forms of transport to complete a single multi-stage journey). The various aspects of the issue of possible endogeneity (which could mean that shared-mobility impacts are systematically overestimated) are important, and therefore will remain on the research agenda for the

foreseeable future. A strategy that would help address such concerns would be to seek to identify impacts from data sources such as traffic counts and parking-demand observations, rather than self-reported survey data.

The fourth paper, by Clark, Gifford, Anable, and Le Vine, investigates another segment of the shared-mobility market: business-to-business (B2B) carsharing. With much of the existing body of literature focused on *personal* (i.e., business-to-consumer [B2C] and peer-to-peer) use of shared-mobility networks, there has not previously been a reliable resource that has specifically addressed the impacts of B2B carsharing. Whilst most usage is on a B2C basis, Clark and colleagues show that, at least in Britain, the B2B segment is growing at a faster rate. The authors demonstrate that B2B carsharing has impacts on modal use for *commuting* trips (which are not in general performed in B2B carsharing vehicles), in addition to *business* trips (for which B2B carsharing is used). This is in keeping with the need noted earlier for researchers to analyse shared-mobility using *patterns of linked activity/travel behaviour* as the units of analysis, rather than *individual journeys*. The study reported by Clark and colleagues is based on a dataset for which the response rate was quite low (3%); hence it must be viewed as subject to possibly-large response biases, and, even if not, then representative of only the specific empirical context in which the data were collected. There therefore remains much to be done to corroborate (or refute) and extend the findings the authors present regarding B2B shared-mobility activity.

The fifth paper, by Nourinejad and Roorda, develops optimisation algorithms for comparing alternative shared-mobility business models (specifically round-trip and one-way carsharing, as well as a novel hybrid system that combines service features from both). The authors' find that in order to serve a fixed origin-destination demand matrix, a carsharing fleet operating a one-way business model is more efficient in terms of required fleet size, but less efficient when characterised by the number of required non-revenue generating movements required to re-position vehicles. As with the papers of Ciari *et al.* and Morency *et al.*, strong assumptions regarding the nature of traveller preference structures for shared-mobility

service features are required in order to render the analysis tractable. For instance, users of a carsharing system that operates a one-way-usage business model must implicitly accept that they may be 'denied a return trip' (after an outbound journey) if a vehicle is not available where and when they wish to begin their return journey, and behavioural response to this service feature has not yet been rigorously established. Another yet-to-be-addressed behavioural dimension is heterogeneity in preferences regarding 'spontaneous-usage' versus 'assured-usage-following-advance-reservation', both *between* travellers and *within* the individual traveller (whose preference can be expected to be context-dependent). Addressing traveller response to these dimensions of shared-mobility services will become increasingly important as the sector matures.

The final paper in this collection is by Shaheen, Chan and Micheaux. The authors document the history of one-way carsharing systems and present findings from a survey of carsharing service operators regarding their views and expectations for the future, as the 'one-way' business model becomes more widespread. As the authors were limited to surveying existing carsharing operators, the sample was small (n=26) and the usual caveats regarding small-sample analysis apply. The study is valuable, however, as this group will have much influence on how shared-mobility business models evolve in future. On the important question of whether one-way carsharing will prove to have different impacts than those of round-trip carsharing, the authors report their sample of carsharing operators to be evenly split. Respondents identified 'parking management' and 'system rebalancing' as the two leading challenges to the one-way business model – which highlights the importance of the research being taken forward by Nourinejad/Roorda, as well as others (Correia *et al.* 2014).

Shared-mobility involves multiple ongoing points of interaction between private and public sectors. At present, decision-making is largely ad-hoc amongst both policymakers and operators. Appropriate policy responses (and how to administer them) are not fully clear, and the growth in private-sector investment will be stunted in the absence of suitable analytical capability. The challenge, to which the research community is now squaring itself, is to

credibly incorporate the collection of shared-mobility modes into the standard toolkit of urban transport modelling. John Maynard Keynes (1931) famously sought to bring forward the day when economists would be seen to be as humble and competent as dentists. In the judgment of the guest editors, we in the shared-mobility community will have discharged our duties well when, in several years' time, it is generally-acknowledged that analysing, managing, and contracting with shared-mobility services has become as routine, standardised and boring as dentistry.

We believe that, taken together, this collection of papers provides a set of valuable and timely insights into the challenges posed for transportation system analysis by shared-mobility, and we hope it will inspire the next phase of research within this rapidly evolving and increasingly policy-relevant sector of the transport market.

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