International Transport Forum


# How Mobility as a Service Impacts Public Transport Business Models

## Discussion Paper

184 Roundtable

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# The International Transport Forum

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# Introduction

Mobility as a Service (MaaS) is a relatively new concept, first being popularised during the European Congress on Intelligent Transport Systems in Helsinki in 2014. MaaS, as a concept, has been encouraged by the technological developments, which not only define the concept but also differentiate it from its predecessors. The existence of smartphones and their widespread distribution, demographic change, the ability to work with big data and the extensive disruption brought about by ride-sourcing companies (as an example) has revealed the potential for this new type of service which provides integrated transport "for purchase" rather than relying on ownership of transport assets.

As a relatively new concept, the definition of MaaS has not settled to one accepted by all. This discussion paper uses the following definition:

> To qualify for MaaS, the scheme or product first must offer a mobility service with the user at the centre of the offer; second, the mobility options offered must be selected from a multimodal portfolio and finally, the offer must provide the integration of transport service starting from providing the information for travel, enabling a payment option (either at the point of use or with a pre-purchased mobility bundle) and providing the ticket for travel. (Hensher et al., 2020; p. 41).

The presence of MaaS raises questions about not only its own business case but also the business model of public transport operators who are key stakeholders in the provision of mobility, particularly in urban areas. This discussion paper addresses these questions starting with a broad discussion of business models in the first section. This makes clear that any discussion of business models is critically dependent on the organisational form of stakeholders and their governance. These latter issues are not central to the discussion in this paper but have required the postulation of four different potential organisations of stakeholders as described in ITF (2020), so as to discuss the implications for business models. The first section also identifies the potential stakeholders and discusses the critical aspects of potential business models, both for MaaS operators and for public transport operators.

Public transport operations are rarely financially self-sufficient and are typically financed for various reasons arising from the multi-faceted nature of transport policy. The second section looks in more detail at the different ways around the world that public transport operators are financed and the ways in which this subsidy policy may be implemented in the different organisation of MaaS stakeholders identified in the first section. This section suggests a polarity of outcomes, depending on whether MaaS is a niche presence or whether it becomes ubiquitous giving rise to a discussion as to the conditions under which a transition from the former to the latter might occur.

The third section looks forward since the earlier sections do not take into the account how the Covid-19 pandemic might have longer-term impacts for public transport operators and for the development of MaaS, together with the potential change in the operating environment brought about by the emergence, in a practical way, of autonomous public transport vehicles.

The final section points to knowledge gaps, which require further research.

# Components of a Mobility as a Service business model

Zott, Amit and Massa (2011) identify that business models have been a recent preoccupation of academics and practitioners with no development of a consistent language in their description, nor a clear consensus as to what they should comprise. Three main areas of development of business models are identified: e-business and business information use; strategic issues; and innovation and technology management (Zott, Amit and Massa, 2011). In this paper, the idea of a business model follows the second strand – that of identifying the strategic issues in the development of Mobility as a Service (MaaS) and the implications for public transport operators' business models as a consequence.

A business model in this paper is characterised by value creation as the central issue. In particular, this paper considers how value can be created by firms/businesses which are networked so that value is created by a collection of firms and partners (as well as the wider set of stakeholders in the MaaS ecosystem) producing mobility for multiple users. The definition of a business model provided by Seelos and Mair (2007) seems apt as "a set of capabilities that is configured to enable value creation consistent with either economic or social strategic objectives" (p. 53). The business model therefore encompasses the activities of firms/businesses, their network of partners and the value created collectively. But the market for mobility, in the case of MaaS, contains a number of firms/businesses (often with overlapping and competing interests). So, business models will need to take into account their place in the market more generally and spatially and, in this context, business models can be used as a way of achieving a competitive advantage (Casadesus-Masanell and Ricart, 2010).

In the case of MaaS, there is a further imperative in the investigation of business models. That is, potential business models need to be investigated for their contribution to sustainability so that policies and plans can be put in place to promote those models contributing to sustainability and providing a block to those that do not (Bocken, Boons and Baldassarre, 2019). For example, a business model that pushes users away from using public transport into using driver-only car sharing, or increases social exclusion, is likely to add to congestion and mitigate urban transport policy aiming to promote more sustainable forms of travelling.

