Transportation Research Part A 115 (2018) 114–125

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

# The governance of smart mobility

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ARTICLE INFO

*Keywords:*
Governance
Transition
Public value
Smart technology
Mobility
Externalities

ABSTRACT

There is an active contemporary debate about how emerging technologies such as automated vehicles, peer-to-peer sharing applications and the 'internet of things' will revolutionise individual and collective mobility. Indeed, it is argued that the so-called 'Smart Mobility' transition, in which these technologies combine to transform how the mobility system is organised and operates, has already begun. As with any socio-technical transition there are critical questions to be posed in terms of how the transition is managed, and how both the benefits and any negative externalities of change will be governed.

This paper deploys the notion of ensuring and enhancing public value as a key governance aim for the transition. It sets out modes and methods of governance that could be deployed to steer the transition and, through four thematic cases explores how current mobility governance challenges will change. In particular, changing networks of actors, resources and power, new logics of consumption, and shifts in how mobility is regulated, priced and taxed – will require to be successfully negotiated if public value is to be captured from the transition. This is a critical time for such questions to be raised because technological change is clearly outpacing the capacity of systems and structures of governance to respond to the challenges already apparent. A failure to address both the short and longer-term governance issues risks locking the mobility system into transition paths which exacerbate rather than ameliorate the wider social and environmental problems that have challenged planners throughout the automobility transition.

## 1. Introduction

The mass adoption of motor vehicles (the 'automobility transition') was one of, if not *the*, major socio-economic transformations of the 20th century (Geels, 2012). Over the 80 years in which the car has "wound itself inextricably into a large part of our affairs" (Buchanan, 1963: 52), much research has been undertaken about the evolution of the socio-technical systems that have facilitated mass car ownership, and how the economy and society have been transformed by automobility (Urry, 2004, 2008), from the sheer distances travelled in everyday activities to the location of economic activity, the operation of the housing market, the structure of retailing and differential access to educational and health opportunities. Alongside these huge gains in prosperity and quality of life, however, came the well-known negative externalities of mass car use, such as congestion, crashes, poor air quality, physical severance, social exclusion and inactivity/obesity, which the state has often struggled to manage effectively.

Most contemporary imaginings of 'Smart Mobility' describe a transition of equivalent reach and significance to that of 'automobility', focusing on a range of positive changes to how we travel around. Proponents of the 'Smart Transition' outline a vision of the future in which mobility will be framed as a personalized 'service' available 'on demand', with individuals having instant access to

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http://dx.doi.org/10.1016/j.tra.2017.09.012

Available online 08 October 2017

a seamless system of clean, green, efficient and flexible transport to meet all of their needs (see Wockatz and Schartau, 2015). Accompanied by the widespread adoption of connected and automated vehicles (AVs) (see Fagnant and Kockelman, 2015), it is argued that the 'Smart Transition' will bring huge gains in safety, and the costs of transport to the user will be lower because the capital stock of the mobility system, primarily infrastructure and vehicles, will be used much more efficiently. There will be much greater consumer choice as new models of shared ownership of mobility assets, real-time aggregation of data and peer-to-peer mobility matching reduces the grip of large monolithic providers on the supply of transport.

Given that the state took several decades to come to terms with the challenges of managing the car and the profound impacts of the automobility transition on the economy, the environment and society, there is no time to be lost in beginning the task of thinking through how state action and public policy will need to change to take account of the implications of the transition to a 'Smart Mobility' future. This is particularly so given that the push towards a smart future is being led by the technology sector, which has a product – the sensors, vehicles, and software etc that underpins Smart Mobility – to sell, and where some interests will seek to create a market in which there is *more* mobility, not less, in order to maximise its returns. Only a naïve view would see the producer interests of a sector estimated as being worth 1.0–1.5 trillion US dollars by 2025 (Wocatz and Schartau, *op cit*) as inevitably aligned with the wider, more complex needs of society as a whole. In this paper, we explore the key contention that the transition to Smart Mobility as currently envisaged will require an equally important and far-reaching transition in the governance of mobility, so that the Smart Transition delivers more, rather than less, public value.

The paper proceeds as follows. First, we set out the two pillars of our analytical framework. In order to frame our understanding of what the 'Smart Mobility' transition is and what its implications might be, we review how thinking about innovations in mobility can be contextualized within work on the progression of wider socio-technical transitions. We then, in Section 3, apply literature on how the state might effect its own strategic transition from the traditional task of carrying out 'public management' to instead ensuring the capture of 'public value' in order to approach the challenge of governing the Smart Mobility transition effectively. Section 4 then considers why governments have traditionally intervened in transportation in order to complete our framework against which the governance of 'Smart Mobility' innovations can be assessed.

Section 5 introduces some key elements of the Smart Mobility transition as currently postulated, including new actors entering the mobility marketplace and their commercial propositions, infrastructure requirements and the centrality of data ownership and management to the operation of the Smart Mobility system. Section 6 then reviews four cases which were selected by the authors as posing distinctive governance challenges and these are discussed through the framework established in Sections 3 and 4. We conclude with some key messages surrounding the necessary transition in the governance of transport that must accompany the transition in technology.

## 2. The 'Mobility System' and socio-technical transitions

Frank Geels' work on the notion of the Socio-Technical System (STS) is a useful starting point for exploring how systems of provision such as the mobility system emerge, and how innovations such as smart technology break into such systems once they are well-established (Geels, 2005, 2012). Important to the STS concept is the notion of an extant and dominant *regime* which comprises technology (e.g. cars and traffic lights), infrastructure (tracks, roads, filling stations and paths), knowledge, markets and user practices, cultural and symbolic meaning, policy and institutions, and the industries involved in production and operation. Such a conception allows for the multiple factors that affect the setting of something like a speed limit to be considered in the round, and importantly illuminates why change might be difficult. It is not simply a matter of engineering know how, road design nor policy preference, but also a matter of negotiating social norms, customs and practices.

