Questioning mobility as a service

Unanticipated implications for society and governance

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ABSTRACT

In this paper we focus on the development of a new service model for accessing transport, namely Mobility as a Service (MaaS) and present one of the first critical analyses of the rhetoric surrounding the concept. One central assumption of one prevalent MaaS conceptualization is that transport services are bundled into service packages for monthly payment, as in the telecommunication or media service sectors. Various other forms of MaaS are being developed but all tend to offer door-to-door multi-modal mobility services, brokered via digital platforms connecting users and service operators. By drawing on literature concerned with socio-technical transitions, we address two multi-layered questions. First, to what extent can the MaaS promises (to citizens and cities) be delivered, and what are the unanticipated societal implications that could arise from a wholesale adoption of MaaS in relation to key issues such as wellbeing, emissions and social inclusion? Second, what are *de facto* challenges for urban governance if the packaged services model of MaaS is widely adopted, and what are the recommended responses? To address these questions, we begin by considering the evolution of intelligent transport systems that underpin the current vision of MaaS and highlight how the new business model could provide a mechanism to make MaaS truly disruptive. We then identify a set of plausible unanticipated societal effects that have implications for urban planning and transport governance. This is followed by a critical assessment of the persuasive rhetoric around MaaS that makes grand promises about efficiency, choice and freedom. Our conclusion is that the range of possible unanticipated consequences carries risks that require public intervention (i.e. steering) for reasons of both efficiency and equity.

1. Introduction

Urban mobility technologies have experienced substantial and increasingly rapid change over the past two decades. At the same time there is increasing recognition that the way we use transport technologies has significant negative impacts, such as greenhouse gas emissions (Chapman, 2007), public health concerns and social equity implications (Mackett and Thoreau, 2015), that make current transport systems unsustainable (Banister, 2005; Hrelja, 2011). Consequently, there are growing efforts to develop innovations that can supply individual mobility whilst addressing these challenges. In this paper, we focus on the concept of Mobility-as-a-Service (MaaS), a term which generally indicates integrative approaches for accessing transport services (which themselves could be

new) via mobile applications (apps). These could be described as disruptive technologies that could be game-changers for future patterns of urban mobility. It has been suggested that trends such as an apparent levelling off in the rise of car use, and the social change exemplified by the 'sharing economy', represent a window of opportunity for a sustainability transition in the mobility system (Geerlings et al., 2012, Kemp et al., 2012). However, it is not yet clear whether MaaS or any combination of the 'Smart Mobility' innovations will be sufficient to transition away from a technological regime dominated by the private car with an internal combustion engine. In addition, it is also uncertain whether the result will be more sustainable than the present system, especially as many of the mobility innovations that promote sharing are commercial rather than social transactions, and thus are likely to seek to maximise mobility rather than minimise it (Bardhi and Eckhardt, 2012).

MaaS represents an important case for detailed critique because, whilst there are still multiple definitions of what could be considered MaaS, a central assumption that is gaining ground is that transport services can be converted into service packages, akin to those offered in the communications and media service sectors. The promised result is provision of on-demand door-to-door mobility being offered by platforms that broker the transaction between users and providers of the mobility services, and MaaS promoters commonly bracket this objective with visions of 'individual freedom' and 'collective efficiency' (both examples from MaaS Global material). This rhetoric is clearly persuasive, but the claims need to be critically thought through. In this paper we define rhetoric as "The art of effective or persuasive speaking or writing, especially the exploitation of figures of speech and other compositional techniques" rather than as "Language designed to have a persuasive or impressive effect, but which is often regarded as lacking in sincerity or meaningful content"[1]). The disruptiveness of MaaS technology does not solely pertain to direct changes, but also carries implications for a wide aspect of societal sectors, as disruptive technologies often do (Jasanoff, 2007, 2016). Thus, informed by previous experiences in the transport sector (Akyelken et al., 2018; Blyth et al., 2016; Schwanen et al., 2004; Whitmarsh, 2012), we can reasonably expect that any widespread roll-out of MaaS will have unanticipated and perverse outcomes ranging from changes in travel behaviour and attitudes to changes in land use and land value affecting urban form, as well as having differential impacts on certain social groups. We should also note that the term itself is very young, possibly originating in 2014 with a Masters' thesis (Heikkilä, 2014), and it's 'capture' of policy imagination has been relatively rapid.

In addition, as there are still plenty of MaaS components open for further development, each having associated uncertainties (such as how to design packages, Matyas and Kamargianni, 2018), evaluating the technology during this phase of entrepreneurial experimentation enables us to consider what implications it has for mobility governance as MaaS deployment will challenge institutional structures and the policy landscape in new ways. Dowling points out that smart mobility is characterized by a blend of technological and business disruptions that create difficulties for transport governance which "is dependent on, and works through, legally defined or socially accepted categories" and these are not aligned with many of smart mobility's propositions (Dowling, 2018, p51). Emerging innovations therefore have important implications not only for the way in which urban mobility is currently governed and how it will be governed in the future, but also are likely to have some potentially significant social and environmental effects that influence the objectives of wider urban governance. At the heart of governance (howsoever organised) is the functional capacity to "steer the economy and society" (Peters, 2014), and thus there must be a mechanism for first deciding on the collective goal and then implementing ways of achieving those goals (Peters, p 302). However, the research on wider implications for governance of MaaS is underdeveloped, and this gap has been repeatedly highlighted in recent publications (Bruun, 2018; Jittrapirom et al 2017, 2018; Kamargianni and Matyas, 2017; Mulley, 2017; Rantasila, 2015; Sochor et al., 2015; Smith et al., 2018a, 2018b). Whilst Audouin and Finger (2018) have undertaken a Multi-Level Governance analysis of the progress to commercial roll-out of Whim Helsinki, their analysis does not extend to identifying plausible unanticipated outcomes and their implications for future governance.

The paper is divided into four main parts. After explaining our methodological framework, we elaborate MaaS as an emerging technological concept accompanied by a set of rhetorical visions. We set out some of the actions taken by key actors that are implicated in constructing a pathway for MaaS that would take it from niche to regime change. Second, we then describe and discuss some plausible unanticipated consequences that we have identified. In the third part of the paper we situate the consequences within the context of urban governance and associated policy discourses that place pressure on the regime level and create windows of opportunity for MaaS to enter a transition pathway. Here, we outline potential actions and directions for future research. Finally, the concluding section provides recommendations for policy and governance.

1.1. Research questions and analytical framework

This paper addresses two main questions. First, to what extent can the promises to citizens and cities of MaaS innovators be delivered, and what are the unanticipated societal implications that could arise from a wholesale adoption of MaaS in relation to sustainability and key societal issues such as health and well-being and social inclusion? Second, what are the challenges for urban governance from potential MaaS adoption, and what are the potential governance and policy-making responses to these challenges?

To date, the frameworks that have been used to analyse MaaS do not fully address the need for development in mobility governance, due to their narrow interpretations of governance and technology concepts, as well as depoliticized notions of their normative foundations (Docherty et al., 2017; Mladenović, 2019; Pangbourne et al., 2018). In exploring the unanticipated implications of any substantial mobility transition to MaaS and the interventions that may be required to address them, we draw on transition theory as well as on some fundamental ideas that are often advanced to justify government intervention, namely efficiency (public

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[1] both usages are given in the Oxford Dictionary of English (https://en.oxforddictionaries.com/definition/rhetoric last accessed 3/12/2018.

goods, addressing externalities and conditions of market failure), equity (such as social inclusion, intergenerational equity and spatial justice) and ethics (e.g. Cabinet Office, 2001; Howlett, 2009). In this paper we restrict our consideration to efficiency and equity. The reasons are because achieving transport efficiency is a long-standing goal of urban and transport planning and policy and because equity is increasingly recognised as entwined with mobility and accessibility to life opportunities (goods, services, employment, education and healthcare). The alterations to our transport networks that could arise from widespread deployment of MaaS will have both efficiency and equity implications. For manageability we leave ethics to one side but recognise that equity has an important ethical dimension (see for example Martens, 2016).

