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Tackling road congestion – what might it look like in the future under a collaborative and connected mobility model?

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ABSTRACT:
Traffic congestion continues to be the bane of many metropolitan areas and has exercised the minds of experts for at least the last 60 years. With the advent of smart (intelligent) mobility, aligned with digital disruption and future connected and collaborative transport including extensions to autonomous vehicles, the question of whether we have a new window of opportunity to tame congestion is now high on the list of possibilities. It is however very unclear what the future will look like in respect of congestion on the roads, especially if we rely on ‘smart’ technology and continue to reject reform of road user charging and new opportunities to fund the sharing model. This paper looks at a number of themes as a way of highlighting possibilities and challenges.

KEY WORDS:
congestion, pricing and funding reform, intelligent mobility, governance, data ownership, smart cities, business models, public transport futures

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Introduction

The growing interest in smart cities and the role of digital-based technology in driving new agendas for how our cities will perform in the near and far future has opened up commentary on what this might mean for curbing road traffic congestion. Will, for example, autonomous vehicles (at levels 3 and 4 in particular) contribute to reducing if not eliminating or better manage traffic congestion, and when might this occur? How might a move to a sharing culture with less private car ownership affect levels of congestion even without autonomous cars? What will all this mean for future investment in infrastructure, especially major highways, and might the design of such roads change in recognition of the safety outcomes associated with computer-controlled cars that can travel in platoons? Will lanes be narrower, with possibly autonomous intersection management? Under the sharing model, car-based movements might start to take on the feel of conventional bus public transport, albeit with smaller vehicles, offering improved public transport-like services that can stretch throughout suburbia under a point to point initiative, or as a first and last mile (almost seamless) connection with conventional line-haul high capacity public transport. These speculative assertions are eroding daily as we come to grips with the real possibilities of technology-enhanced mobility opportunities, driverless or otherwise. What this will mean for the changing landscape of service provision under the adage ‘the customer comes first’, and the implications for the governance of cities, are rapidly becoming priority agenda items.

With a focus on what this might mean for future levels of traffic congestion, this paper looks closely at a number of themes that might throw up clues as to the implications for future congestion and what conditions are likely to have to be in place to support taming traffic congestion. We have selected four themes: smart mobility, governance reform, ownership of information, and road pricing reform. In one sense the arguments presented below are speculative (although almost daily we acquire further factual evidence); but then so is the future. To recognise that the digitally disrupted future and its interface with autonomous vehicle technology may have significant downsides, once we start to understand behavioural response, must be given a greater focus. Importantly, we need to be clear from the outset that mobility as a service (MaaS), the popular interpretation of future collaborative and connected mobility services, must be considered under both the presence and absence of autonomous vehicles as well as the extent to which we can change society to adopt a sharing culture. These are the critical elements that have to be in place or not in judging the opportunity to change the way transport services are provided and the success of any initiatives (see also Cavoli et al. 2017 for an excellent review of the literature and Cohen et al. 2017).

This paper is as much about uncertain futures as it is about identifying research themes that will need to be given greater attention if we are to gain greater confidence in the likely impact that these exciting initiatives might have on levels of congestion. There is one outcome that we feel reasonably confident about however – congestion is likely to become less random and somewhat more predictable, but it is unlikely to disappear. Much of the criticism of historical and current traffic congestion is related to its great variability and uncertainty every time one travels, and the growing incidence of accidents and breakdowns as a contributing influence.

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1 See Lyons (2017) for a review and critique of the meaning and value of the word ‘smart’.
2 A Level 3 autonomous system is capable of monitoring the driving environment around them, allowing vehicles to make decision themselves. Cars with on board computers that can handle tasks like indicating, braking and steering at the same time are classed as Level 4 systems. A Level 4 car is officially driverless in certain environments and can drive safely on its own even if a driver chooses not to intervene when asked. See https://en.wikipedia.org/wiki/Autonomous_car
3 Although this may require no lane access by heavy vehicles
Smart shared mobility and potential implications for levels of congestion