Whilst for many decades the dominance of the automobile and the existence of siloed approaches to managing transport around distinct transport modes has dominated thinking about the path dependence of planning and the fixity of the 'regime' (Low and Astle, 2009), this may now be changing. There is no doubt that in the 20 years since the mass adoption of the worldwide web, and the decade or so since the emergence of the smartphone these technologies have transformed many aspects of everyday life in less than a generation, leading to a situation in which the ways we communicate with each other, how we organise patterns of work, shopping, and socializing, as well as the information we have available whilst physically mobile are unrecognisable from only a few years previously (see, for example, Castells et al., 2014; Wang et al., 2016). It is the transformation in what and how things get done which Watson (2012) suggests, marks the transition of a socio-technical system.

Like any other complex socio-economic system, the mobility system can be described as a "set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems" (Rotmans et al., 2001: 16). Thus the automobility system is comprised not only of the "manufactured object" of the car, but a set of diverse factors ranging from the cultural importance of the car as an icon of "individual consumption"; to the belief system that shopping mall and suburban quarter-acre house plot represented the "good life" and so on (from Urry, 2004:25–26).

Just, therefore, as the real importance of the automobility transition lies in the ways in which it altered established ways of conducting everyday activities – and then in turn changed the kinds of activities people undertook – so the same is true for the 'Smart Mobility' transition. As Wadud et al. (2016) point out, the potential for automated vehicles to reduce end-to-end travel times for a complex array of possible journeys will have much more profound impacts on society and the economy than simply some time savings for individual activities however important these might be in themselves: as the Smart Mobility system evolves, the new mobility opportunities it presents will lead to a reconfiguration of the systemic elements that produce different mobility outcomes in the first place, such as land use patterns, employment and housing locations, and so on (see, for example, Kim et al., 2015).

Contemporary imaginings of Smart Mobility – which, as we noted above, are often highly producer-led – offer optimistic visions of a society in which technological advances have delivered a benign mobility system that all users can access seamlessly and on-demand, avoiding much of the waste, pollution and environmental degradation of today's conditions. However, there is no guarantee that such a vision will come to pass; indeed, given there has now been several decades' effort to ameliorate the negative externalities of the automobility era (see Marsden and Docherty, 2013), we should at the outset recognise that none of the technological innovations in car-based mobility to date[1] have unlocked such a positive outcome, and so we should be wary of claims that the 'next big thing' – in this case 'Smart Mobility' – will automatically be more successful. In fact, because mobility is a *system*, many *different* potential 'Smart Mobility' futures exist, even for any given package of technological innovations. The task facing the state today is therefore one of undertaking a more fundamental "positional analysis" (Söderbaum, 1982, 1987) of its role in managing mobility. The state needs to understand when, with whom, on what and how to act in order to steer the Smart Transition in ways which satisfy the often competing range of economic, environmental and social objectives that we mediate through our democratic processes.

## 3. Governance, transitions and public value

In his response to critiques of his socio-technical transitions ideas, Geels (2011:25) acknowledges issues about the role of (regulatory) agency and how transitions unfold in the "politics and power struggles" of real life as areas for legitimate criticism and refinement. In conceptualising how the state might address the complex challenges of major socio-economic transitions, we see clear and important links between Geels' and others' refinement of their theorising about the role of governance in the unfolding of socio-technical transitions, and the broader body of political science work seeking to understand the apparent shifting role of the state from one of the 'public administration' of directly provided services, through an intermediate phase of the '(new) public management' or the coordination of public services provided by a wider range of actors, to that of ensuring the capture of 'public value' in contemporary, highly complex and fluid patterns of service provision in all domains (Pollitt and Bouckaert, 2011).

Geels (2011:25) himself notes that one of the distinctive factors of environmentally-relevant transitions is that they require strong input from the state and (civil society) because it is unlikely that they "will be able to replace existing systems without changes in economic frame conditions (e.g., taxes, subsidies, regulatory frameworks)… (which) will require changes in policies". Here he draws heavily on the ideas of Smith et al. (2005), who contend that managing transitions successfully depends on the level of "adaptive capacity" in the prevailing system of governance to adapt to changing circumstances, that is its ability to articulate what needs to be done in terms of changing the terms of debate, policy interventions, monitoring frameworks and so on, and then applying resources such as money, skills and knowledge to achieve this in practice (see also Lyons and Davidson, 2016).

Crucial to Smith et al.'s argument is the notion of human agency in the task of governance. They contend that the role of governance in addressing profound socio-technical transitions is to be "purposive", that is to develop a set of normative goals for the wider outcomes of the transition that the resources of the governing organisations will be deployed to secure. The call for a 'purposive' approach talks directly to work from political science on changing forms of governance which has sought to conceptualise and examine the notion of 'public value'. In his 10 year reassessment of his highly influential paper *Understanding Governance*, Rhodes (2007) postulates that the task of modern governance can be understood as the expression of a set of "beliefs, practices, traditions and dilemmas" that are negotiated democratically. Similarly, Boyte (2011:632) defines governance as the "sustained efforts by a mix of people who solve common problems and create things, material or symbolic (to achieve) lasting civic value". Bryson et al. (2014) build on these ideas in their attempt to define how the role of the state has evolved to one in which its primary responsibility is now to act as the guarantor of public values (i.e. overall societal objectives including operational parameters for private firms) agreed collectively through "broadly inclusive dialogue and deliberation" (p446).