1.2. Theoretical framework and method

In this section we explain how the key concepts that we utilise are working together in our analysis. The theoretical framework draws on transition theory, blended with insights from innovation and governance literatures. Transition theories are important to our analysis because much of this body of work focuses on the global socio-technological challenge posed by climate change (the 2015 Paris Agreement set a target of keeping within a 1.5 °C average increase in global temperature) (UNFCCC, 2015). The objectives of transport policy have been influenced by climate policy, though a true step-change has been elusive. In 2016, the transport sector was responsible for 27% of the total EU-28 greenhouse gas emissions, 72% of which comes from road transport alone. Furthermore, emissions from transport 22% above 1990 levels, yet need to be two thirds below that level by 2050 to meet the long-term emissions reduction target contained in the 2011 Transport White Paper (EEA, 2018).

We are particularly utilising the Multi-Level Perspective (MLP) of socio-technological transitions (Geels and Schot, 2007), which in part answers the call of (Audouin and Finger, 2018). The MLP provides a framework within which transition can be understood as a process in which an incumbent socio-technological regime remains in place over time as a relatively slow-changing wider landscape tends to limit the impact of forces that drive change. Nevertheless, there is more or less continuous incubation of new technology and social innovation at the niche level. Occasionally technologies transition from niche to regime level, as windows of opportunity are opened by pressures emerging at the landscape level. It has been observed that climate change and environmental concerns are currently exerting pressure on the incumbent automobility regime from the landscape level (e.g. Geels, 2012). Within the MLP the processes of regime change or adaptation are not seen as under the full control of any of the actors in the system; however, there are transition mechanisms at work. These were not fully specified in the original MLP conceptualisation. However, business models have been conceptualised as a transition mechanism for commercialising an innovative technology. Finding the right model can enable niche technologies to disrupt the incumbent socio-technical regime (Bidmon and Knab, 2018; Sarasini and Linder, 2017).

Alongside the MLP there exists a substantial body of work on more normative and directed transitions to address the challenge of climate change (e.g. Transition Management, Transformative Climate Action, Transform Political and Economic Systems, Social-Ecological Transformation, Grassroots Transition). We have not incorporated these alternative approaches into our framework, as they are more prevalent in the climate change domain (Hjerpe et al., 2017) rather than transport, apart from the use of Transition Management perspective by (Sharmeen and Meurs, 2018).

We make two contributions in this paper. First we highlight the role of rhetoric in building a transition pathway for MaaS from niche to regime. Second, we argue from inference how urban governance could be undermined by unanticipated outcomes from MaaS roll-out if too much reliance is placed on the rhetoric. Rhetoric as a persuasive tool has been identified as an important mechanism in the social construction of technology and the challenges that technological solutions are intended to address (e.g. Berkhout, 2006). Thus, rhetoric plays an essential role in simultaneous co-construction of the societal challenge and technological solution that MaaS represents. We show how these functions are evidenced in the rhetoric that exhibits four discursive features that are typical of early stage technological development (Berkhout, 2006; Olson, 1973; Segal, 1994; Gill, 2006):

- Rhetoric conceptualizations are concrete enough to be applicable in the real context.
- The rhetoric is critical of contemporary times and existing technological regime.
- Rhetoric conceptualizations often provide very compelling arguments for social change.
- The rhetoric underlines the technological impact that would render previous technological transitions almost irrelevant.

We employ an inductive approach in this paper, combining documentary analysis (defined as texts existing in either electronic or physical form) (Grant, 2019) with a high level case study of the deployments of Whim and a narrative synthesis using relevant material from the peer-reviewed literature. Secondary data is drawn from documents and websites of MaaS actors (the main sources are those used for the examples in Table 2). Qualitative case study approaches are appropriate in the case of understanding new phenomena. The approach provides insight which is transferable to similar cases rather than global generalisability, and Smith et al., 2018b advocated for more case studies on the diffusion of MaaS developments in a wider range of institutional settings.

For the most part the documentary data has been accessed in English. Some material was sourced in the local languages, and the skills of the authors and automated translation tools were utilised for translation purposes. The authors are multi-lingual and located in or near to the countries from which the case studies are drawn, and have good access to the material. We take the view that these documents are socially constructed with authorial intention to persuade specific types of reader, and thus are mostly biased *towards* MaaS benefits. Our analysis of the documents utilises a traditional understanding of the art of rhetoric overlaid on to a discourse analysis that sceptically interrogates the validity of the key persuasive claims made by pro-MaaS actors (Jasanoff, 2016; Kamargianni et al., 2016).

2. What is MaaS? Converging technologies, definitions and rhetoric

In this section we begin by outlining the evolution of MaaS as an example of socio-technological innovation converging towards the currently dominant definition of MaaS as a 'bundled service model'. We then illustrate how a regime pathway is being constructed for MaaS with reference to the actors that are involved and a several countries where plans to introduce this model of MaaS are relatively advanced, with operational pilots from a single pioneer start-up, MaaS Global: Belgium, Finland, the Netherlands, and the UK. This range of cases provides a similar supranational context within EU and a single brand, whilst enabling comparison accounting for differences in governance structures and cultures among these countries.

2.1. Technological convergence as a foundation for MaaS

Technologies, as complex socio-technical phenomena, usually develop through convergence and non-linear pathways (Jasanoff, 2016). MaaS is therefore an outcome of a convergence among several socio-technological trajectories, involving a multitude of actors in dynamic interaction. At the core of this development are Information and Communication Technologies (ICTs) which enable integration of information, booking and payment, and support operational flexibility for near-real-time demand-responsiveness. ICTs thus create opportunities for various prototype mobility integration platforms, that converge towards the early uses of the term MaaS itself in Finland (Heikkilä, 2014). Thus, the broad definition of MaaS is a product that enables users to buy access to a range of mobility services including public transport and commercial services such as car hire or taxi.

The early manifestations of such models were advanced under the heading of integrated or intelligent transport systems (ITS) before smart mobility and MaaS entered the lexicon. We divide these into four main groups. The first group of synergistic applications include ticketing systems, particularly those which integrate payment and access through a single interface, such as London's Oyster Card (Kamargianni et al., 2016). A second group of synergistic applications rose through ICT industry engagement with the so-called 'sharing economy'. Existing social movements for peer-to-peer sharing were able to 'scale up' by the application of mobile ICTs (e.g. BlaBlaCar). This sharing is increasingly commercial rather than social, and thus better defined as an 'access economy' (Eckhardt and Bardhi, 2015). Continued development of these models now permit many users to share vehicles through companies such as Zipcar or CityBike. A third development includes a proliferation of smartphone apps providing real-time transport information, either crowd-sourced, utilising open data or public authority/operator Application Programming Interfaces (APIs) (e.g., Moovit). Some of these innovators have business models that are more explicitly aimed at transportation management: Moovit's approach is a business-to-business (or Transport Authority (TA)) model, presenting itself as a data analytics service creating value as the 'owner' of mobility data crowd-sensed from 140 million users, thus proffering a tool for 'anticipatory governance' of mobility services to TA (Quay, 2010). A fourth development focuses on providing demand-responsiveness for limited modes or defined areas with payment integrated into a service app. Kutsuplus is a recent Finnish example (Jokinen et al., 2019; Weckström et al., 2018), though there have been other prominent trials in Europe and North America, such as UbiGo (Sweden) and GoDenver (USA).