The transition to smarter mobility that is taking place, referred to as Smart Transition, typically involves greater car sharing (facilitated by apps) and less owning of cars by private individuals, as well as the future role of (electric) autonomous vehicles. It has an underlying mandate to redefine and commit to a Collaborative and Connected Society (CCS) whereby the mode is far less important that the service levels that satisfy customer needs. While we will always need reflective and effective governance frameworks to ensure deliver of CCS, we have an opportunity to finally break the stranglehold that outmoded mode-specific regulatory models have had on the provision of transport services.4 Why should we continue with mode-specific contracts, often associated in the public transport sphere with public monopolies or provided by competition for the market (i.e., competitive tendering – see Hensher 2017), all supported with provider-side subsidies? This includes the limitations imposed on the over-specification of network service levels (and the predominance of timetables for conventional public transport). The car-based systems associated with taxis are now being broken by the arrival of new service models such as Uber and Lyft, although they are essentially mode-specific (though covering an increasingly expanding mix of intermediate modes, many of which are being defined for the first time). Fundamentally, we increasingly see many variants on the conventional wisdom that are tantamount to delivery models that cannot operate under outdated regulations. Smart Transition is the context in which we have to contemplate that anything goes as long as it has a sensible customer outcome, and one might hope an acceptance by government as the custodian of societal interests through a reformed governance (and funding) model.

The current interest is in how this all relates to the future of road congestion reduction, something that is claimed to be a major benefit of an era of intelligent mobility. This appears to be premised on one crucial consideration, the success in moving society to a regime of collaboration and connectivity, initially without autonomous vehicles but subsequently with such vehicles. Collaboration is often associated with the sharing economy which can take at least two paths – shared and pooled (see Wong, Hensher and Mulley 2017), or without others, for a particular ‘point to point’ or ‘point via another point to point’ trip. It is far from clear how much of the congestion challenge can be resolved through greater sharing of private cars (no matter whether they are autonomous or not), increasing occupancy, assuming a constant number of person trips. However, sharing of private cars could lead to increased trips overall through a higher number of trips per vehicle, and to greater congestion if the number of trips overall goes up.

A very specific issue being raised within the new reform agenda is what all of this might mean for the number of cars on the road and the amount car usage (vehicle kilometres travelled). The limited evidence on smart transition (predominantly associated with smart apps, opportunities to ride hail and dispose of a car), is simultaneously creating the promise of a system that can reduce demand (congestion), but at the same time fulfilling previously unmet demand and creating new demand. Smart transition moves society to a rentier model where the incentive for the mobility service provider is to generate as much mobility as possible (i.e., trips and kilometres) to maximise returns on capital (Karlsson et al., 2016).

What little evidence there is at present, based on simulated scenarios of futures, is informative, but can it be relied on? Two studies are of particular interest, one from the ITF/OECD, and one from University

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4 Interestingly, NSW made a start with this is the 2014 Passenger transport Act where linking of specific vehicles of modes was removed.
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of California Davis (Clelow and Mishra 2017). These studies say nothing about the impact of autonomous cars or indeed any renewed future role of public transport (except on demand buses) – they primarily focus on shared cars with a driver, the latter likely to be the basis of car travel for at least the next 20 years.

The ITF/OECD study modelled the impact of replacing all car and bus trips in a city with mobility provided through fleets of shared vehicles. The study found that if all individually-owned private cars were removed from the city with shared vehicles only, 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 vehicle kilometres driven of 6.4 percent per day. Once the assumption of perfect conditions breaks down, and 50 percent of private cars are assumed to remain, the performance of the system deteriorates further, with up to 90.9% more kilometres being driven per day. This does not sound like a congestion buster? Even more congestion on our roads; although the congestion levels may be more predictable (non-random) with improved reliability, and maybe a lower value of travel time savings and reliability willingness to pay.\(^5\)

ITF/OECD (2017) also undertook a simulation study, using mobility and network data from Lisbon, Portugal and examined scenarios where shared mobility is delivered by a fleet of six-seat vehicles (shared taxis) that offer on-demand, door-to-door shared rides in conjunction with a fleet of eight-person and 16-person mini-buses (taxi-buses) that serve pop-up stops on demand and provide transfer-free rides. Rail and subway services are assumed to keep operating in the current pattern. They tested scenarios where car owners could use their car for one, two or three days each working week, which corresponds to having 20 percent, 40 percent, and 60 percent of trips currently made by private car continuing to be made by that same mode\(^6\). Allowing for 60 percent of the private cars\(^7\) brings virtually no reduction in congestion, thus producing no visible result of improvement, and no support for the political argument in favour of introduction of shared mobility solutions. On the contrary, allowing 40 percent of the private cars (each private car allowed two days per week) reduces vehicle kilometres at the peak hour by 13 percent, which according to the authors ‘essentially makes congestion disappear’. The reduction of parking space needs is also visible (see Rantasila, 2016) and it is suggested that this would allow a benefit for pedestrians (and cyclists) in many parts of the city (assuming this space is not used for other endeavours). Environmental impacts are also likely to positive (Brendel and Mandrella, 2016). These "quick wins" can be essential to gain political support for the change.