We see the notion of capturing public value as a useful means to articulate and understand the real world policy implications and actions that together comprise the notion of proactively 'governing the (Smart) Transition' . In our analysis, we, like Bryson et al. (2014), utilise the definitions of public value offered by Bozeman (2007:17), who defines the notion as:

> "(1) the *rights, benefits, and prerogatives* to which citizens should (and should not) be entitled; (2) the *obligations* of citizens to society, the state, and one another; and (3) the *principles* on which governments and policies should be based."

Rauschmayer et al. (2015) suggest that the consequences of an absence of clear normative goals for governing sustainability transitions could lead to the transitions faltering or even failing to deliver the environmental or other improvements and innovations that they promise. We therefore frame our understanding of the rationale for governance intervention in and management of the Smart Transition as being to harness the opportunities put forward by this particular socio-technical transition to (a) maximise the benefits to individuals that mobility provides (e.g. access to employment, education, healthcare and civic life); (b) to manage the distribution of these improved mobility opportunities according to democratically agreed objectives on equalities and social justice, and (c) to do this within the framework of international agreements about reducing the impact of mobility on the environment, and particularly with regard to decarbonisation.

[1] Indeed, the notion of a 'smart' future implies a 'non-smart' today. The transition to an increasingly intelligent and interlinked mobility system has been underway for decades.

**Table 1**
Core reasons for state involvement in transport governance.

| Need for intervention | Key issues today |
|---|---|
| *Public policy* | |
| 1. Setting overall direction of policy | Increasing recognition of the role of transport in supporting economic growth, social progress and health |
| 2. Environmental, economic and social externalities exist | Climate change, air quality, congestion, social exclusion and inequity are not tackled through the market |
| 3. Coordination of transport, land-use and economic goals | Planning to accommodate growth in many cities whilst maintaining or improving accessibility requires intervention |
| 4. Setting standards and communicating with public about transport system operation | Defining levels of service and reporting on how these are met, justifying efficient spending of taxation, managing disruptive events |
| 5. Balancing the needs of different transport systems and users | Decisions on infrastructure spend and maintenance, road space allocation and legal frameworks on rights |
| *Market failures* | |
| 6. Conditions for a free market do not exist | Managing monopoly infrastructure providers and limited service competition, preventing collusion |
| 7. Acting as a provider or procurer of services which are not profitable | Often to ensure basic levels of service to some communities, evening and weekend services or for bespoke services such as school or hospital transport |
| 8. Problems of co-ordination between modes exist | Competition can exist between public transport operators within and between modes. Limited ticketing integration |
| 9. Basic standards of operation and rules of movement | Interoperability between systems, data, standardization of laws and enforcement |
| Investment as policy | |
| 10. Funding the provision and upkeep of infrastructure | Sets general taxes and mobility related taxes and charges at various levels of government to fund the upkeep of infrastructure and subsidy of some services. The state can borrow at lower rates than the private sector |
| 11. Supporting the adoption of transport innovations | Innovations are sometimes expensive in their early stage adoption or require additional infrastructures, supported by state subsidy and investment or new regulation |
| 12. The state is an aggregator of risk and has primary accountability | The state ultimately remains guarantor when private provision of public services fails and retains accountability via the ballot box |

## 4. Why and how has mobility been governed until now?

Having established, from the literature, the rationale for governing the Smart Mobility transition from a public value perspective, this section addresses the extant reasons for intervention in governing the mobility system. The extent to which these approaches are deployed, challenged or potentially bypassed in different Smart Mobility futures is then discussed through case study examples in the subsequent section. The reasons for state involvement vary according to the ideological lens through which the state is viewed. In the UK and US, for example, more neo-liberal market-led traditions dominate (see, for example, Peck, 2001) whereas in much of continental Europe a stronger 'welfare model' exists with greater state involvement in the provision of transportation to promote a series of social policy goals (Ranci, 2011; Shaw et al., 2008). Increasingly, a blended approach exists everywhere, with increasing attention paid to the impact of different processes for governing such a complex system (see Cairney, 2012). We acknowledge that context and history will be important to how public value might be interpreted in different places but, in order to work towards enhancing public value in all places, Giddens identifies that the state has to do more than just enabling the opening up of markets:

> "The idea of the enabling state suggests that the role of the state is confined to stimulating others to action and then letting them get on with it. The ensuring state is an enabling state, but one that is expected or obligated to make sure such processes achieve certain defined outcomes".
>
> (Giddens, 2008: 9)

In order to both enable and ensure the development of the mobility system there are a number of well-defined areas in which governments intervene today which are set out in Table 1 (drawing on Shaw et al., 2008; Bache et al., 2015 and Gray et al., 2017). These are clustered into three broad headings of 'public policy', 'market failure' and 'investment as policy'. Whilst the interventions *involve* the state this is not synonymous with being *dominated* by the state as governance is acknowledged to be a process conducted through networks (Treib et al., 2007; Rhodes, 2007). It is important to note that smart mobility innovations occur alongside existing systems of provision and rule sets and it is sometimes the incompatibility or insufficiency of existing ways of managing the mobility system which create tensions.

Wider justifications for state intervention in mobility may also prove resilient: the state will always have a role in trying to understand and shape the delivery of objectives for the public good, such as correcting market failures, managing 'crowding out' effects and so on (Heibling, 2012). And as Millard (in press: 9) suggests, even if "government becomes just one actor amongst many… it still needs to fulfil roles which other actors normally cannot… Accountability for services and performance, and responsibility especially if things go wrong, is a critical issue". Transparency is a further key aspect of the OECD definition of 'good governance' alongside participation (Ball, 2009). So, in thinking about governance of the 'Smart Mobility' transition, there is a need to pay attention simultaneously to the why (the public policy function), what (the rules of the game), who (the networks of actors and their position, power and objectives) and how (the manner in which the public is involved and accountability and transparency are

maintained) of the governance system. We now explore the challenges posed by Smart Mobility, linking them to the key governance elements set out in this section and their potential to deliver public value.