Against this background, the next section considers the range of stakeholders in the MaaS ecosystem before looking at the different ways that these stakeholders can be configured into a value-creating network of firms/businesses and their partners.

## Who are the stakeholders in the MaaS ecosystem?

There are a number of stakeholders (sometimes referred to in the literature as "actors") involved in the development and delivery of the MaaS ecosystem. Stakeholder identification is important since value is captured through their actions, and benefits are obtained through participation in the ecosystem (Arias-Molinares and García-Palomares, 2020). A shortlist of stakeholders might be the four identified by the United Kingdom's (then) Transport Systems Catapult (Transport Systems Catapult, 2016) (the Customer; the MaaS Provider; the Data Provider; and the Transport Operator). Hensher et al. (2020) identify a further stakeholder in the form of the "MaaS Champion" who can provide vision and strong leadership. Arias-Molinares and García-Palomares (2020) propose a more detailed list of stakeholders and include customers, transport authorities, transport operators, data providers, technology and platform providers, ICT infrastructure providers, insurance companies, regulatory organisations, universities and research

institutions, unions and other media, marketing and advertising firms. It should be borne in mind that each of these roles needs to be defined and allocated and that the functions to be performed may be context-specific. For the purpose of this paper, certain stakeholders are defined as follows.

### Operator

This stakeholder provides the transport services (in a typical MaaS ecosystem there will be multiple transport operators, both mode-specific and multi-modal). This will include the provision of transport assets (rolling stock, highway capacity) as well, although ownership and operation will be influenced by the regulatory environment. Transport Systems Catapult (2016) suggest other urban-realm assets such as car parking, electric vehicle charging points and even digital assets (such as ITS infrastructure) fall within the responsibility of the transport operator stakeholder.

### Public authority

The Authority has a clear role to play (at a minimum) as a facilitator. Moreover, specifically in an organisation of stakeholders known as "Public MaaS" (discussed in more detail in the next section), the integrator role will be provided by the public transport authority (PTA) which may form an integral part of the local authority. Defining the "transport authority" or the "government" is again not necessarily straightforward as demonstrated by the administrative science literature which identifies the public sector in relation to transport as sometimes "unitary" or provided by a single body or, in other cases, provided by a number of different bodies operating over different spatial jurisdictions giving rise to multi-level governance (Veeneman and Mulley, 2018). This means that the public authority stakeholder may well take different forms in different contexts.

### Regulator, usually by state/national government

This is again a context-specific role. In Finland, the Ministry of Transport and Communications (MTC) has been responsible for developing the National MaaS Framework built around the "Transport Code" introduced under The Act on Transport Services (2018) which is designed to encourage new digitally-led business models as a precursor to MaaS-type services, and a new public procurement law requiring the use of electronic channels. In this respect, the MTC is also performing the role of MaaS Champion. In contrast to the centralised Finnish approach, in NSW, Australia, the state government appears to be keen to encourage start-ups and existing businesses to take the role of broker in a test of a potential MaaS delivery model and has sponsored a number of MaaS innovation challenges.

### Aggregator/integrator/broker

This has emerged as the key stakeholder role. The aggregator acts as a data broker to service the data and information sharing requirements of the Transport Operators and MaaS (Platform) Provider. ITF (2020) suggest that the integrator role may be performed on a commercial basis (via a marketplace with agreements between the MaaS provider and transport operators), or assimilated to an "operator" via the characteristics of their business model; or on a public basis via the Public Transport / Authority Integrator (see Authority above); or by a public entity operating a third party platform (as public infrastructure) with rules determined by the public authority; and (in the future) as a decentralised blockchain solution with self-executing contracts (a possibility also identified by Transport Systems Catapult, 2018). Purely information brokers such as Google may operate in a *quasi* aggregator role by responding to routing requests with sponsored or other links to specific mobility or other services (ITF, 2020). Hensher et al.

(2020) suggest that, so far, there appears to be a varied approach to whether government takes the broker/aggregator role or not. This role is key to the MaaS ecosystem and is explored further below given its centrality to the business model discussion.