Clelow and Mishra (2017) presents findings from a comprehensive travel and residential survey deployed in seven major U.S. cities (Boston, Chicago, Los Angeles, New York, San Francisco/ Bay Area, Seattle, and Washington, D.C.), undertaken in two phases from 2014 to 2016, with a targeted representative sample of urban and suburban populations. 4,094 completed responses were collected between the two surveys, with 2,217 from respondents residing in dense, urban neighbourhoods and 1,877 from more suburban locations\(^8\). They show that directionally, based on mode substitution and

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\(^5\) The study only forecasts a minor increase in travel times by having distributors and local streets absorb much of this increase—thereby ignoring the road hierarchy and bringing associated externalities.

\(^6\) A related issue and cautionary evidence is what happened when Athens allowed vehicles to be driven every other day (odd and even registration plates), albeit for pollution control. The outcome was an increase in the number of vehicles as households moved to buy more vehicles so they had a permitted vehicle for each day or they went for one of the exempted vehicles. It is not easy to stop people once they have a car, so reducing the number of vehicles overall has to be where we start.

\(^7\) The study found that if conventional cars were replaced with driverless cars that take either a single passenger at a time or several passengers together, as long as half of travel is still carried out by conventional cars, total vehicle miles travelled will increase from 30 to 90 percent, suggesting that even widespread sharing of driverless cars would mean greater congestion for a long time.

\(^8\) The authors correctly express concern about many other studies in the USA that have self-selection bias in that their samples are from locations where car ownership is typically much lower than normal, and the socio economic
ride-hailing frequency of use data, that ride-hailing is currently likely to contribute to growth in vehicle miles travelled (VMT) in the major cities represented in this study. Specifically, they find that ride-hailing users, on average, do not possess significantly fewer vehicles than their non-ride-hailing counterparts, and have more vehicles than those who only use transit. While some amount of ride-hailing users reduce the miles that they personally drive, and nine percent disposed of a vehicle, these miles return in the form of miles travelled in a ride-hailing vehicle. They found a strong correlation between increasing ride-hailing use and increasing rates of vehicle reduction. That is, the more frequently an adopter uses ride-hailing services (from once a month to daily), the more likely they were to have reduced their household vehicles. The reduction of vehicle ownership is primarily of value insomuch as it reduces total vehicle miles travelled (VMT), although the reduction in the number of vehicles in the system is encouraging. What is currently unclear is the net vehicle miles travelled (VMT) adjustment due to the introduction of ride-hailing – has it gone up or down? And what are the likely longer-term impacts of these services as ride-hailing companies operate a commercial model with a usage maximisation objective?

There is nothing in this evidence to inform us about the role of autonomous vehicles. Whereas the studies reported above are related to driver based cars, a study by MacKenzie et al. (2016) estimates that autonomous cars can cut the cost of travel by as much as 80 percent, which in turn drives up kilometres travelled by 60 percent. Clearly the price elasticity is at work and really does matter. MacKenzie suggests that “You are talking about a technology that promises to make travel safer, cheaper, and more convenient. And when you do that, you’d better expect people are going to do more of it.”

As interest in shared mobility grows, with evidence thus far mainly focussing on switching between a privately owned car usage model to a car-based shared vehicle model, a broader question of interest becomes the mix of modes that will (might) be offered through the subscription plans that are starting to enter the market, or being actively considered, by mobility service providers (and how these ought to be allocated including the link with modal efficiency and land use—see Wong, Hensher and Mulley 2017). When autonomous vehicles are added into the mix in future years, and there is greater acceptance of sharing non-owned cars (in contrast to sharing existing public transport)11, there are real prospects of significant changes in the performance of the transport network, especially roads. But the question remains – how much of the kilometres travelled on the roads by shared vehicles will be car based and result in significant reductions in conventional public transport use (Hensher 2017)? Will this also make traffic congestion worse, even if more predictable, but in a safer mobility environment, or not? Maybe the advent of the small bus will become nothing more than a higher-vehicle occupancy shared car, which maybe a good thing and is almost inevitable that it will become the bus mode under a demand-responsive system13?

can be built into existing contracts (as variations) or being actively considered, as a way of encouraging competition. If as might be expected in some

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10 To realise this savings, significant investment is required up front with a long term ROI model.

11 This also implies a greater level of personal intimacy—how acceptable this is has yet to be adequately tested.

12 All this depends on the pricing model. One of the serious impediments to sharing is the way in which the private car is a low marginal cost mode, especially in comparison to shared cars, public transport etc. MaaS relies on people being prepared to understand the full costs of car ownership.