To summarise, MaaS is a relatively recent and rapidly shifting concept associated with Smart Mobility, and consists of a hybrid technological innovation combining ICT with a business model for delivering integrated access to transport services (Heikkilä, 2014). A range of definitions are documented, amounting to a set of dimensions that MaaS ought to have (Jittrapirom et al., 2017). For our purposes, the central dimension is that users are purchasing mobility services via a broker (often termed a mobility operator) that provides an interface connected to multiple transport services. These could be from one or many operators. In Section 2.2 below we outline the actors who are involved in developing MaaS from niche to mainstream and describe some of the key actions that are being taken.

2.2. The social construction of a regime pathway for MaaS

At the European Union (EU) level, MaaS is portrayed as an 'essential' smart mobility service in the Strategic Transport Research and Innovation Agenda, which takes the view that business and governance models need to be better integrated to stimulate innovation (A). There are several other organizations voicing support for MaaS and user-centric mobility services in general such as CIVITAS and Polis (B, C). The EU MaaS Alliance (MA) (founded in 2015) is a public-private partnership created to promote the concept. MA comprises such actors as cities, national and transport authorities (TA) but also automotive companies, ITS manufacturers, consultant companies, as well as universities and research institutes. MA states its goal as the facilitation of "a single, open market and full deployment of MaaS services", being achieved through partner meetings and their coordinated activities, such as reports, public talks, all the way to social media posts.

MA is focused on addressing a fragmented approach to governance across Europe, as it perceives this to be a barrier to providing seamless cross-border services. MA advocates for market-based innovation facilitated by open, standardized ICT architectures and APIs, better data quality and more flexible transport regulation (D). Their promotion of market-based solutions is presented as grounded in societal need, e.g. MA underlines the inconvenient parts of individual journeys and makes claims for improving the efficiency of the entire transport system. Their rhetoric also highlights the need for inclusion of different kind of users, including persons with reduced mobility or disabilities, as well as aiming at environment sustainability, and thus at least includes equity considerations at the rhetorical level. At national level there are various similarities in approach across the three countries we examine. These are discussed below.

In Finland (FI) governance processes have led to regulatory action to focus on the business opportunity based on competencies in developing digital products and services (Heikkilä, 2014). Business Finland (formerly Finnish Funding Agency for Innovation) and

the Finnish Ministry of Transport and Communications (LVM) had several funding programs for supporting MaaS developments. LVM and Finnish Transport Agency (FTA) both advise public authorities to create the environment for attracting market-based, domestic and foreign funding, with the intention of developing exportable mobility innovations (E). The most significant development is the 2017 Finnish Transport Code (Liikennekaari), making changes in taxi licence quotas and forcing all transport service providers to open data and single tickets APIs (F, G). These activities solidify the perspective that the role of the public sector is to enable the change and provide favourable operating conditions, by facilitating business efficiency, whereas the responsibility for both innovation and service development lies with the private sector. This governance environment has facilitated MaaS Global to introduce its app service Whim to the Helsinki area.

Organisations in the Netherlands (NL) and Belgium (BE) are looking to developments in FI and Sweden (SE) as their main sources of information and inspiration on MaaS as a key component in achieving a goal of providing 'Smart Mobility'. Twenty-nine public and private sector organisations, including telecom companies, provincial governments, transport consultants, the Dutch travellers' association and universities signed a 2016 manifesto (Q) calling for the rapid adoption of MaaS in the Netherlands. At the time of writing, a MaaS Taskforce had been established with over 40 members. MaaS is mainly available for corporate travel – several schemes provide access to a range of public and private mobility services via a single card. For the last 2 years, MaaS Global's Whim has operated a PAYG service in Antwerp (BE) and there have been plans to launch in Amsterdam (NL) for some time (O). Several other app-based mobility services are presented as demonstrators and entrepreneurial experiments converging towards MaaS.

In the UK, MaaS is similarly regarded as a market opportunity, though several TA are also exploring the concept. A trial of Whim has been launched in the West Midlands region. To maximise the smart mobility business opportunity, the UK government created the Transport Systems Catapult (TSC) with the aim of stimulating the development of technologies to improve mobility (people and goods) and positioning the UK as a global leader/exporter. TSC defines MaaS as consisting of bundled mobility services and also highlights the possibility of a data bonanza for TA and operators in improving the level of service (broadly an 'efficiency' promise) (H). Overall, TSC seeks to smooth innovation pathways, identifying barriers to widespread MaaS provision that need policy intervention to overcome. Here, the private sector is expected to shoulder the risk and take the benefits accordingly. Moreover, large consultancies are embracing MaaS as a new business stream from TA who are struggling to continue to provide public transport in its current form (e.g. I). In the context of UK's devolved democratic structure, there are also coalition building efforts in Scotland, where MaaS Scotland is a young organisation supported by over 60 public and private actors with aims similar to MaaS Alliance and MaasiFest.

These organisations are networked together across borders. For example, MA has a TSC member as a board member, the founder of MaaS Global has made presentations to MaaS Scotland, MaaS Scotland is a member of MA. Thus it is unsurprising to find common rhetorical threads amongst the different bodies. In Section 2.3 we analyse the role played by rhetoric in developing the regime transition pathway for MaaS.

2.3. Analysis of the role of MaaS rhetoric in building from niche to regime shift

In this section we analyse the MaaS rhetoric as available through websites and documents such as those indicated in Section 2.2 and listed in Table 1. The key common feature of MaaS is that the interface by which mobility is purchased is provided by an operator or broker positioned between users and service providers. Its central feature is that users can select a package that bundles access to a mixture of transport modes. These packages comprise different levels of PAYG access to or monthly pre-purchase of transport services. The modes included range from traditional public transport to taxis, but also incorporate vehicle-sharing such as cars and bicycles, with the number or price of trips by each mode being determined by the choice of plan. Table 2 illustrates the range of packages offered by Whim in the different deployment regions. Data on usage is difficult to find. However, personal contacts suggested that Whim West Midlands experienced difficulties in recruiting trial participants,[2] and supplied firmer information about Whim Helsinki suggesting that the app has been downloaded 60,000 times (GooglePlay says 50,000 + with the download link for all three regions), reaching 0.5% of Helsinki population and supporting 1.8 m trips per month (out of 374 m trips). This package model of MaaS is gaining centrality in the rhetoric, for example, by the diffusion and consequent frequent repetition of the phrase "Whim could be thought of as similar to a 'Netflix for transport'" which was originated by Sampo Heitanen CEO of MaaS Global. This was repeated, for example, by Mike Waters, a director of TA Transport for West Midlands' (TfWM) in a news piece from March 2018.[3] We examine each in turn below. Table 3 contains examples of typical rhetorical material from the sources in Table 1, categorised by the rhetorical function in pathway-building.

Taking sections Table 3 consecutively, the first rhetorical task in building the transition pathway is to make the conceptualization of the emerging innovation more concrete, so that the audience can understand how it might apply in their context. Therefore, we see references to the outcomes of research and the existence of demonstration projects, as well entrepreneurial experimentation, and an enlisting of supporting technologies (such as business models), other trends such as the sharing economy. The rhetoric must also highlight contemporary issues and trends, explicitly or implicitly critiquing the existing technological regime. This market formation

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[2] Between revision and acceptance of this paper, the likely truth of this information was highlighted by announcements that Whim West Midlands had amended its offer by removing the monthly packages and reverting to a PAYG service covering public transport, taxi, hire car, with bike-share still described as "coming soon". A new monthly package "Whim Everyday Bus", aimed at users mainly using the bus with occasional taxi use, was described as "Coming soon". https://whimapp.com/uk/ last accessed 18 January 2019.