## 5. What is 'Smart Mobility'?

In order to begin the task of thinking through the implications of Smart Mobility that actors and institutions of governance will be confronted with, we identify some key components that are common to different views of the future as they are being debated today (see Kuosa, 2016), especially those changes that are either already emerging or which are the subject of the most intense R & D effort, e.g.:

- The shift towards 'Mobility as a Service' (MaaS), where individuals' ownership of vehicles is increasingly replaced by "usership", that is the ability to purchase access rights to an interoperable package of mobility services (car, taxi, bus, rail, bike share) owned by others, usually corporate, providers. This is facilitated by integrated aggregation and payment platforms, with intensive processing of 'big data' to match provision to demand in real time (see Thakuriah et al., 2016);
- New user-generated and user-centred information which is context specific and integrates mobility and non-mobility options, which draws upon crowd-sourced, real-time data (see Toole et al., 2015);
- Increasingly 'intelligent' infrastructure, including connected vehicles, which derives operational information from users and provides feedback in real-time to influence traveller behaviour and optimise system performance (see Alam et al., 2016);
- The electrification of the vehicle fleet using battery power, plug-in hybrid and/or other new technologies. Combined with a smart energy distribution grid, electric vehicles could be both emission free at the point of use (thus satisfying consumer desire for 'sustainable' mobility, see Bakker et al., 2014) and also be part of the electricity storage solution for the widespread adoption of renewables more generally in pursuit of decarbonisation objectives (see Coronado Mondragon et al., 2015);
- Automated vehicles that do not require 'driving' by any of the passengers, and which enable all occupants of the vehicle to focus on other tasks whilst they are in motion (see Fagnant and Kockelman, 2015).

The list is not comprehensive of today's opportunities (we do not, for example, address changes in the movement of goods in this paper, which are equally dynamic – see Hopkins and McCarthy, 2016) and new ideas will surely emerge. Nonetheless, we can pick out from these core building blocks some key elements of the socio-technical transition that appear in the more technology-led imaginings of 'Smart Mobility' futures.

First, there is the assumed move away from ownership to "usership" identified as a critical innovation by key technological and corporate advocates of 'Smart Mobility' (Wockatz and Schartau, 2015). This early stages of this shift are already apparent: car share clubs had almost 5 million members and 92,000 vehicles worldwide in 2014, an increase of more than ten-fold over a decade previously (Le Vine et al., 2014). But with universal adoption, 'usership' is argued by proponents to have very significant benefits: for example, the International Transport Forum (ITF-CPB, 2017) modelled that an integrated system of on-demand taxis and taxi buses feeding the existing rail system in Lisbon could achieve a 44% reduction in peak vehicle kilometres and 53% reduction in $CO_2$ emissions in the city, and release fully 95% of parking spaces for other public uses.

Second is a transition in the definition of the marketplace that is 'mobility'. Today this market is dominated by private vehicle ownership, roads funded by the state (usually through general taxation) and a public transport system which, to varying degrees in different places, has some form of state direction and support, usually consistent with a public management model in which the state offers concessions for private firms to operate transport services. The transition to a new smart model of mobility therefore implies that this traditional business model for the public–private allocation of tasks across the mobility system will evolve. As one recent study into the market for intelligent mobility put it, "value in mobility is derived from traveller spend, whether this means spend on travel tickets, vehicle ownership, or services and apps." (Wockatz and Schartau, 2015: 8). Fundamentally, the commoditisation of individual journeys and the journey time of users is what makes 'Smart Mobility' pay for itself, and represents a continuation of the longstanding trend towards the neo-liberalisation of the transport system (Gössling and Cohen, 2014).

Whilst these innovations are often 'sold' as reducing the cost of mobility to many people, and also in their potential to create wider benefits for society and the state by the release of 'lost' travel time to be used for activities that are economically-productive or aid wellbeing, these outcomes are usually treated as secondary or residual impacts by the technology sector pushing the Smart Transition (see Blanes et al., 2015). More important for Smart Mobility proponents is the potential to grow the mobility market by more effectively "address(ing) significant unmet lifestyle needs across a range of traveller types" (Wockatz and Schartau, 2015: 1). This neatly reveals the essential paradox of much 'Smart Mobility' rhetoric at present, i.e. that the Smart Transition will simultaneously create the promise of a system that can reduce demand, whilst at the same time fulfilling previously unmet demand and creating new demand.

Third is the greater convenience and comprehensiveness of inter-modality or "from the current 'modal-centric' to future 'user-centric' transport system" identified as an important benefit of this more marketised approach to accessing mobility services (Yianni, 2015: 3). Heitanen (2014: 3) sets out his view of future mobility as seeing "the whole transport sector as a co-operative, inter-connected eco-system, providing services reflecting the needs of customers. The boundaries between different transport modes are blurred or disappear completely. The ecosystem consists of transport infrastructure, transportation services, transport information and payment services." Crucially, this transition requires the emergence of new integrated mobility aggregators, smart intermediaries that match mobility supply to demand in real time to tailor services to the needs of the travellers. The new role of aggregator, which is effectively a form of arbitrage for mobility, is one of if not the most important change elements in the 'Smart Mobility' system of the