13 An important question is to what extent conventional fixed route timetabled bus services will be replaced by demand responsive bus services (DRTs), and importantly what this will mean for future large bus needs and contracting models. Some pundits have suggested that DRTs can be built into existing contracts (as variations) under tendered or negotiated contracts; however the author argues that DRTs should be part of an economically deregulated market, at least initially, as a way of encouraging competition. If as might be expected in some
MaaS (Australia)\textsuperscript{14}, for example, argues that without public transport at the centre of MaaS complemented with on-demand transport covering the first and last mile, it will not succeed in delivering mobility solutions that are more than simply commercial propositions designed to make money for car-based services, but will deliver on the goals and expectations of government and society more broadly. It is a balancing act – optimising the supply and demand chains of the transport services without compromising the intended goals and objectives. This will require all transport providers and MaaS operators to collaborate transparently (the commercial model yet to be contested / trialled). This creates a real challenge for a number of the players in this space who have a vehement interest in a car-based solution, and who are reticent about joining forces in a subscription plan with conventional public transport modes, which they believe will be loss making. This raises important questions about how the packages can be designed to allow for internal cross subsidy\textsuperscript{15} and still deliver an acceptable return on investment, while at the same time not requiring government subsidy, and hence allowing the MaaS model to be delivered under a truly free market setting\textsuperscript{16}. MaaS (Australia) envisions that mobility ecosystem benefits will be realised by establishing a trusted partnership between the public and private sector and unlocking the access to data.

The ‘limited’ evidence also suggests that if the cost of mobility drops under a CCS model (after accounting for removing ownership and hence costs, and eventually the widespread presence of autonomous cars), then we should expect more road based travel (i.e., increased passenger kilometres), but what is unclear is whether the move to sharing will reduce vehicle kilometres – it may be fewer vehicles doing more kilometres since they will be on the road for many more hours (being more temporally efficient) than the privately owned vehicle. If you believe some pundits, this is the model that will evolve as the business model of the growing number of competing ride sharing and ride sourcing services, forcing prices down\textsuperscript{17} and increasing the hours that any one car has to be on the road to recover the commercial objective (aligned with arguments given by Hollands (2015)). Conventional public transport needs to heed this warning as does government.

Part of the solution in protecting the future of public transport may rest with future government funding models\textsuperscript{18}, especially if the current provider side subsidy regime for public transport is replaced with a user-side controlled scheme\textsuperscript{19} that gives users control on where subsidy is allocated given what public transport trips they choose. This will also engender a competitive process as mobility providers compete to attract customers, and hence is expected to result in a much more efficient level of subsidy provision and hopefully modal mix of offers. If it results in reduced demand for public transport services and

\begin{footnotesize}
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\item \textsuperscript{14} I thank Hany Eldaly (Managing Director and Co-founder of MaaS (Australia)) for discussions on this theme and the commitment that MaaS (Australia) has to ensuring public transport is in the mix. See \texttt{http://maasaustralia.com/}.
\item \textsuperscript{15} This is the basis of a current study by ITLS, led by Corinne Mulley, on community transport in NSW.
\item \textsuperscript{16} There is a lot of value add from the data collected by apps; hence if this has real value in a MaaS context, then this value can be used to deflate the MaaS package price. In the UK, although less in Australia, for example, there is a lot of advertising around leasing of cars (for individuals, not necessarily firms). These are all inclusive lease prices (car, repairs, maintenance and in some cases road tax). The more this becomes the way in which people buy their cars, the more the MaaS package will look less expensive as the marginal cost of the car use will be including all the costs rather than just fuel. I thank Corinne Mulley and participants at the January UTRSG meeting in The UK for these insights.
\item \textsuperscript{17} Including low labour costs for drivers, which is a criticism of many Uber services; and with driverless cars in the future these costs will be even lower (possibly halved), making car based travel very popular at the risk of a future role for public transport.
\item \textsuperscript{18} I am indebted to John Stanley for suggestions and discussion on this point.
\item \textsuperscript{19} As is potentially going to happen for with the community transport sector in New South Wales.
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increased demand for shared car services, government will have to decide how much of conventional public transport should continue to be provided, both in the MaaS package and separate from such packages. It is likely that conventional rail (and bus rapid transit) will remain as the backbone of the transport network (even if scaled back where services are no longer justified), but the rest of the public transport system (essentially bus based and increasingly demand responsive) might be folded into the new mobility model.