[3] https://www.wmca.org.uk/news/whim-under-the-spotlight-as-west-midlands-hosts-mps/ last accessed 13 December 2018

Table 1
Key actors and documents.

Organisation (Ref)	Author(s)/Date	Title and/or retrieval site
European Commission (A)	Lennert et al/2017	*Smart mobility and services: expert group report* http://civitas.eu/content/civitas-insight-18-mobility-service-new-transport-model
CIVITAS (B)	2016	*Mobility-as-a-service: A new transport model*
Polis (C)	Hoadley/2017	*Mobility as a service: implications for urban and regional transport. Discussion paper offering the perspective of Polis member cities and regions on Mobility as a Service (MaaS)*
Maas Alliance (MA) (D)	2017	*Guidelines and recommendations to create the foundations for a thriving MaaS ecosystem.* White Paper, MaaS Alliance, Brussels. Also: https://maas-alliance.eu/library/
Finnish Transport Agency (FTA) (E)	2015	*Maas Services and Business Opportunities.* http://www2.liikennevirasto.fi/julkaisut/pdf8/lts_2015-56_maas_services_web.pdf
LVM (F)	2017	*Finnish Transport Code. Act on Transport Services.* https://www.lvm.fi/lvm-site62-mahti-portlet/download?did=246709 Accessed 6 July 2018.
LVM (G)	2017	*Second stage of the Act on Transport Services encompasses the whole transport system.*Press release. Helsinki
Transport Systems Catapult (TSC) (H)	2016	*Mobility as a Service: exploring the opportunity for mobility as a service in the UK*
Atkins (I)	undated	*Journeys of the future: introducing Mobility as a Service.* http://www.atkinsglobal.co.uk/en-GB/uk-and-europe/about-us/reports/journeys-of-the-future
MaaS Taskforce (J)	undated	*Highlights of the Dutch MaaS Action Plan*
MaaS Scotland (K)	2018	*Mobility as a Service: Positioning Scotland for an Emerging Global Market*
MaaS Global (L)	Undated	*Website:* https://maas.global/
Whim websites (M−O)	Undated	*See* Table 2 *for websites*
Cubic (P)	2018	*MaaS Whitepaper* https://www.cubic.com/sites/default/files/Maas_Final_Whitepaper.pdf 2018. Last accessed November 2018
MaaSifest! (Q)	Undated	*Weblink:* http://www.connekt.nl/wp-content/uploads/2015/10/MaaS-voor-copyshop-mvr-1.pdf *(Dutch)*
Government Office for Science (R)	2017	*Foresight Future of Mobility project, MaaS Roundtable*

consists of 'making a case' for MaaS by highlighting problems in need of a solution, such as car dependence and sub-optimal asset utilisation as well as the well-known externalities of the current transport regime. There are explicit calls governmental enabling actions and critiques of: car-dependence as an asset utilization problem for individuals and cities; poor intermodal integration and a user need for customization. The rhetorical case must then put forward compelling arguments for change. In the case of MaaS these centre on promises of freedom and efficiency.

The argument that markets the 'service package' model therefore promises several things to different audiences: 'freedom' (appealing to users' affective or hedonic values), door-to-door mobility service (for users this reduces cognitive effort; for cities this could solve a social inclusion problem), greater 'efficiency' (for users this would be a generalised reduction in cognitive effort or an improvement in convenience; for cities and operators this could represent network flow optimization or better asset utilisation) and the opportunity to break car-dependency (solving a societal problem). Finally, the rhetoric must underline the technological impact that would render previous technological transitions almost irrelevant. Thus, a vision of a transformed future through changes to mobility practices are common. To deliver these promises, promotors must gain a place in the mobility marketplace that is more substantial than a niche in order to disrupt the status quo. To further understand its conceptual power, we should think of this vision of MaaS concept as a technological assemblage. MaaS is not solely an app or the value concept of service packages, or even the revenue streams that define the business model, but it is a set of organizations, legislation, and other aspects, which collectively serve to lock a technology into society.

The MaaS business model that actors are seeking to make dominant is at the centre of the three sub-processes that are necessary for socio-technical transition. Expressive processes work to articulate expectations and visions that align the activities of different actors and, crucially, attract funding and publicity. There must also be a learning process in which the performance of the innovation is improved. The building of a social network around the innovation is the final sub-process (Bidmon and Knab, 2018). It seems clear that these processes are under way in the case of MaaS. The efforts to attract attention, users and funding for pilots and for venture capital represent the expressive sub-process. The persuasive rhetoric forms a key part of the expressive process, and also highlights that learning is advanced: learning processes are evident in the trials and pilot projects, with knowledge exchange taking place amongst the partners involved (inter-organizational knowledge transfer). The creation of umbrella organisations and business networks, with associated events devoted to MaaS, clearly represent the building of social networks.

Overall there is an assemblage of interdependent promises to cities, citizens, as well as the private sector. The promise for citizens is framed under the overarching idea of "freedom", including such aspects as multitude of travel mode choices, tailoring to individual needs, reduction of ownership costs and effort, and overall improvement in service quality (such as door-to-door solutions). For cities, the rhetoric centres on "efficiency", including such aspects as better utilisation of limited resources through sharing and modal integration, and improvements in accessibility and overall sustainability through technological smartness (which also contributes to city image). Finally, the interdependent promises culminate with the focus on creating a new market for the private sector, that

Table 2
Range of packages offered by Whim in launch cities (Sources: listed in table, information correct at time of writing).

	Helsinki, FI https://whimapp.com/monthly-plans/			West Midlands, UK[1] https://whimapp.com/uk/				Antwerp, BE https://whimapp.com/be/		
	Active since October 2016				Active since April 2017				Active since early 2018?	
Offer	Whim to go 0€/month	Whim Urban 49€/month	Whim Unlimited 499€/month	Offer	PAYG £0/month	Basic £99/month	Unlimited £349/month	Offer	PAYG 0€/month	Whim Everyday €55/month
Local Public Transport (HSL HRT)	Pay per ride (PPR)	Unlimited single tickets	Unlimited single tickets	Buses, trams and trains within West Midlands county; Whim Swift Card. (National Express West Midlands;Transport for West Midlands)	PAYG	Unlimited	Unlimited	Local public transport (de Lijn)	PPR	Unlimited
Taxi (Lahitaksi; Taksi Helsinki) (5 km radius)	PPR	10€ per ride	Unlimited	Taxi (Gett) (3 mile radius)	PAYG	PPR	Unlimited	Taxi (DTM taxi)	PPR Book/ pay through app, est price upfront	Max €10 (5 km radius)
Car (Sixt; Toyota RentaCar)	PPR	49€ per day	Unlimited	Car (Enterprise)	PAYG	Max £49 per day	Unlimited	Car (Sixt)	Per day	€49/day
Bike share (Go by Veho)	Not included	Unlimited (30 mins)	Unlimited	Bike share (nextbike)	Coming soon	Coming soon	Coming soon	Bike share (Velo)	PPR	Unlimited
Add-ons and other features										
Car subscription	✔	✔	✔	None	–	–	–		–	
HSL regional	PPR	+50€/m	✔		–	–	–		–	
HSL regional 3		+100€/m	✔		–	–	–		–	
Cancel any time	✔	✔	✔	Cancel any time	✔	✔	✔	Cancel any time	✔	✔

[1] Whim West Midlands removed the Basic and Unlimited packages at some point in late 2018/early 2019.

Table 3

Examples of the MaaS rhetoric used in our analysis. Italic font is used to highlight the type of statement relevant to the criteria (Sources: various).