**Table 2**
Role of the state in smart mobility transition (Wockatz and Schartau, 2015: 4).

| State level | Action | Table 2 |
|---|---|---|
| National Government | Fund research and development activities and skills development… | 11 |
| | Focus on filling the gaps in provision of reliable, fast, and ubiquitous connectivity | 11 |
| | Establish a data exchange mechanism and mandate open data where appropriate (e.g. in rail franchises) | 9 |
| | Create a central ticketing platform and multi-modal marketplace and encourage multi-modal integration to support expected advancements in dynamic pricing and timetabling | 8 |
| | Foster cross-industry collaboration to unlock value from Intelligent Mobility | 6 |
| Local Government | Encourage and support new business and participate in experimentation with new Intelligent Mobility solutions in private and public transport | 11 |
| | Shift focus towards procuring against challenges rather than procuring for solutions | 7 |
| | Push for integration and innovation in public transport (e.g. demand responsive services) | 8 |

future.[2] We return to the question of the implications of this role being played by the state or private firms below.

Fourth, there is a transition in the role of the citizen in the transport system. This is both as a source and recipient of information through mobile communication and through bringing their resources to the shared mobility platforms. This has so far manifested itself in people using their vehicles as part of ride-share systems, as vehicles on-demand for Uber and Lyft and by renting out driveways for other users.[3] This is part of a wider transition away from the state as the prime source of information to being one of many actors feeding information into the mobility system.

Most visions of 'Smart Mobility' are not blind to the role of the state, but instead see it as a relatively passive facilitator of innovation. In its review of the future market for intelligent mobility, the UK's transport innovation platform identified the role of the state in the transition as shown in Table 2. We assign the state roles which are identified against the categories set out in Table 1 and find that they largely relate to tackling existing market failures which might stymy innovation or providing funding and resources to accelerate the development or adoption of innovation.

## 6. Towards effective governance of smart mobility

In this section four challenges are examined in addressing the governance transition that will be necessary to effectively engage with and steer the various aspects of the shift to 'Smart Mobility' so that genuine public value is generated and captured. The challenges are assessed against the framework of the reasons for public intervention in steering the mobility system developed in Table 1 (the why and what) and the modes of governance (the who and how) from Section 4. The challenges are not definite or preferred world views or pathways but intended to be illustrative of why governance matters to how the Smart Mobility transition could unfold in different places.

### *6.1. The short versus the long game*

This example considers the tension between supporting the uptake of innovations which offer benefits in the short-run but which may create bigger governance challenges as they scale. The change of relationship between producers and consumers of mobility implied in the major shift from ownership to sharing is explored. Notions of mobility as a service[4] are already being piloted by amongst others BMW with their i-Mobility initiative and of course by Uber (whose share price is predicated on it becoming much more than a taxi company, however smart). But there are fundamental decisions to be made about what exactly is the public good that mobility as a service will provide, and therefore the role of the state in governing it. Although the mobility as a service model is very carefully portrayed as both more responsive to consumers by virtue of its 'smart' matching of supply to demand, and more sustainable because it tackles the problem of the fixed costs of car ownership encouraging additional 'free' discretionary trips, it is essentially a *rentier* model where the clear incentive for the mobility service provider is to generate *as much mobility as possible* to maximise returns on capital.

Even if the direct costs of more vehicular-based mobility are to some extent mitigated by greater efficiency of and less pollution from the vehicles themselves, the potential costs at the system level are potentially huge. We saw in Section 5 how the International Transport Forum's model of Lisbon presented the possibility of very substantial positive gains from Smart Mobility. But probing the construction of the model reveals that its best case scenario depends on some very ambitious assumptions indeed:

- There is *one* overall system optimiser/manager;
- The existence of only one or two models of provision of shared mobility which *everyone* uses;
- All users being accepting of sharing which is *imposed* upon them by the system manager.

[2] For example, Maas Global, which is based in Finland, supported by Toyota and markets an app inviting people to travel on a 'Whim', has aspirations to be that country's next global corporation, in the mould of Nokia in its prime. See http://maas.global/maas-finland-to-revolutionize-the-global-transportation-market/.

[3] See, for example, http://www.justpark.com.

[4] http://www.transdev.com/en/media/videos/jules-julie.htm.

The first run of the modelling work (see Masterson, 2015) found that if *all* individually-owned private cars were removed from the city then there would be a substantial reduction in the number of vehicles required to service overall mobility demand and greater equity of service across the city as a whole. However, the findings suggested an *increase* in total vehicle kilometres driven of 210,000 km or 6.4% per day. Once the assumption of perfect conditions breaks down and 50% private cars are assumed to remain, the performance of the system deteriorates further with up to 90.9% more kilometres being driven per day.[5] Whilst the numbers generated by such exercises can be debated (see ITF-CPB, 2017 for further optimisation), the key issue here is the set of assumptions about how a system would have to be governed were it to achieve public value. Such tightly regulated approaches do not exist today in even the most progressive welfare societies and there has yet to be a commitment to the types of parking restriction and charging measures that would be necessary to make the transition from today's mixed fleet to a fully shared system beneficial.

The Smart Transition to date has clear echoes of other transport markets through the decades, which have tended towards conditions of oligopoly or monopoly: without effective regulation, preventing anti-competitive behaviour such as a global-scale company providing mobility services from strangling new market entrants at birth through price attacks could be well-nigh impossible. A further issue to be considered about how these new systems concerns the allocated access to public space of different sorts. As Dowling and Kent (2015) identify, even an apparently simple 'smart' innovation such as organised car sharing requires re-negotiation of the relationship between state and various private interests, with the state allocating public space for a commercial operator to run a business, leaving others to deal with the externalities and opportunity costs. Similarly, the state has been heavily subsidising the provision and management of public charge point networks for electric vehicles, locating them in prime high value locations (Strasser et al., 2015).