### Platform provider

This stakeholder may also be referred to as the MaaS provider. However, this role may not be provided by a dedicated operator with platform providers having other interests or being integrated with other roles. They are responsible for designing and offering the MaaS "value proposition" to the customer. Hensher (2017) suggests that this role may be performed by an entrepreneur. This role is also key to the MaaS ecosystem and is explored further below.

### Customer

This is the stakeholder whose influence should not be overlooked. At its most basic, the customer consumes the MaaS offer that is made available, for example, in the form of a monthly subscription plan.

### Other service providers (as possible conjoint activity)

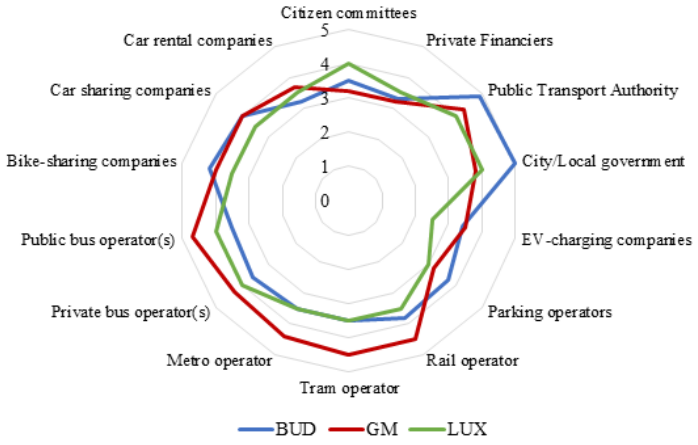
This includes non-mobility operators (e.g. financial enterprises such as banks and insurance companies, other tech enterprises). Entertainment-related companies may also be interested in offering subscription packages and discounts, which may extend beyond mobility such as with card payment system operators as a financial services operator, as MaaS Global has recently undertaken[1]. The influence of non-mobility providers in debates around the future of MaaS (particularly during the Covid-19 pandemic) is gaining greater importance. These stakeholders might be more used to facilitating complementary or other funding streams to help their viability.

### The MaaS champion

This stakeholder provides strong leadership. The candidates for these roles and the extent and nature of engagement have not yet been well defined although Hensher et al. (2020) suggest that there are a number of candidates (Government, local authority, private sector, or transport operator).

Polydoropoulou et al. (2020) offer a further contribution to the discussion around stakeholder definition by also considering their relative importance within the MaaS ecosystem, which will (of course) be strongly governed by context. This is shown in Figure 1 for Budapest, Greater Manchester and Luxembourg. It should be noted that these stakeholder relationships were determined in a pre-implementation context.

Figure 1. Key stakeholders in the MaaS ecosystem in Budapest (BUD), Greater Manchester (GM) and Luxembourg (LUX)



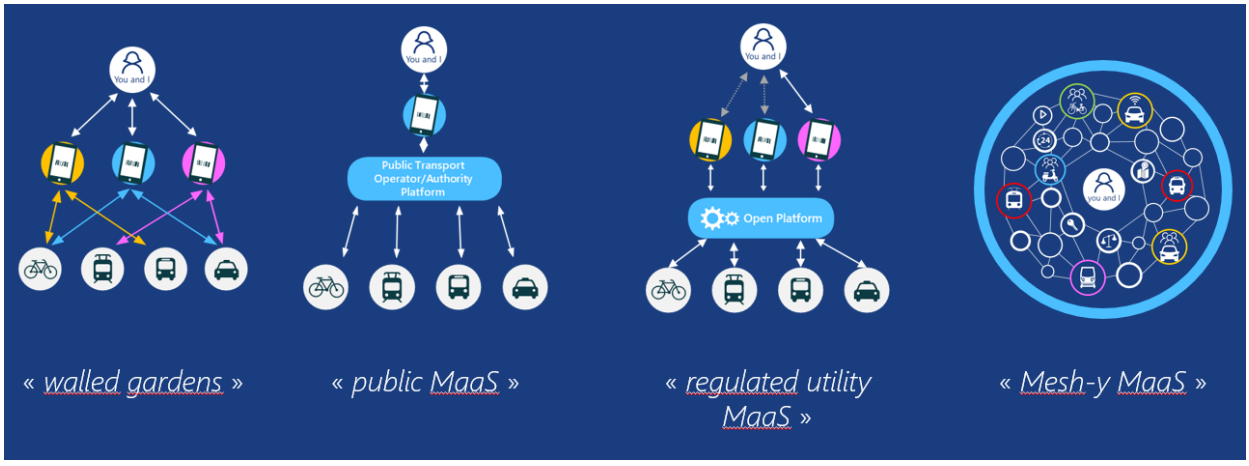

Note: The importance is rated from 1 = "not important" to 5 = "extremely important".