Making the concept concrete: *Explaining how it works or giving examples of how it is already here*

"If you were asked to give an example of MaaS, *Whim, Ubigo or Smile would immediately spring to mind.*" J

"Booming demand for more personalised transport services has created a market space and momentum for MaaS … *All over Europe, MaaS initiatives are planned or starting up* and the MaaS Alliance helps these to cooperate through a shared work programme engaging service providers, transport operators, public authorities and users in order to create a vital and interoperable MaaS ecosystem to fulfil high expectation" (D, p2 & p4)

"MaaS Scotland has been facilitating the development of a MaaS Project pipeline that will seek to deliver MaaS solutions in a range of different environments - urban, rural and island communities. …. *Scotland's first MaaS project was launched in October 2017 through the ESP Group's NaviGoGo scheme and the Dundee MILL initiative will provide further MaaS pilots in 2018.*" (K, p10).

"There are two core strengths to the MaaS business model: *servitisation, whereby the MaaS Provider creates a value proposition that comprises a 'bundle' of different mobility services; and Data Sharing, whereby the MaaS Provider shares data on the mobility needs of customers, to help Transport Operators improve their service.* (K, p6)

Compelling arguments for (social) change: *Explaining how the proposed solution is better*

"MaaS is a carefree, *environmentally sound alternative to owning a car.* It works out the best option for every journey – whether that's a taxi, public transport, a car service or a bike share. From office commutes to weekend getaways, it manages daily travel in the smartest way possible." (L)

"we believe there's the right vehicle for each and every journey. Sometimes it's a car but often it's a train, a bus, a tram, a bike or a taxi. That's why we've created a smarter way to get around and a more affordable option to car ownership … *we're here to help you travel smarter and live better – all while saving you money.*" (M)

"We believe owning a car doesn't make much sense anymore for most people. *Whim is a more affordable alternative for car ownership without all the hassles. Every journey is covered* – whether it's taxi, public transport, a car service or a bike share." (N and O)

"We are not far from a world in which transportation is more sustainable and people-centered than it is today, *a world in which it significantly enhances the user experience and even supports economic growth, all while realizing key policy objectives, such as eco-friendliness and accessibility for all, including low-income and underserved communities.*" (P, p3)

"The potential for a MaaS Provider to manage the mobility needs of both workplaces and employees may support a reduction in peak hour travel demand." (K, p17)

Critique of existing technological regime: *Explicit and implicit references to existing problems and trends*

"Dynamically updated and user-relevant information should be the norm, not an exception. This is evident in the way customers adopt services such as Uber. In the future, this trend will continue due to growth of urban populations and changing preferences of younger generations that care less about ownership and more about experiences. *This trend will be especially evident when the car industry confronts an environment where customers prefer not to buy cars but instead require only occasional access to a vehicle and service – this represents a clear shift from an ownership model, to a service model.*" (H, p3)

"MaaS can become *the remedy to the issues that plague our cities, the answer to the challenges brought about by the technological revolution of the 21st century and the context for the new trends in consumption* – but only if it is properly implemented, responsibly managed and well executed. Such an approach to MaaS presents the transit industry with a unique opportunity to bring value where it can't be found today, offering benefits to consumers, communities and cities, as well as to the transit agencies themselves, and in doing so makes the important point that people don't choose to ride the train or the bus, they make journeys" (P).

Potential scale of the technological impact: *Claims that the proposed solution is significant and large scale*

"MaaS has *the potential to change the choice set.*" (D, p11)

"Mobility as a Service (MaaS) *stands for a transition in mobility, where a consumer buys in mobility, instead of investing in transport equipment.* In *many sectors this transition already took place,* like in music or hotels, now it's time for mobility … New services will form a combination between classical forms of public transport, demand-based transport and private vehicles. Between these forms *borders will vanish and a more integral system will evolve.*" (Q)

"*Data usage and phone calls do not stop at the border. Neither does mobility, and the same should therefore apply to MaaS.*" (J)

"In the MaaS ecosystem, *the mobile phone or application will be the remote control and command centre for personalized mobility, replacing tickets and cash as unnecessary elements in the operations. In a mature MaaS ecosystem, some of the services could … be non-mobility related, aligned with the mobility patterns of users and integrated into the provision of mobility services.*" (D, p5)

"Maas can be *a great positive force for generations to come*" (P, p4)

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purport to respond to a range of value shifts that challenge existing business models. This assemblage of promises is introducing a specific emerging effect, enabling MaaS conceptualization to be fluid for interpretation depending on its context. One could say that MaaS promises everything, for everyone, with a potential danger that if MaaS comes to fruition the only fulfilled promise is the one for private sector actors. Therefore in the next section we examine unanticipated implications of MaaS for efficiency and equity.

3. Potential unanticipated implications of current MaaS conceptualizations

In this section we discuss possible implications of MaaS for cities and citizens, focusing on overall efficiency and equity under the headings environment, health and well-being, and social inclusion. As highlighted in its rhetoric, MaaS will readily incorporate a range of mobility modes and providers, as the integrator approach is positioned as an 'optimizer' that can make multi-modal travel more convenient for end-users and more efficient for TA and service operators. Current developments of MaaS establish user relations mostly on the individual level, failing to acknowledge that current problems (e.g., traffic congestion and urban air pollution) are large-scale emergent phenomena arising from the aggregate of our individual activities and preferences.

MaaS rhetoric promises unfettered freedom and instantaneous mobility to individuals within the context of a finite transport network. For example, MaaS Global advertises its application as "mobility on a whim", promoting directly this idea of individual unfettered freedom. However, this promise of freedom is on a collision trajectory with a challenge of simultaneous demand for travel in a transport network with a finite capacity, in which the main transport policy objectives are to reduce congestion (and the impacts that has on emissions, journey times and urban quality of life) and to reduce GHG emissions and air pollution. By modelling MaaS packages on those used in telecoms, the impression is given that any desired trip can have a door-to-door solution supplied on demand. Here, a fundamental error is made, as the transport network has a finite capacity, and thus everyone cannot travel at once (c.f. Pangbourne et al., 2018).

3.1. Environment

If efficiency is considered from the point of view of reducing network congestion and increasing vehicle utilisation, the rhetoric claiming that MaaS enhances transport's sustainability might be plausible. Some authors suggest that MaaS has potentially positive effects combating the automobility regime (Urry, 2004) by supporting a reduction in private car ownership (Kamargianni et al., 2018, Ho et al., 2018). If this reduces congestion and emissions by encouraging more use of non-car or shared vehicle modes through facilitating access then this could be positive for sustainability outcomes, i.e. reducing congestion through making more efficient use of the existing vehicle fleet and increasing vehicle occupancy (Audouin and Finger, 2018). However, this is contingent, thus some actors *do* temper their rhetorical support for MaaS as a business opportunity on the basis of data from other disruptive transport technologies: "*although the taxi service apps have gained customers by offering some MaaS features* e.g. *easier transactions, they have not significantly improved multi-modal journeys*" (H, p6).

For a pre-paid package model of MaaS, (Pangbourne et al., 2018) identifies the possibility of a rebound effect arising from the theory of loss aversion (Tversky and Kahneman, 1991): MaaS users could experience regret if they feel they are not getting value for money from 'unlimited' modes in their packages, resulting in extra discretionary trips. It can be seen in Table 2 that the Unlimited packages include unlimited trips in taxis. Taken with regulatory changes such as those to remove caps on taxi licences (cf F, Table 1), it is plausible that any reduction in personal car ownership could be accompanied by an increase in the taxi vehicle fleet in order to meet demand. It may still be a net reduction in total vehicles, but the impacts on vehicle kilometres travelled needs to be investigated. The environmental consequence of any impacts on public transport use also need to be considered. There is evidence that public transport use is being reduced by the business models of ride-hailing brokers like Uber or Lyft that make impulsive door-to-door service exceptionally convenient (Clewlow and Mishra, 2017). Having shared vehicles available through MaaS could magnify this effect, leaving high-capacity, fixed route modes in the cold. This would make the widespread adoption of shared self-driving vehicles much easier without necessarily reducing congestion. The spatial effects of this technological development are also in need of thorough investigation to ensure that further sprawl does not result.