Although both of these examples may appear trivial, this is because few people are *currently* using them and their impact on behaviour at the aggregate level is modest (McGuirk and Dowling, 2009) and often positive (Le Vine et al., 2014): they could in fact be clear signposts to the creeping privilege of certain mobility solutions over others through the differential allocation of public assets, most importantly road space and the wider public realm. Seemingly trivial and experimental decisions in the "relatively carefree" early phase of transition (Bakker et al., 2014; 52) could prove at best difficult to change and potentially irreversible given the rapid establishment of new norms of usage and powerful providers. For example, we currently provide 'free' spaces for licensed vehicles to wait for and collect taxi passengers, but what are the implications or limits to this practice with the exponential increase in kerb space required for the mass use of potentially automated taxi type services whose key selling point is seamless 'door-to-door' mobility?

### 6.2. Who pays? Taxation and value sharing

This example considers the potential need for a radical rethink as to how the transportation system is paid for. The majority of the infrastructure networks that the mobility services of the future will operate on were built and maintained by the state using the proceeds of (historic) taxation. We know that the balancing of taxes, charges and subsidies paid by or to different use classes (such as cars, HGVs, buses) today is a complex, politically-charged problem, and that striking the necessary balances, such as in price setting for public transport services, often requires some degree of public sector involvement. It might be possible, at least in the early stages of the Smart Transition, for those state organisations that have retained enough power and expertise (e.g. Singapore LTA or Transport for London) to fulfil the role of service aggregator (i.e. acting as the portal and contractual authority for the purchase of 'Smart Mobility' services) themselves, such that access to and the pricing of mobility services is meaningfully regulated in a similar way to now. Such a situation would also make it possible for the state to take a robust view about the taxation of new forms of mobility, not only to raise revenue *per se* from the surpluses generated by 'Smart Mobility' services, but also to crystallise the additional value released by the greater capacity potential of new uses of historic infrastructure such as roads that were built and maintained by the taxpayer. The urgent importance of thinking through how a 'Smart Mobility' future will be taxed cannot be underestimated[6], since even non-smart electric vehicles,

> "are three times as energy efficient as internal combustion vehicles, (therefore) complete electrification will reduce the energy tax base to one-third. In addition, the tax on electricity use is only about one-tenth of the fossil fuel tax, as reckoned per energy unit. The loss in tax revenues from fossil fuel taxation in the EU is estimated at €800 billion as a consequence of the vehicles that could enter the car fleet by 2020. This calls for new market correction mechanisms for road transport in the future, if the external costs of transport in the form of road wear, congestion, local pollution and accidents are somehow to be internalised."
>
> (Lindberg and Fridstrøm, 2015: 8)

Co-founder of Zipcar, Robin Chase (2015: 201), believes that "absent taxes on negative externalities… (and) platforms that are financed and controlled by investors will continue the trend to increased income inequality and lack of concern over environmental deterioration". Congestion charging or time varying per mile tariffs remain at the forefront of options which would address usage effectively but there could be alternative or additional approaches which for example address the liveability impacts of pick up and drop off in environmentally sensitive areas.

It is important to consider the changing dynamic that could open up opportunities in this space. First, national governments have

[5] The approach also does not assume any demand increases as a result of lower user costs which would further impact on performance.

[6] It is instructive to note the peak or surge pricing being adopted by Uber and being accepted by users in stark contrast to the slow pace of deployment of congestion based charging led by the state.

generally been averse to establishing a surveillance based national charging system due to a combination of privacy, competence and political risk concerns. However, the 'Smart Mobility' system promotes the role of the mobility aggregator or provider as the intermediary between the government and the traveller. Such providers are likely to use time varying pricing structures anyway as well as relying on increasingly sophisticated digitally georeferenced location platforms and so may provide both the technology platform and the political cover to support a change in how we charge for use of the network. The debate however seems some way off this and there are challenges as to how to make the transition with a mixed mode of private and shared mobility.

### 6.3. Data and information asymmetry

A critical asset that the state needs to exert some form of control over in order to avoid anti-competitive practices and other negative externalities is the data upon which the Smart Transition depends. Data is the most valuable commodity in the smart system, because it structures the matching of mobility to demand, and therefore both the price of mobility to the end user but also the size of the surplus generated by the mobility service transaction. In the smart future, data is the knowledge upon which the power to control the marketplace is built. Yet, in line with the wider neo-liberal framing of the Smart Transition to date, in which the role of government has been set out as creating the conditions for technological innovation to occur (see above), the state is actively *giving away* this data to private interests:

> "A key enabler of the value chain for Smart Mobility services is a city's upfront investment in ITS and other intelligent infrastructure that generates key raw data… Public agencies, including city government, are seeing the economic value in making their data available at no cost… for private data owners, this raw material may be a saleable asset in its own right."
>
> (Buscher et al., 2014: 30)

Whilst the 'open data' movement offers myriad opportunities for more user-led and intelligent planning decisions to be made as a result of thousands of individual developers and users creating new ways to harness and distribute mobility data, the critical risk is that this shift in the control of knowledge and associated power will make governing mobility much more difficult in the longer term. The state is already losing its position as the principal source of knowledge about travel patterns on the network relative to mobile phone operators, with this information asymmetry also set to grow further through e.g. better peer to peer sharing of location data. Chase (2015) suggests that the positive externalities of opening data outweigh the negative but that there are also ways for the state to avoid the negative too. For example, it is possible to license access to free 3D infrastructure maps and service data such that anyone making commercial gain from this open provision has to provide the state access to some aspects of the data they generate.[7]

Our concern about information asymmetries is particularly important in the longer run in a system where automated vehicles are the norm and/or where the aggregation of mobility services across different forms of transport is the proviso of a small number of powerful corporate interests. The power of the state to intervene to steer demand could become, we suggest, much more constrained and subject simultaneously to criticisms of interference and stymying of productivity should efforts to manage demand for whatever reason be brought forward, as the companies and not the state will be the primary sources of knowledge about demand. It is important to recognise the commercial value in such data. In the UK, bus companies have been fiercely resistant to sharing data on route utilisation and there seems no reason for other private sector providers to act differently on a purely voluntary basis. This points to a need for very clear approaches to data sharing which protect public interest and ensure the state can use the data to support public value creation.