Source: Polydoropoulou et al. (2020).

## Organisational permutations of stakeholders

This section provides an overview of the possible permutations of organisation of stakeholders in a MaaS ecosystem taken from ITF (2020). Whilst these organisational forms have underpinned discussions on governance (discussed elsewhere in this Roundtable), they are included here because of the implications for value creation, which is central to understanding the implications for business models. However, it is important to note that a business model may look very different depending on how the division of public and private responsibilities are governed during the development and diffusion phases of MaaS (Smith, 2020).

Figure 2. Possible permutations of stakeholders in a MaaS ecosystem




Source: ITF (2020).

Figure 2 identifies four different formations for MaaS ecosystems. These are caricatures of ecosystems since, as identified above, the roles and functions undertaken by stakeholders may vary and the

combination of stakeholders are likely to be context-specific and be determined by the governance framework. A similar typology was developed as part of the MaaSiFIE (Mobility as a Service for Linking Europe) project (Aapaoja, Eckhardt and Nykänen, 2017).

In the first three schemas of Figure 2, there are three levels within each ecosystem. The lowest levels are the different modes, here represented by four circles of bicycle, train, bus and shared car, although in a functioning MaaS ecosystem it is likely that other modes will be present (e.g. other micromobility modes such as e-scooters). The middle layer, characterised by a smartphone, represents the platform providers/integrators, here shown as three separate providers (commercial, public and regulated utility – all discussed below); and finally, at the top of the pyramid is the customer or user. The final schema, Mesh-y MaaS, has no formal structure between the different elements. The following sub-sections look at these schemas in more detail as the framework for considering the benefits, constraints and risks to business models below.

### Walled Gardens

In this arrangement, the platform providers/integrators each have arrangements with the mode or mobility operators, not necessarily with all modes and so the offers from each platform provider/integrator to the user may be different. It can be distinguished from the public MaaS arrangement (see below) by being a closed MaaS ecosystem curated by a commercial entity, many of whom will have a business model that creates value add by providing additional services (see the section on aggregators above). The most common outcome might be for a single platform provider to operate in a city. The governance arrangement would allow competition for users (i.e. customers) between the platform providers/integrators but also competition for modes may occur between the platform providers/integrators and the operators. The users link to (usually) one platform provider for the purchase of their mobility requirements. This arrangement is probably closest to the analogy which has commonly been made between purchasing MaaS as a "package" of mobility and the purchase of a "package" of mobile phone features through a subscription (although demand studies have shown that purchase of a "package" is often not preferred to purchase of mobility services within a MaaS app by "pay as you go"). This sort of organisational permutation has been seen in Singapore.

### Public MaaS

In this arrangement, the integrator role is taken by the public transport authority (who would not be an operator in competition with private-public transport operators), or in some cases by the public transport operator, who makes arrangements with the mode or mobility operators. Typically, the integrator sets the rules and there is one platform provider in the space between the integrator and the customer or user. This arrangement of organisational permutation has been seen in Oslo and Berlin (Smith, G. 2020. E-mail communication with authors, 20 August).

### Regulated utility MaaS

The public authority regulates a platform provider, usually by a public entity, which serves as public infrastructure for integrators to set up their mixes of mobility that can be offered to customers/users. In order for this organisational form to be realised, the mode or mobility providers have to share their application programming interfaces (APIs) so that interactions can be made between the different software in use. This arrangement of organisational permutation has failed in Sweden (Smith, Sochor and Karlsson, 2020) and is under development in Denmark (Smith, G. 2020; e-mail communication with authors, 20 August 2020).