3.2. Health and well-being

There is a strategic case to be made for shaping decisions about the nature of MaaS packages because the choices that are promoted within and between the packages will have unavoidable effects on individual users in relation to their physical health and subjective well-being. At the aggregate level this becomes a public health issue. As exemplified by Table 2 above, Whim does not consistently offer active travel. What if those that might have chosen to cycle 5 km switch instead to a taxi, if they deem maintaining a separate membership of the bike share scheme inconvenient? We find it quite surprising that a product such as Whim, which is apparently predicated on making multimodality more convenient, should launch without a key active travel sharing option already integrated. A key drawback to the absence of active travel in existing packaged MaaS products is the consequent lack of evidence to support the claims that bundling access to transport via MaaS packages improves transport sustainability.

Moreover, the current approach of packaging by the month (as with mobile phone contracts) with the only alternative being PAYG (which typically have higher unit costs), is poorly designed to support the established knowledge that individuals should undertake a minimum level of physical activity each day or across the week to maintain their physical and mental well-being. Healthier options, such as walking or cycling, are not prominent in MaaS products which are predicated on monetizable modes, and which also obscure the unit costs of public transport. For many people the efficient way to achieve minimum recommended levels of physical activity is to switch some shorter journeys to active travel (walking or cycling). Having a MaaS package might result in a neglect of these minimum amounts of active travel through its door-to-door promise.

3.3. Social inclusion

Social inclusion is important for equity (Lucas et al., 2015). If MaaS attains regime status and becomes sole access point to geographically bounded transport networks, it is important to ask what happens to those excluded from that enclosed system whether due to dissent, cost or technology aversion. Having in mind a potential for such "technological gentrification" of transport, there is little discussion to date of how MaaS can work effectively to tackle urban transport problems if there are urban residents outside the system. So far, the model's promise to TAs of 'efficiency' seems to be predicated on total integration via the MaaS provider as a single user access point generating all the data needed to optimize the system. However, evidence on social impacts has been requested by the Dutch government (MIVM, 2017).

Moreover, MaaS's reliance on registration and digitalization might further exclude social groups experiencing difficulties in handling new technologies or having access to banking. For example, there is evidence that older age groups are not comfortable with using applications on smartphones, especially taxi-hailing apps, and have anxieties about online transactions (Shirgaokar, 2018). Furthermore there remains a 'capability' question for older age groups in using app-based platforms (Fitt, 2018) casting doubt that older age groups would be adopters of MaaS. MaaS Alliance, LVM and other actors in the emerging MaaS ecosystem are looking for business opportunities beyond Europe. However, 37% percent of the adults in developing economies (mainly Bangladesh, China, India, Indonesia, Mexico, Nigeria, and Pakistan) still do not own a bank account (Demirgüç-Kunt et al., 2018). Women, poorer, and lower educated adults are more likely to be unbanked. This further undermines the MaaS promise of system-wide efficiency if there are substantial numbers of transport system users who are not MaaS subscribers if MaaS brokers introduce their product in cities of the Global South, as these travellers will not be users, and thus not accounted for in the overall mobility management scheme for the

particular area.

Currently, the MaaS rhetoric does not anticipate challenges about a right to mobility outside of a MaaS subscription or the potential for higher trip costs for PAYG users (indeed the Helsinki webpage for MaaS jokes that it is trying to upsell to users by highlighting PAYG's limitations). Current MaaS designs may not address transport poverty, defined as unaffordability, lack of accessible mobility options, and disproportionate exposure to transport externalities (Lucas et al., 2016). Whilst in the UbiGo project, the trial participants signed up as households (with minimum monthly cost of 135€), and the TSC vision document talks of family packages, the current packages offered by Whim are offered to individuals so providing a package for each family member would represent a substantial percentage of an average household income. This implies that the targeted early adopters are an urban elite, who can afford to take a chance on MaaS.[4] This 'elite' market is reflected in the take-up of BlaBlaCar, France's largest car-pooling operator: most driver participants were in the higher income brackets, whereas most passenger participants were in the lowest income quartile though more highly educated than the French average (Shaheen et al., 2017).

4. Implications of unanticipated societal implications for governance

The delivery of mobility services has experienced substantial changes over recent decades, and further changes continue to take place. A plethora of niche innovations have been introduced into the mobility landscape by a range of actors, some of whom are not traditional transport actors. Thus, there have been changes in the providers of these services, the ways in which services are delivered, the nature of the services themselves, and in the behaviour of end-users. This creates a dynamic policy-making environment (Stead, 2016). Clearly, these transitions intersect with current mobility governance and have implications for how it will be governed in the future. These transitions are occurring in parallel with more general shifts in urban and regional governance, including more public-private collaborative initiatives (see for example Lidström, 2007; Stead and Kovács, 2016; Karlsson et al., 2016), yet current transport regulation remains highly mode specific, operator-focused rather than customer-focused. The user perspective is for service in MaaS that genuinely adds value beyond the convenience of having the single payment (Pangbourne and Masthoff, 2016). As the multi-modal brokerage model is based on incorporating car-based solutions that provide more options for non-car owners, such as car-share or taxi, the obvious convenience of these for door-to-door service will undoubtedly impact on the use of traditional public transport, particularly fixed-route scheduled buses, yet public transport is the backbone of MaaS. Furthermore, given that the promises of freedom are false, that still does not mean that there is no case for MaaS, if the packages are designed to be more socially inclusive, and if the front-end interface has value-added features to support user health and well-being with advice to increase active travel when appropriate (Davis, 2018). Therefore, to achieve these benefits and mitigate against unanticipated implications such as those we have identified, we consider that there is a rationale for government intervention on both efficiency and equity grounds.

4.1. Critical questions for urban mobility governance and policy-making

In several respects, MaaS repackages existing ITS ideas of integration, and sounds intuitive, understandable and attractive. In part, this intuitiveness relates to integration and seamlessness between modes, which have been an 'efficiency' goal of TA for many years, since the first efforts to introduce ITS into urban areas. As MaaS is promoted in this way, it is hard for stakeholders not to embrace it, and this positive framing can be read as a power play. This appears to have been highly successful in FI, where MaaS development is closely aligned with strategic national priorities for developing intelligent urban systems and services and mobile Internet technology. Indeed the very development of MaaS as a term indicating a servitized, bundled approach to providing access to mobility services originates in FI and has been enabled through innovation funding and legislation. Consequently in the Finnish context MaaS development represents a depoliticized consensus on the priorities for a national future that privileges economic opportunity, assumes that the MaaS model will lead to transport efficiency, and overlooks questions of transport equity.

However, it seems obvious that the rhetorical promise of freedom cannot be delivered with respect to well-being and inclusion, and undermines the efficiency promise through the potential for increased trip-making leading to simultaneous or induced demand. Furthermore the symbiosis with other mobility innovations does not *automatically* reduce the environmental impact of transport. Therefore, the enthusiasm with which organisations are embracing the concept masks some significant uncertainties around the role of governance, including ensuring that other issues such as human rights (including data privacy), consumer protection and legal liabilities are addressed. However, at the time of writing, steps towards clarification have started to be taken (e.g. by the Dutch government (MIVM, 2017) and D).