In summary, will MaaS schemes be dominated by car based offers? What does it mean for conventional public transport, and government’s response to a car dominated solution? Does it matter what modes are in the mix? Maybe in the future the autonomous car in a safe platoon will act like public transport and so does it not matter what the mode is? This, however, is likely to be less spatially efficient than purpose-built large vehicles (and higher cost autonomous or not, being unable to reap economies of scale from shared components—engines, etc.) and possibly sabotage many of the intrinsic benefits (e.g., land use) of fixed route mass transit. The land use implications (in terms of density and where people will live and work) must be given closer scrutiny since the initial transition to sharing under MaaS without autonomous vehicles, and the subsequent roll out with a significant amount of autonomous vehicles, will change the location landscape, with even more diverse origin-destination patterns and longer commutes expected. The one instrument that can protect a preferred land use and activity profile for our cities in particular is pricing and funding reform, which may be the greatest disruptive instrument available to government to achieve its desired objectives. This should be central to the new governance model and an opportunity not to be missed.

The need for a governance framework to ensure smart mobility delivers congestion reduction

As the interest in innovation in delivering customer-focussed mobility services grows, and especially the tendency to support the role of the market, and entrepreneurs and start-ups in the mix, including their roles as providers of digital platforms, government needs to start contemplating the role it might (or should) have in ensuring that outcomes are consistent with the broad goals for our society ('smart' liveable cities in particular). MaaS has often been described as a concept that can deliver sustainability gains in terms of reduced congestion and transport emissions and improved accessibility and improved public transport performance, but we question this given the limited evidence and thoughtful considerations above. MaaS is also billed as an innovation opportunity, underpinned by the development of new business models in transport, such that it can deliver economic benefits.

Hollands (2015) points to a concern about smart cities being driven by corporate power and commercial interest at the expense of understanding the consequences for social and urban development “which is crucial to the liveability and sustainability of these cities” (Hollands, 2015: 68). Lyons (2017) also echoes these same sentiments. Docherty et al. (2017) suggest that it is far from clear that these opportunities will be recognised or, even where they are, realised due to the complexities of steering any transition in the mobility system. Governing the smart mobility transition will be a key role of government in the presence of the growing network of actors and the new resource interdependencies (including who owns crucial big data – see later) that are almost certain to emerge.

Karlsson et al. (2017) suggest that overall, the assessments suggest that a broader introduction of MaaS could result in overall positive impacts, in terms a modal shift, a change in attitudes and an increase in perceived accessibility to the transport system. However, in their empirical research in Scandinavian countries, conflicts between impacts on different levels were identified where, for example, increased accessibility to the transport system – a desired impact on an individual and societal level – may result in an increase in the number of trips made – possibly a desired impact on an individual level but an undesired impact on a societal level with negative implications for emissions as well as congestion.
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When planning for a further introduction of MaaS from a societal perspective, such conflicts must be addressed in order to best determine how to potentially integrate overall societal goals into the MaaS offer and the business model\(^\text{20}\).

Whilst the numbers of vehicle kilometres generated under different smart mobility models can be debated, a key issue 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 (Docherty et al. 2017), 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.

In reflecting on this matter, one might think that we have been there before. 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 impossible. A further issue to be considered is how these new systems handle allocated access to public space of different sorts. The recent lack of transparency in data sharing around the first more highly automated driving system accidents in the US is also a concerning initial marker.

One possible way forward under a smart future might be for government to consider supporting mobility subscriptions rather than the transport services which underpin them, which could include a social contract as part of the right to operate, a new kind of ‘Public Service Obligation’ for Smart Mobility? For example, as suggested by Docherty et al. (2017), a kind of ‘Tobin’ per-transaction charge could be levied in areas with very high sharing densities which subsidises the areas which would otherwise be under served. The user-side subsidy funding model associated with specific modes such as buses, as discussed in the previous section, could also be part of this model, ensuring that the MaaS subscription plan not only offers a multi-model contract but also has inbuilt competitive processes in setting the prices to attract customers who will pay for a plan that is accompanied by a reimbursement claim equivalent to the level of subsidy provided to a customer. The customer then controls the market and MaaS providers compete for business. This does not guarantee that all MaaS providers would want to include public transport in the mix, but it does ensure that there is sufficient public transport available that is an attractive alternative to the car based services where this is deemed by government to be a desirable feature in the jurisdiction of interest.

We may also need an independent office\(^\text{21}\) of the smart mobility regulator? Much will depend on how brokers (aggregators) and orchestrators of the intelligent mobility model respond by designing multimodal subscription plans with public transport in the mix.

Data access and sharing – necessary to manage network congestion

“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 cited in Docherty et al. 2017)

\(^{20}\) The author and colleagues at ITLS are undertaking a stated preference study to establish broker (aggregator) and orchestrator preferences for different subscription plans (allowing for equity, risk, modes and possible government subsidy). Current mode-specific operators and non-mobility providers are in the sample.