### Mesh-y MaaS

Of the four permutations shown in Figure 2, this organisational form is unproven in a comprehensive system-wide application as the technology that underpins it is not yet available at scale. Mesh-y MaaS, as the figure portrays, is a distributed system with automatic transactions occurring between customers or users at the centre of the ecosystem, relying on blockchain to process in a transparent way the automatic transactions that occur between users and mode or mobility providers. In principle, there are no transaction costs and so bilateral contracts between users and providers will not need integrators to act as intermediaries. There will be no fees for integrators to receive for procuring the services for users. This arrangement has been trialled in one of the MaaS pilots in the Netherlands in 2020 where a feasibility study was conducted over three days with some success[2].

The typology proposed by Aapaoja, Eckhardt and Nykänen (2017) is broadly similar and proposes *commercial MaaS* (with a distinction between resellers, such as travel agencies, and integrators); the *public transport operator* model which places the public transport operator at the heart of the ecosystem; the *PPP* (public-private partnership) model in which the public authority aggregates the activities of transport, mobile and logistic providers; and a rural variant of the PPP model.

## Critical aspects of business models in the MaaS ecosystem

Business model formulation has a number of components. Understanding the critical aspects is important for creating a model that is sustainable in the market. This section considers the major issues that require consideration in this context.

### Understanding costs and perception of costs

In a business plan, understanding costs is critical for establishing the value that can be created since profitability at a simple level is the difference between revenues and costs. Within the ecosystem, the different stakeholders will present different cost structures as a result of different capital structures and also the relationship between fixed and variable costs. Trains, for example, have a higher capital component to their unit costs than buses yet a bus service typically carries a higher labour component per passenger carried than a rail service. Integrators from different backgrounds will carry different cost structures and this can affect their willingness to contract with mobility providers and the offer they make to customers or users. Overall, an understanding of costs allows the stakeholders to make decisions on the basis of their escapable costs.

For the aggregator/integrator, the creation of the business model requires estimation of demand for the different modes as a pre-requisite to formulating a plan based on this estimation and knowledge of the different capital/operating structure of the mode.

A clear motivation for the promotion of a MaaS ecosystem is the movement away from owning personal mobility infrastructure, such as a car, to a sharing environment. For the user, this has a critical impact on the perception of costs. With MaaS, users move from a low marginal cost mobility environment (there is significant evidence that users of private cars do not take depreciation or servicing into account in the decision to travel, only the marginal costs of fuel and maybe parking; see, for example, Walters [1961]) to a high marginal cost environment where the costs of using a shared car will include an element of depreciation and servicing in the fee for use. It may well be that the promotion of different business plans will need to include an educational element to “train” users into better understanding of the relative costs of their mobility choices.

## Understanding the customer perspective

The customer perspective is perhaps the most critical aspect of the business model as, without the customer, the *raison d'être* for MaaS evaporates. Guided by the definition of MaaS, the evidence to date on various aspects of the customer perspective can be divided into the categories of platform, payment method and service design. Understanding what customers want, and importantly are willing to pay for, must be a guiding principle for designing the business model.

### *Platform*

MaaS is predicated on the existence of a platform, in the form of a smart app, which allows the interrogation of journey information, and the potential to book and pay. The evidence of a number of studies (Caiati, Rasouli and Timmermans, 2020; Guidon et al., 2020; Ho et al., 2018; Ho, Mulley and Hensher, 2020) suggests that travellers are demanding this but not enough research has been done to identify whether customers are willing to pay for the app and, if so, how much. The studies by Ho et al. (2018) suggest that travellers want the app but are not willing to pay an amount significantly different from zero for it. This is not surprising if they consider the MaaS platform to be akin to a journey planner (which is normally free at the point of use). Guidon et al. (2020) on the other hand found that willingness to pay exceeded CHF 100 (more than USD 100) which they acknowledge as high, even for Swiss budgets. There is clearly not sufficient research undertaken to establish how much, if at all, customers are willing to pay for a MaaS platform.