### 6.4. Business models, equity and inclusion

Maintaining some kind of effective economic regulation is only one challenge the state will have to meet. Managing the distributional impacts of service delivery is one of the key elements of public value and so ensuring an appropriate degree of equity and non-discrimination in access to 'Smart Mobility' services will also require careful intervention. We acknowledge that many visions of a 'Smart Mobility' future in which user costs are lower have the potential to resolve some long-standing exclusion issues. However, the 'Smart Mobility' transition will not occur at the same pace or to the same degree across different spatial areas and will not be uniformly accessible to all members of society. As intensive utilisation of vehicles is at the heart of the business model for usership rather than ownership, it is unsurprising to see these services predominantly located in central areas or in particularly dense nodes in bigger cities. Dowling and Kent (2015) found, for example, that almost half of the car club vehicles in Sydney were within or very close to the CBD, a pattern that can be seen with bike share schemes and coverage of taxis.

Whilst there is obvious potential for the 'sharing' economy to allow more bottom up solutions to emerge that work at times and in places that public transport has retreated from, there will be big differentials between urban, *peri*-urban and rural experiences of a 'Smart Mobility' future. In order to address these inequities, the state will have to engage differently and think about how best to ensure that new mobility services have some kind of universality. At present, this 'safety net' function (where it exists) is expressed through subsidies for certain types of public transport service. But this model is already gravely threatened by the decline of so-called 'lifeline' public transport services due to car competition and increasing public sector austerity in many places. In a smart future, will the state need to consider supporting mobility subscriptions rather than the transport services which underpin them or could a social contract form part of the right to operate, a new kind of 'Public Service Obligation' for Smart Mobility? For example, a kind of 'Tobin'

[7] The recent lack of transparency in data sharing around the first more highly automated driving system accidents in the US is a concerning initial marker.

per-transaction charge could be levied in areas with very high sharing densities which subsidises the areas which would otherwise be under served.

These issues demonstrate how questions about the potential asymmetry of power between the state and global corporates acting as mobility providers and aggregators re-emerge in many analyses of the impacts of the Smart Mobility transition. If the principal transaction in the smart future is between mobility companies and individuals, then this will in turn change the dynamic about who speaks for the consumer, and what the 'public interest' is in the first place.[8] Those firms acting as mobility service providers and aggregators – who, as we have seen, will have access to the crucial datasets underpinning the smart ecosystem – will be in a very powerful position to claim that they understand the preferences of their users better than anyone else, and that it is for public authorities to respond to these preferences. The risks of excluding the needs of those groups of people who engage with Smart Mobility service provision in some form of 'different' manner are obvious: those people with limited budgets who use very little or no service (e.g. people for whom cycling and walking will meet the majority of their mobility needs) will therefore have very little voice in such discussions.

Finally, there is the issue of the state's position as guarantor of agreed social norms and how these are reflected in the 'Smart Mobility' future. Perniciously, some types of social aggregation services have *already* been shown to demonstrate selective approval processes – "Digital Discrimination" – on the grounds of race (Edelman and Luca, 2015; Edelman et al., 2016). Research has also demonstrated the unease with which many people approach the idea of sharing vehicles (see, for example, Merat et al., 2016). But without some form of regulatory control for social obligation, what kinds of digital discrimination will emerge in 'Smart Mobility'? Gender-segregated shared taxis? No services for areas deemed undesirable (or unprofitable) by mobility firms themselves? Premium costs to travel on a Saturday night for young people aged under 25? or "better service in areas with more white people"? (The Washington Post, 2016).

### 6.5. Governance challenges

Our analysis identifies that although the transition appears to be at an early stage, changes and trends we can already see suggest that we are nonetheless now at a 'critical juncture' for the governance of Smart Mobility. Capoccia and Kelemen (2007: 348) define critical junctures as "relatively short periods of time during which there is a substantially heightened probability that agents' choices will affect the outcome of interest". Given the pace of innovation, for Smart Mobility this window might be relatively brief, and might be the only time when policy makers will have a relatively broad range of options for intervention open to them to have a significant impact on subsequent outcomes before a new mobility regime becomes established. In mobility governance terms, the key first principles questions characterising the critical juncture are about what regulatory posture the state will want – or perhaps be able to – adopt in future (see Docherty et al., 2004; Cowie, 2010).

In Table 3 we draw together the key aspects of our four examples against the framework set out in Section 4 to do two things. First, we identify the different reasons for government intervention that each of the examples suggest, summarising why they come about. Second, we summarise the approach to governance that seems most appropriate to steer the mobility system through the transition.