\(^{21}\) Such an office can set the network price with inputs like time of day, location and modal efficiency used to define the rate of mobility credit consumption under an economically deregulated broker market.
One of the very real challenges facing government is the flow of information that can be used to optimise the efficient use of the transport network in the new age of intelligent mobility. From a network control and management point of view, the current concept of operations in cities needs to be reviewed and assessed in conjunction with the current and emerging technologies. Once such assessment is completed, defined strategic and tactical plans (targeting certain applications / services) will be required to close any gaps and deliver the opportunities identified. Funnelling the data available today is one of the main challenges for the transport operators, planners and providers to serve their respective business; it is kind of overwhelming.

Open, cloud-based Internet of Things operating systems exist today, and they allow infrastructure operators to easily connect their assets and perform data analyses without having to develop or invest in the requisite IT infrastructure. The traveller of the future may get in their car, check the potential routes, and drive in a smooth traffic flow to a nearby train station, where they walk onto a train that departs just one minute later, getting them to work in half the time. The driving may be autonomous, guided by a smart infrastructure that tells the car where it can find the fastest and safest route.

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 may 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 and other players such as Google; with this information asymmetry also set to grow further through, for example, better peer to peer sharing of location data.

While governments own important data sources as well (especially integrated traffic control systems, public transport electronic ticketing data), they typically provide it free of charge to others who then process the data into a form where it can be usefully used to design travel planners, route guidance systems and even potential demand for new subscription plans that are multimodal. The positive externalities of open data outweigh the negative, but there are ways for the state to avoid the negative. 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 aspect of the data they generate. Governments have been somewhat conservative in recognising the value of this asset, and just like physical networks such as roads and railways, they should start thinking about a charging regime along similar lines as user pays for roads.

Road pricing reform

The smart mobility paradigm is almost silent on the role that road pricing reform will continue to play and the opportunity that it will open up to give such reform a whole new meaning as part of an integrated pricing strategy. Specifically, we have concluded for many years now that there are few non-blunt instruments available to ‘tame’ congestion over the longer term and to relate the fee for use of the road network to the benefits that are obtained (allowing for internalisation of negative externalities). We have also known for many years that pricing reform is not an issue of economics and planning, but of politics and marketing. Buy in has become the raison d’etre as we continue to struggle to find ways to satisfy the voting population in ways that will gain political support and action (see for example, Hensher and Mulley (2014) and Hensher and Bliemer (2014)). Digitally defined mobility services, be they part of a subscription plan delivered by a broker (or integrator) under MaaS or even a standalone shared service such as Uber or Lyft, provide the opportunity to build in an appropriate pricing mechanism for the use of the road network which is provided by government. Such providers or plans

22 The focus is on efficient economic user charges for the entire network in contrast to tolling which is road specific and typically based on commercial pricing and distortionary impact in terms of overall social welfare
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are likely to use time varying pricing structures as well as relying on increasingly sophisticated digitally geo-referenced 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 road pricing reform becomes hidden and becomes nothing more than a non-declared (to user) component of the cost of using a transport mode on the road network.

Integrators (or mobility brokers) however, have argued for a relaxation of congestion charges for pooled vehicles in those Nordic cities that have implemented them. Further, and similar to integrators, point to point orchestrators (particularly those involved in ride sharing) have argued that governments should implement exemptions from congestion charges and parking fees given the sustainable aspects of using their services. This creates a dilemma because, on the one hand we have in MaaS a real opportunity to reform economic road user charges, and yet we see the arguments for giving concessions on congestion related charges as a way of attracting switching away from the solo driving private vehicle towards the sharing car model (although the suggestions in a previous section suggest a real possibility of high vehicle kilometres around the clock, even with fewer vehicles). On balance, the arguments are weak on this matter given its small contribution to the financial impost of individual car users, and one suspects this might be a ploy of the integrators and orchestrators to reduce their subscription of service charges to customers as a way of growing profitability.

We should also learn from the experience in London, where having been captured by the environmentalists, the then mayor (Ken Livingstone) gave exemptions to environmentally friendly cars. London has had creeping upwards congestion, much of it fuelled by environmentally friendly cars (as people make longer term decisions for durable purchases). The moral of the story is that if it is a road user charge, road users should pay it. If something is deserving of a subsidy, make it direct because this way it can be varied.