### *Payment method*

There are two alternative methods of payment: payment for the mobility services taken at the time of travel on a pay as you go (PAYG) basis or subscription-based where the traveller, rather like a mobile phone contract, prepays for a periodic subscription for a mixture of mobility services such as public transport, shared car etc. The research evidence is mixed. With MaaS not being in place, stated preference studies (Caiati, Rasouli and Timmermans, 2020; Fioreze, De Gruijter and Geurs, 2019; Guidon et al., 2020; Ho, Mulley and Hensher, 2020; Matyas and Kamargianni, 2018) have posed hypothetical options to respondents and have concentrated more on what travellers would like to see in their mobility bundles rather than whether they would prefer PAYG to a prepay option with a discount offered. Nevertheless, there seems to be some context-specific outcomes. Guidon et al. (2020) identified that respondents in Switzerland valued bundles of mobility services more than separately (public transport, car share and park and ride) but that other services made these bundles less valuable (bike sharing, taxi services) and could thus be offered as free standing services on a pay-per-use basis. They did not consider the question of how often bundles should be "refreshed". Against this, Caiati, Rsouli and Timmermans (2020) found bike hire extremely popular. In Sydney, Australia, (Ho, Mulley and Hensher, 2020) found that subscription bundles were preferred whereas a study by Vij et al. (2020), also in Australia, found PAYG to be preferred. And in live applications, context-specific offerings can be seen by the same MaaS operator: Whim in Helsinki, Finland offer both subscription and PAYG options for travellers whereas Whim in Birmingham, United Kingdom offers only the PAYG option, after failing to make commercial success with a subscription offer. Real pilots can offer some further insights (see Hensher et al. (2020), Chapter 4) but still, there is no universal answer. For business model development, this is an area that will need to be considered on a site-by-site basis until or if some more certain conclusion is reached.

### *Service Design*

Whilst a critical part of a business model, this aspect is informed by the same studies and pilot experience as payment methods. There is really no homogeneous outcome from research studies (e.g. (Guidon et al., 2020; Ho, Mulley and Hensher, 2020; Matyas and Kamargianni, 2018) although public transport and car-

sharing appear to be a common requirement by potential (or actual, in trials) subscribers. The uptake of other modes – car rental, taxis, Uber, bikesharing - having varying appeal. The more worrying aspect of service design is the effect found by Guidon et al. (2020) whereby including modes such as bike share and taxi reduced the willingness to pay for the bundle. This implies how important it is to get the mix of a subscriber package appropriate for the traveller and, maybe learning from the mobile phone market, this might mean an array of packages might be needed to capture most travellers in subscribed packages. It is important to acknowledge that one of the benefits to subscription packages from the supplier viewpoint is the opportunity to cross-subsidise between the elements of the package to make it more attractive to passengers and more profitable for the supplier. It is also important for "desktop studies" to reflect on how well survey respondents understand the functionality of the offered platform. There are parallels here with some of the studies of the impact of flexible transport services where strong branding and a willingness to spend money on the marketing of the product have been shown to be important (Weckström, et al., 2018).

## Understanding the supplier perspective

To date, led by the way in which MaaS is portrayed as improving service to the customer, more research has been undertaken on what users want rather than considering the supply side of the equation. Supply-side investigations have been rather limited (Hensher, et al. (2020); Chapter 6). Despite this, the supply side view is intrinsically important to the business model development. In exactly the same way as it is important that the market delivers what customers are willing to pay for, so it is critical that there is a good understanding as to what the business community is prepared to supply. There should be sufficient availability of transport services for consumers to choose from, but digital connectivity, APIs and an appropriate regulatory environment are as important to a functioning MaaS ecosystem.

An overarching requirement for the supply side in the MaaS ecosystem is partnership and co-operation between the various players. A key player in this respect is the MaaS aggregator/integrator, who acts as the intermediary or broker between the suppliers of mobility and the customers. The MaaS models depicted in Figure 2 show the aggregator/integrator role being played by different entities – this is explored more in the next section.