Whilst each example is open to interpretation and resolution in the local implementation circumstances that exist (as can be seen for example with the early adoption or rejection of Uber in cities) there are some general points of reflection. As the Table shows, the different examples cover the full range of different reasons for intervention[9]. Critically, the examples point to the importance of clarity about the overall national, regional or local public policy goals and priorities against which the benefits or disbenefits of specific or combinations of innovations will be assessed. As with any policy intervention there will be winners and losers in the Smart Mobility transition and the principal tensions will arise around the obligations which the state imposes to either align producer interests and public value or to ensure sufficient compensatory mechanisms are in place to deliver the rights and benefits to citizens which capture public value. It seems clear also that whilst the state will remain a central actor, its role as a key knowledge source and as a provider or funder of services will diminish. This will place greater emphasis on the development of approaches to governing through an increasingly complex network of actors at a range of scales. As Millard (in press, 4) notes in the context of broader smart city transformations, this will involve:

> "breaking down, or at least cooperation between, silos across different administrations, levels and locations… this involves huge challenges technically, politically, legally, organisationally and in terms of working cultures".

A recent review of 100 research articles on transportation policy identifies almost no attention to questions of multi-level governance, nor to how policy gets made rather than what policy is (Marsden and Reardon, 2017). This is both a significant research gap as well as policy need. Without increased attention to *how* policy is made, the state's widely perceived status as 'lagging' behind market innovation in 'Smart' transport will continue, and it may become even more difficult over time for government to organise to capture public value from the Smart Transition.

[8] The very public clash between Apple and US law enforcement agencies on the issue of data encryption is an important early example in how new understandings about the relationship between individual, service providers and state rights is highly problematic.

[9] Support for innovation was not a feature in the examples but was set out in the discussion around Table 2.

**Table 3**
Summary comparison of governance challenges from examples.

| Topic | Reasons for intervention (numbers correspond to Table 1) | Modes of intervention |
|---|---|---|
| Short versus long game | 1, 2, 3, 4, 5, 6, 7, 8, 9. The changing set of actors involved in transport provision challenge the existing rules of the game. Different types of market failure will emerge and need to be managed. New operational rules and co-ordination procedures will be required | To ensure public value, clarity of overarching goals remains critical so that the contribution of new mobility options to more sustainable futures is evaluated. The networks of actors will significantly broaden and governance approaches will require skilled alignment of interests in a dynamic environment |
| Who pays? | 1, 5, 9, 10, 12. Absent intervention, the tax base supporting transport investment will decline. In addition the relationship between ownership and use will change as well as fuel mix so no change also represents a very different policy in 10 years from that in effect today | Requires transparency in why a taxation transition is necessary and how it can be done fairly. Strong political accountability necessary and public participation. Providers as stakeholders but without privilege |
| Information asymmetries | 4, 6, 8, 9, 11. Lack of intervention will lead to exacerbation of existing private sector data harbouring, reducing power of state in understanding and managing the transport system | State acts as an arbiter of a broader set of interests on standards and co-ordination, as a co-provider of information and in setting standards for sharing. Critical questions surround the balance between unfettered and partnership models for data sharing |
| Equity and inclusion | 1, 2, 3, 4, 5, 7, 12. There is potential for smart mobility to solve but also widen some equality and inclusion gaps. There is a need to redefine how necessary services are defined and provided and how subsidy is channelled | The state is a partner with the new mobility providers to try and develop systems which deliver greater public value than today. There may be a need to regulate to balance profitable provision with social obligation |

## 7. Conclusion

There will undoubtedly be a transition to smarter mobility futures which will have a significant impact on the role of mobility in society. New actors, networks and technologies are already fundamentally challenging the extant regime and how transport is governed. This is not a debate about state versus non-state actors but instead about the role the state takes within these new networks to steer, facilitate and also reject different elements of the mobility system. To do this effectively we have identified through our case studies the importance of a clear set of overarching goals and a commitment to act in ways which enable innovation to flourish but which simultaneously ensure the enhancement of public value. Failure to do so risks the state being overtaken by events and moving to a responsive and piecemeal mode of governance, doing little more than plugging holes in the public policy dike before others open up.

As different countries and cities have quite different start points in terms of transport systems, objectives and modes of governance we can anticipate a pluralistic approach to the smart mobility transition and many transition pathways. Transition is a process and will require continuous adaptation but it is one in which governments will continue to have significant agency. However, early thinking about how we want to accommodate Smart Mobility solutions for broader social goals, rather than for competitive advantage on economic innovation grounds, is necessary as we are already at a 'critical juncture' in determining how some of these innovations might develop. Our analysis points to the need to think about the long-term position when the majority, not the minority, are relying on these new systems to fully understand the governance challenges. Whilst energy, openness and optimism are all necessary to deliver innovation, a blindness to the downside risks and longer-term positions that might well emerge would be to forget the failings of past transitions.

Maintaining a strong regulatory posture will be difficult if not impossible in many contexts. State power in the transport domain is weak in many places, especially those such as many North American cities where the private car is already the overwhelmingly dominant form of mobility and in which the state has little or no existing role in the 'belief system' about how mobility should be distributed beyond building as many roads as possible. At a time where governments around the world are seeking to shrink the state and reduce administrative costs (simultaneously leaching expertise), it is difficult to be optimistic that governments, at different levels, will pick up the baton to orchestrate the Smart Transition despite the need for, and benefits of, action identified here. Our hope in starting these critical debates, some fifty-three years on from Buchanan's visionary report about the risks inherent in the rise of automobility, is that society 50 years from now is not left similarly looking back at the mismanagement and missed opportunities from the next great mobility transition.

## Acknowledgements

This paper is partly based on research undertaken as part of the *Disruption: the raw material for low carbon change* project, funded under the RCUK Energy Programme, ESPRC Award No. EP/J00460X/1. The authors would like to thank Glenn Lyons, Jon Shaw and Richard Walker for their comments on earlier versions of the paper, and for Louise Reardon for convening the Leipzig research seminar session in which some of our ideas were tested and subsequently improved.

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