We, amongst many others, have proposed ways of reforming the price associated with road use, moving away from fixed charges (that are essentially administrative such as registration fees) to variable charges such as distance (and time of day) price per kilometre. For example, Hensher and Mulley (2014) set about to identify a reform that would both now make Treasuries not financially worse off and the great majority of motorists, and which would ensure a high degree of buy in as the initial objectives. Any demonstrated gains in reduced congestion would ensure as the next stage evidence for adjusting the charging regime. The proposed charging regime involved a 50 percent reduction in annual registration fees and a peak period only distance based charge of 5c/km. Motorists had the option to opt out and travel in the off peak periods (which is feasible for a sufficient number of motorists) reducing traffic by 6-10 percent in the Sydney Metropolitan Areas, returning peak periods in normal times of the year to those experienced in school holidays.

benefits for the entire network. The presence of toll roads under a PPP create a messy situation; however governments need to find a way to gain back control of the network, which has been lost in cities such as Sydney where private companies have 30 year concessions to operate the key motorways. See Hensher (2018) for a discussion.

23 Surge pricing, defined both by time of day and location, is a step in the right direction—it is service-specific though, not network encompassing. The congestion issue is compounded by temporal imbalances between demand for road space occupancy and its (more or less) fixed supply. In any discussion of 'using smart transport to 'resolve' congestion', a degree of temporal, and geographic granularity is desirable (as has always been promoted in road pricing reform – location and time of day) so as to focus the deployment or adoption of 'vehicle sharing' and 'road user charging' towards the domains of greatest challenge and opportunity.

24 Maybe a discount if it is more spatially/temporally efficient.
Conclusions

Whenever I attend a conference on future mobility and autonomous cars, we are told by experts in the technology space, especially those from telecommunications businesses, that congestion will be a thing of the past and all our roads will perform at totally safe free flow levels with optimised spacing between vehicles, as well as intersection and lane merging controls to ensure free flow performance at all locations along a road. Vehicle-to-infrastructure communication will make the city function like a giant computer, with a central operating system that everything flows into. As appealing as this prediction is, one wonders how much faith can be placed on this speculation. What is likely to occur, however, is that the information obtained, after being compiled and analysed by a central platform, will help maintain the traffic flow and direct traffic intelligently, but impact on levels of congestion in a directionally unclear manner, and adapt the infrastructure to meet acute requirements. These assertions appear to fail to recognise the implications of evolving car-based business models focussed on profits. There is a hint here about the possible role of government and whether user or provider side subsidy may be required (maybe less than currently outlaid on conventional public transport) if it ensures a business model that respects the needs of the city over the needs of the commercial operator.

With a fixed amount of road network capacity, if the popularity of the collaborative and connected economy actually takes hold, with or without vehicles being autonomous (and regardless of the fuel source, although this may impact favourably on the cost of car usage if electricity and hence attract even more ridership), we might expect congestion to continue to exist, albeit as more predictable (i.e., less due to random circumstances; lower uncertain travel time variability), and hence the case for efficient road user charging that accommodates congestion impacts will remain real. This will also be required as a mechanism to pay for the roads (as increased support for hypothecation mounts).

It is almost impossible to think of an argument that would result in fewer car kilometres on the roads under even a shared mobility model (which has the greatest prospects), especially if the claim is to also satisfy pent up latent mobility demand and round the clock commercial imperatives. What might be expected is that intelligent mobility opportunities will buy a number of years of growth in automobility in such a way that it will take pressure off the need to invest in currently planned future road investment (which will a good thing), but will require imposing meaningful road user charges. Encouragingly, such reformed road user charges will no longer be imposed on individuals (where the real sensitivity exists), but on mobility brokers who deliver the shared mobility services. Breaking the nexus between ownership and mobility should also break the resistance to supporting road pricing reform at the individual traveller and voter level.

In the debate on traffic congestion, we need to stop looking just at cars. What if there was a smart infrastructure that connected road, rail, and other modes of transportation in such a way that all of them worked together to serve the mobility needs of the modern urban population? It is in this context that the congestion debate should be positioned. As McCabe (2017) suggests, MaaS may well be a fraud if it is car centric, and that if all of the arguments associated with car sharing are currently designed to get more people using cars without protecting the future of public transport, we are likely to see congestion getting worse, not better (after allowing for positive initiatives such as automated roads and reduced vehicle size in platoon settings).