There is a 'collective action problem' arising from the effects of a network of competing private firms and individual MaaS users making choices that maximise personal priorities (Davis, 2018), and there is a likelihood that existing public transport services represent another incumbent socio-technical regime that will be as affected as automobility by MaaS (Hjerpe et al., 2017, Hensher, 2017; Paulsson et al., 2017). This situation demands governance coordination that creates and maintains a vision for cities and citizens that is robust to the inward-looking demands of the ICT industry, and which ensures that those at risk of experience transport exclusion have a safety net (something which can be done with MaaS-related systems such as London's Oyster card).

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[4] A full affordability analysis is outside the scope of this paper, but a quick data search suggests that Whim's unlimited packages would represent 28% of average per capita disposable income in Birmingham (ONS, 2018) and 18.3% of average household disposable income in Helsinki (OSF, 2016) (27 estimated that the same package would be 21% of the average monthly wage, and that the current average individual transport expenditure in Finland is 15% of average monthly wage.

Overall, the emerging MaaS context, combined with contemporary urban governance shifts (e.g. redefining of the role of the nation-state and the strengthening of lower levels of self-government; increasing diversity, variation and even asymmetry of governance; increasing marketization of the public domain; shifting rationales for intervention), poses a threat of technological determinism and neglect of transitions complexity (e.g. as other mobility technologies such as self-driving vehicles advance and enter the MaaS system we have additional social issues such as the impact on employment to consider). On top of this, combined with a language of unintended consequences, the result might be a complete de-politicization of MaaS development trajectory, as public, private and third sector stakeholders are brought together in the consensus machinery of organisations such as MA or MaaS Scotland. Consequently, governance levers could be lost through ideological pressure to create revenue streams out of previously public goods, resulting in an increased risk that the neglect of social and ecological sustainability will be disguised in optimistic generalisation. In Section 3 we described some of the unanticipated effects that we can imaginatively and plausibly foresee.

One of the first sets of challenges pertains to the old question of market monopolies in multi-actor systems. With the loss of institutional capacity coupled with resource constraints in urban governance, it might be tempting for many cities to let MaaS 'take care of it all'. We particularly note the reliance of MaaS on the new ability to generate and utilise Big Data, and thus establish power position through data enclosure. Essentially, MaaS has the potential to create a new market by selling data analysis to many different actors, not only the mobility service providers and urban authorities, but potentially by other private companies, such as retailers. Thus, geographic MaaS monopolies might have to be guarded against, as the MaaS providers could block new mobility providers from entering the marketplace through developing new entrance exclusion mechanisms related to data ownership or exclusive relationships. In this situation, in the case of lack of alternatives, single MaaS operators could constantly raise mobility prices to the end users, with little recourse from those users, and with the possibility of the raised income being taken as profit by the MaaS brokers rather than distributed amongst the transport operators.

In the context of monopolies, we must recognise that MaaS innovators are primarily private sector firms who are attempting to steer the development of the mobility system in their own interests (Vergregt and Brown, 2007). This risks regulatory capture by MaaS brokers through manipulation of governance mechanisms, something already seen in the transport domain (Morton et al., 2017) and the Finnish enablement of MaaS Global could be seen as further evidence of this. For example, TSC did not identify a role for TA in the MaaS ecosystem beyond being another 'customer', not for the service of mobility but for the data generated through the MaaS provider (H). The TA is perceived as consuming the data and making improved policy choices as a result. However, it is not specified how a TA might be able to have any influence over outcomes beyond negotiation with the MaaS provider or through stringent re-regulation that is likely to be strongly resisted. Drawing from experience in the public health sector, the process might involve subtle methods that co-opt less powerful stakeholders through loose partnership agreements and consensus-based voluntary mechanisms, which both suppress competing points of view and head off mandatory regulatory mechanisms (Hastings and de Andrade, 2016).

Here then, a critical question is whether public transport authorities will be required when private service providers are able to offer a better transport product to those willing to pay. Moreover, the prevalent political economy in some regions might result in the abolition of public transport authorities, whereas elsewhere the TA could be the controller or brand leader of the MaaS platform (e.g. Barcelona, Transport for Greater Manchester). Ultimately, this leads to a further question whether public transport is a service of general interest. If not, then the role of government in providing public transport comes into question. For the moment, the current strategy in the Netherlands seems to be to first provide space for the introduction of MaaS and then consider whether 'regular' public transport services will be made available to MaaS providers. In Finland, the emphasis is on putting the appropriate regulatory framework in place to encourage exportable business innovations built through large scale public 'experiments'. In the UK, it is about encouraging the private sector to take on the risks. None of these perspectives seem focused on delivering efficiency or ensuring equity.

Such a focus on outsourcing innovation to the private sector creates a critical governance gap in managing the Smart Mobility transition (Pangbourne et al., 2018). Alternatively, the public sector could step in, and innovate on its own behalf. In relation to the technology development processes, emerging technologies such as MaaS, typically face the challenge of institutional void (Hajer, 2003) and organized irresponsibility (Beck, 1992). This means that none of the current institutions has a full understanding or control of undesirable consequences associated with MaaS or other technological constellations. In turn, the resulting distributed responsibility for transition management and technological development limits individual and institutional accountability.

4.2. Potential governance and policy-making responses

Governments in some countries are starting to act to address some of the challenges for governance outlined above. For example, legislative actions in Finland have established an enabling landscape for MaaS (see above and Table 1). In the UK the Government Office for Science has hosted a workshop (R) to explore the policy implications.[5] Key points relevant to our argument include the notion that MaaS should not be more expensive than the current transport system and should be fully inclusive (i.e. not creating *"the MaaS and the Maas-nots"* (R, p2), meet air pollution and carbon emissions obligations on air pollution and carbon emissions, and reduce vehicle ownership. In relation to the promises of freedom and efficiency made in the MaaS rhetoric the consensus amongst attendees was that a trade-off between these was inevitable. MaaS was also see as an opportunity for travel behaviour change, with dynamic pricing mentioned (something that could be at odds with an all-inclusive package without extra cost or rationing of

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[5] We note that whilst public and private actors were involved, including MaaS Global, there were no academic institutions acknowledged.

mobility). Cities have been slow to specifically address MaaS within key policies, even though MaaS components are already operating in many places, and this has been characterised as a strategic omission arising from an uncritical assimilation of the rhetoric that sustainable urban mobility will automatically follow MaaS deployment (Li and Voege, 2017). However, aggregate patterns of mobility obscure the highly heterogeneous nature of individual mobility profiles, and the current range of packages available is very limited, and there is little knowledge of how to design realistic packages (Matyas and Kamargianni, 2018).

Therefore, as MaaS is facing numerous dimensions of potentially undesired implications, discussion should not remain narrowly expert-focused, depoliticized, and focused dominantly on technical development and anticipated positive effects, with a shallow basis for conceptualization and rhetoric, avoiding questions of wider (re)distribution of consequences or solidifying existing inequalities. In this context, strategic management is needed to set objectives, monitor mode share changes, and to understand social, distributional and environmental impacts, as well to provide an environment where innovation (by both the public and private sectors) can flourish and citizens are full participants in the envisioning process whilst recognising that to have something new, something else may need to be destroyed (Sørensen and Torfing, 2017). There are similar questions around the advance of automation in the transport environment, and thus the recommendations for governance are analogous (Mladenović, 2019).