The business community's preference for different organisations of MaaS has been explored in an international stated preference survey. This proposed a mode-agnostic mobility contract[3] to act as the interface between the mode suppliers and the aggregator/integrator. A number of important results flow from this survey (Wong, 2020). Supplying physical assets, such as bus services, was 25% more popular than simply investing (financially) in the MaaS ecosystem. Conventional (fixed route) public transport achieved the highest support, accounting for between 45% and 55% of revenues. Car sharing and shared ride hailing was preferred by the non-mobility players who expected more revenue from this flexible transport than was anticipated from on-demand transport from the mode-specific operators. Interestingly (and discussed below in terms of subsidy) enthusiastic government support at a strategic and regulatory level was identified as more important than direct subsidy. Branding received mixed views with some business members being prepared to act under the banner of partners. The required return on investment – critical to the health of a business – was 6%-9% and higher for businesses willing to invest rather than mode-specific operators offering mobility services. Non-mobility providers were seriously interested in investing in a MaaS ecosystem, preferring larger to smaller businesses. The average preferred equity stake in the integrator/broker business was about 35% suggesting no desire to monopolise but that they were happy to partner with other businesses to provide a MaaS product (Hensher et al., 2020).

Apart from the terms of the contract, and the willingness of mobility and non-mobility operators to partner and collaborate in the delivery of a MaaS product, there are other areas where the practical resolution will be needed. As travellers will be making payment for their trips via the smartphone app, cashless transactions are, therefore, built into the definition of MaaS. However, this highlights an important aspect of the integrator's business: how to allocate payments to mobility providers, especially if the subscription plan offers a discount. These are more straightforward if there is only a single provider but MaaS and multimodal journeys will involve revenue allocation processes, discussed in Fares and Ticketing in this Roundtable.

### Understanding the competing objectives of stakeholders

Public transport policy is multi-faceted, with government seeking to meet economic, environmental and social objectives. Other stakeholders may also face multiple objectives with their own business plans not necessarily aligning with that of aggregators/integrators or other stakeholders.

The MaaS business models discussed in the previous section are largely predicated on the assumption that stakeholders will work together. Whilst there is a common goal to be part of the value capture process, and thus enjoy the benefits obtained, stakeholders will enter the ecosystem with competing objectives. For example, Helsinki Regional Transport Authority (HSL) was the first public transport authority to fulfil the Finnish transport legislation requirements on data and ticket sales interface openness, but has nevertheless been alleged to impede MaaS developments and their API has received criticism for having low flexibility and strict process requirements (Smith, forthcoming).

To examine stakeholder relationships further it may be helpful to distinguish the different roles or functions that stakeholders may perform which were discussed above as part of Public MaaS. Implications for business models of different organisational permutations.

### Who are the new market players?

Not only research studies but MaaS pilot schemes and fully operational MaaS schemes put public transport at the core of the MaaS ecosystem. The aspirational aspect of MaaS, as contributing to an improvement in the sustainability of (particularly) cities cannot be achieved without collective transport being central to delivery. That said, in developing MaaS, who are the potential operators interested in joining the ecosystem and how might these impact on the core public transport delivery?

Much has been made of the interest of the ride-sourcing company providers, including operators like Uber. However, the Sydney experience of on-demand flexible transport pilots has shown that the larger companies, like Uber, although initially interested in partnering with the bus companies to produce an on-demand pilot, withdrew as they were uninterested in forfeiting their brand to the bus operators and the bus operators were likewise unwilling to relinquish their brand which they depended on to distinguish themselves from other operators. However, since the provision of integrated ticketing via *OpalConnect* in Sydney, one could envisage a future situation where a ride-sourcing company was more willing to take the role of on-demand provider. Perhaps also, ride-sourcing companies are very good at their Business to Customer (B2C) operations but less good at a Business-to-Business (B2B) operation required from teaming up with incumbent bus operators in an on-demand trial. This is an important point because operators may well need to operate outside their comfort zone in participating in a MaaS ecosystem and the conventional bus operators are very comfortable with their fixed route services and very much less comfortable with more flexible services (Daniels and Mulley, 2012) that would be required by MaaS.

Whilst it is clear that the MaaS ecosystem must include the current public transport operators, more niche transport operators such as bike, e-bike, and carsharing will certainly feature. The big question is whether or not there is sufficient value in a MaaS ecosystem for non-mobility operators who seek a new business opportunity to enter. There is clearly value in alliances and is discussed in more detail in Meurs et al. (2020).

### Establishing the MaaS aggregator/integrator/broker role

There can be no dispute of the economic arguments in favour of competition, which provides an efficient use of resource, provides output and pricing that satisfy social welfare criteria and provides consumers with the opportunity to signal what they want. It also provides the framework where innovation is promoted, which in turn can generate economic growth.