What may well be the saviour is ensuring that a public transport contribution to the mix is preserved as a basis of moving large numbers of travellers who prefer it to a car-based offer, and we have efficient

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25 The most recent conference I attended heard from the Chief Scientist of Telstra (Australia) who claimed that we will soon have 5G communications controlling autonomous vehicles that will be the basis of operating our road network with all communication built into the vehicles (no modification required to roads), resulting in the complete elimination of traffic congestion.
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Hensher

road user charging and reformed public funding. If, as is suggested, car use will drop in price as we move to a sharing non ownership society with autonomous electric vehicles, the market will deliver higher levels of demand for such services (exactly what the technology and app developers are hoping for), and thus simple economics without efficient road user charging is likely to deliver congestion growth. So will we end back at a position where the savings associated with selling a car and moving to a non-ownership model with relatively low costs of usage actually discourage travel by a car mode? (See the Appendix for the author’s actual situation in deciding on whether sharing and non-ownership is attractive.) The central theme of his paper is that even with significant sharing of vehicles that are not privately owned, we are unlikely ever to fully tame congestion through the smart technology initiative (Cars are still cars—geometrically unchanged by technology). Road pricing must come to the rescue as well as a new public transport funding model by government designed to switch control of subsidy to users and away from providers as a way of creating a competitive market for mobility contracts that support public transport. The greatest disruption may, in time, be created by pricing and funding reform.

Appendix

There may be many car owners where the economics of sharing does not stack up until we have shared autonomous vehicles that have significantly lower user costs (i.e., no driver wages for example). All the while we have a driver in a shared car, the economics are not very attractive for regular car (centric) users. This is the dominant travel mode in most cities in Australia, and hence I anticipate that the exercise below reflects a circumstance of many current car owners and users.

Suppose I have bought a car for cash for $60,000 (which is a typical price for a quality car), and let me assume I keep it for 10 years and simplify the annual capital cost (depreciation) as $6,000, maintenance costs of $1,000 and parking costs of $300, and the car has a residual value of $5,000 after 10 years, which is reasonable.

The annual registration, insurance, maintenance, parking and fuel/toll bill is around $5,000 per annum, giving a total outlay of $11,000 per annum. There is also foregone interest by not investing elsewhere; however the shared vehicle user cost also has an opportunity cost, so it is reasonably financially neutral.

I now sell my Car (assume I only own one car) and enter the shared society and use Uber. Assume I used to drive my car to work 5 days a week and use the car on weekends, and that I intend to continue using a car based model for these same trips.

If I use Uber for the same trips, then assuming each Uber trip is $20 (which is a basic charge and likely to be greater for some trips, even under a driverless scenario); the weekly cost is around $250 or the annual cost is $13,000, $2,000 greater than the ownership model. If we assume that Uber is used on average 5 days a week (which may be a mix of weekday and weekend), then the annual cost is $9,285 which is less than the ownership cost of $11,000. Clearly the comparison depends on the number of trips to be made under sharing and whether this might be less than under the private car ownership model. Regardless of the specific evidence, this simple exercise is a stark reminder that a sharing model may not be financially attractive to some car centric users. When we consider a view that for many, car ownership is not about cost, this adds another layer of issues to think through in the shared car society.

What is the sharing deal? Not currently very attractive! Some other points worth making are:

1. Even if we assume this possibility, and note the $2,000 difference for the 7 day activity, this is equivalent to 100 Uber trips switching out to PT if that is feasible.
2. If a car owner was to take full advantage of the car share systems existing and proposed, they could rent out their own car (if they continue to own it) when they are not using it, and further recoup some of the costs of owning a car. The private car may then become nothing more than a rentable asset. (This hardly helps traffic congestion!)

3. Most people we suspect believe that it is less expensive to own a car than to take Uber. This is the issue of perceived costs associated with usage. So for which people would it be a good idea to actually sell their car and take Uber instead? Most people forget to include all the costs in this consideration, since they see a high Uber fee, while not considering the hidden costs of owning a car, which have been included in the exercise above.

4. This is only one market segment, but with dominant interest in the car it seems a very important segment to focus on.

5. Not included are some future possibilities such as selling or renting the garage at a private residence. Selling garages is quite common in London. One in central London recently sold for over $1,000,000: [http://www.dailymail.co.uk/news/article-4048546/Garages-goldmines-London-2016-s-expensive-lock-goes-670-000-nearly-TRIPLE-average-UK-house-price.html](http://www.dailymail.co.uk/news/article-4048546/Garages-goldmines-London-2016-s-expensive-lock-goes-670-000-nearly-TRIPLE-average-UK-house-price.html).

6. One questions whether a household might sell the garage at home; however when deciding on a future house purchase, they may avoid having a garage, or may include one but rent it out just like a sublet (like airBnB but airG)? This may impact, however, the future design and scale of residential dwellings and lead to reduced purchase (and rental) prices.

References


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