Whilst technology studies describe and explore the webs of actors and temporal processes that go to make up the emergence of new technological regimes, it is not an analytic perspective that inclines to provide detailed "how to govern" recommendations. At this foundational technological development stage, it is important to recognize two essential premises for developing governance frameworks. First, if we are to reclaim technological futures as plannable space, we must challenge the perception of human ends as well-defined and static, to which we only need to provide technological means (Jasanoff, 2016). Making this assumption about the nature of human beings carries the risk of disregarding evolving relationships between us and our technology, as well as often irrevocable changes, not solely to the built environment around us, but also to our fundamental values and norms. Second, a challenge of technological determinism in the foundational stage of emerging technology might lead us to conclude that technology has unstoppable momentum, reshaping society to fit to its demands (Jasanoff, 2016). Simply put, we might embrace a dangerous attitude that the outcomes of mobility technologies, just as climate change, are inevitable.

However, technological pathways are not linear and are difficult to predict, due to their increasing complexity. In this context, as already identified in the realm of territorial governance (Metzger et al., 2015), there is a threat that some fundamental issues will be depoliticized or even rendered invisible in technology development processes, especially in their foundational stage. Thus, when we reflect about desirable and undesirable consequences we must dedicate special effort to avoid falling into the trap of 'unintended consequences' rhetoric. The very language of unintended consequences implies that it is not possible to think about the full range of undesirable consequences, a narrow perspective that relinquishes our power to question and imagine alternatives.

Here, we recognize an old dilemma. On the one hand, we are unable to estimate the changes from emerging technology until the technology is fully formed and embedded in society. On the other hand, changing a technological development trajectory is very difficult once the technology is fully formed (Collingridge, 1980). For example, in hindsight, one could wonder whether Henry Ford should have foreseen the drastic consequences for the climate and society now associated with his creation of the mass-produced automobile. After all, his intentions were to unlock immense possibilities for all social classes. Nonetheless, we must acknowledge that we when reflect about desired outcomes in the future we tend to discount harms as more speculative, rather than equally uncertain (Jasanoff, 2016). Moreover, we must recognize that, as far as mobility technologies are concerned, we are no longer in the early 20th century. We now have a greater amount of societal knowledge when we talk about emerging and disruptive mobility technologies. On the one side, the least we can do is learn from the development trajectory of passenger automobiles and personal computers, equally disruptive technologies in the present day. Therefore, if we move away from the language of *unintended* consequences to embrace that we are solely talking about *unanticipated* consequences, we open up space for building upon societal knowledge by empowering our collective envisioning efforts to better anticipate a wider range of plausible consequences, and to adopt responsible innovation practices (Owen et al., 2012).

New mobility concepts like MaaS require more envisioning rather than forecasting approach in development of future strategies, as there is a lack of evidence as to how such a service will change mobility practices. Valid predictions about disruptive urban mobility innovations cannot be extrapolated from the current state, as the innovations fundamentally move away from that state, and agent-based simulations have been recommended (Audouin and Finger, 2018; Ronald et al., 2017). This would be useful as governance actors can then explore the consequences of decisions about which modes to prioritise according to the distributed social and environmental needs of their jurisdiction, and thus enable them to specify MaaS packages that could be both efficient and equitable. Second, such modelling techniques can permit the exploration of relations between mobility and urban form in ways that include rules and regulations (e.g., speed limits or restriction on certain links, recommended and restricted stopping points, etc.). This would be useful for joint planning of the built environment and the mobility system and for opening up topics for discussion beyond the rhetoric of the potential benefits of data and service integration. It would also be possible to engage citizens in continuous envisioning processes through engagement with (non)-digital technologies, including social simulation, permitting the public to set parameters for simulation runs and discussing the effects.

The basic foundations for identifying when government intervention is required, i.e. efficiency, equity (and ethics), are central here. Whilst the rhetoric of MaaS is to promise efficiency to cities, freedom to citizens and profit to service providers, we have highlighted in Section 3 above how those promises do not guarantee efficiency or equity (and by extension are not ethical). It is necessary to involve public authorities in piloting and implementation of MaaS trials, and to have revisable data sharing schemes that protect the citizens using the applications right from the beginning of MaaS planning periods. It is not sufficient for the role of public authorities to merely facilitate MaaS roll-out by removing barriers to implementation by private commercial organisations, as this could close down opportunities to develop open-source standards on the functional requirements for MaaS operation, and gives the

private sector the power to control inter-organisational learning by promoting only the technologically optimistic rhetoric, hiding key details of evaluations behind commercial confidentiality.

4.3. Future research directions

There is great scope for further research into the governance challenges posed by innovation, including mobility innovation. If governance frameworks are to help us tackle wicked problems associated with urbanisation, we expect more open debate that includes a wider range of stakeholders about the type of governance needed, and the operational design parameters that can ensure unintended impacts are minimised. As package-based MaaS is primarily a private sector initiative, we should seek private sector contributions to fund independent research to develop the necessary understanding of behaviours, needs/preferences, and consequences (environmental and social) of different modes, to guide bundling choices in a manner informed by local policy. There is also a need to analyse how different market actors use rhetoric to capture and divert strategic attention of the policy community. Urban case studies to explore the policy-framing of MaaS would be a valuable addition to the literature. Methods for studying power imbalances and the boundaries of anticipated futures in the current distribution of roles and responsibilities are required.

5. Conclusion

We have addressed an acknowledged gap in understanding of the societal and governance implications of MaaS. We have described the evolution of the concept and the challenge posed by a service package model of MaaS, with examples drawn from Finland, Belgium, the Netherlands and the United Kingdom, where the concept is beginning to influence urban transport provision. We have thus made two contributions in this paper. First, we contribute the first (to our knowledge) analysis of the regime-building role played by the rhetoric of MaaS actors. Second, we situated this against the governance context to identify potential action and make recommendations. Our examples are at the forefront of technological development in the mobility sector, so the lessons learned have potential for wider policy-learning efforts.

We asked two questions:

1. To what extent can the MaaS promises to citizens and cities be delivered, and are there any unanticipated societal implications that could arise from a wholesale adoption of MaaS in relation to sustainability and key societal issues such as health, well-being and social inclusion?
2. What are the challenges for urban governance from potential MaaS adoption, and what are the potential governance and policy-making responses to these challenges?

In relation to our first question, we conclude that MaaS has considerable potential for deception. The commodification of mobility through the product service package approach requires customers who buy services. Profitability for private businesses inevitably requires growth in the use of their services. Under MaaS, there is strong potential for increased mobility among those who can pay for it. This runs counter to the need to reduce overall automotive movement to prevent or reduce undesired effects and does not address the needs of those experiencing transport poverty. Whilst it is not inconceivable that the less well-off could be supported through subsidies in the MaaS system, this requires strong public-sector input if they are to avoid further transport-related social exclusion.

The promise of freedom fails to acknowledge that current problems of traffic congestion, urban air pollution, noise and greenhouse gas emissions are large-scale emergent phenomena arising from the aggregate impact of our small-scale individual activities and is thus in conflict with the efficiency promise. These larger phenomena in turn have real negative impacts on individuals and communities now, and for future generations. Whilst MaaS could be designed to influence behaviours to be more sustainable, this must be designed in from the start, particularly as the bundling process will obscure the true costs of individual journeys.

In relation to our second question, the threat of potential enclosure of our mobility systems by allowing private entities to control the products that enable people to access to transport through integrated platforms as well as through data monetization, is just one element that leads us to conclude that urban governance is considerably challenged by MaaS. Governance potential is hampered by framing MaaS primarily as a private-sector business opportunity, given that the consequences reach well beyond mobility. Furthermore, MaaS is not fully referenced in strategic urban plans and so may not be shaped to better internalise transport's effects, and this strategic omission permits uncritical thinking about MaaS if it is promoted in isolation from wider urban objectives.

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Declaration of Competing Interest

The authors have no competing interests to declare.

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