The corollary to a competitive market is one where there is a single player (monopoly) or few players (oligopoly). The danger of these markets comes from an equilibrium whereby supply by a monopolist is less than under competition and the price higher. There is also the possibility of collusion between operators in a market where few operators hold the balance of power.

In terms of the establishment of the MaaS aggregator/integrator/broker role, there will be a difference between one that is government-led and one that has its domain as the private sector. Jittrapirom et al. (2018) carried out a Delphi study which found transport operators, private or public depending on context, were the preferred aggregator with a third party mobility provider and then a local authority. This contrasts with calls from industry, for example, the International Association of Public Transport (UITP), and researchers, for example, Kamargianni and Matyas (2017), who argue for a government-led aggregator. It is likely that a government-led aggregator is in a better position to integrate services given that governments in a non-deregulated environment will be contracting public transport and, in many cases, regulating the other modes that are likely to be involved in MaaS, such as taxis and ride hailing (Hensher et al., 2020; p. 99). Against this, there is the possibility that a government-led aggregator ecosystem would lack competitive forces and be slow to innovate and also, possibly, cause a conflict of interest in those operating circumstances where public transport services are provided by public and private operators. In these circumstances, a public-private partnership might be more likely.

These hypothetical discussions are mirrored in the pilots and trials of MaaS, discussed in some detail in Hensher et al. (2020), Chapter 3). A particular pilot of note is Augsburg, Germany where the local authority is not only the public transport operator but also the carshare operator and has positioned itself as the mobility operator and the aggregator in the scheme.

Might a non-mobility operator become the aggregator? As the discussion around aggregators has progressed and talk of more hybrid MaaS schemes abounds, it is possible that a non-mobility operator takes on this role. For example, in Gothenburg, the EC2B service offers tenants of a residential apartment block a subscription plan including public transport, car sharing, bike sharing and moped sharing in lieu of car parking facilities. Tenants are also offered mobility consultations. If a hybrid MaaS scheme moves beyond mobility to include the provision of utilities in the same ecosystem (utilities being particularly pertinent since they share the non-storable characteristics of mobility), a utility provider might become the aggregator. Bigger packaging with more elements makes it more likely that a non-mobility provider will take the central position of aggregator.

## How do organisational arrangements impact on the aggregator role and the role of the public transport operator?

This section considers each of the organisational arrangements in turn and assesses the impact on a business model, and in particular, impact on the public transport operator business environment.

### *Walled Gardens*

In this organisational form, competition will exist between commercial platform operators, which should ensure innovation at this level. The free market at the platform level ensures value creation (if there is no value creation then there will be no interest by platform operators to be in the market). The integrator will need to make arrangements/contracts with service or mobility providers and, provided there is not a dominant platform provider who can drive better responses from the service provider than other platform providers, there should be no risk of market concentration or monopoly type outcomes.

The commercial aggregator will clearly seek the best outcome for itself (and its shareholders), an outcome that may not be in the user's best interests nor provide the contribution to sustainable policy, which is one of the stated benefits of MaaS. The added value of the integrator comes from integrating services, information and payment services for customers. Ride-sourcing companies have shown they are quick to diversify into non-mobility services, e.g. Uber Eats. But it is developments like the "Uber and transit" option in the Uber app, recently introduced in Sydney, Australia, which provide a multimodal option to provide with Uber X the first and last mile parts of the public transport journey, that is likely to produce MaaS outcomes[4].

For public transport operators, their business models are unlikely to need to be very different although their "master" will be the aggregator rather than typically the local authority or government. For the commercial integrator, the challenge will be to manage the more free-market environment of the taxi, ridesharing, car sharing and bike sharing modes on the one hand and the mass transit, largely subsidised in one form or another. It is, of course, possible (to be discussed in the next section) that government still contracts with the mobility providers that require subsidy and that these operators offer subsidised prices to the aggregator alongside the more commercial mobility services that form the MaaS ecosystem.

Government in this arrangement is largely without influence in the market, other than to regulate for safety and possible conditions for market entry. A potential risk for government is the demand of aggregator/integrators for discounts on subsidised fares, adding to the cost to the public purse.

### *Public MaaS*

The aggregator/integrator in this organisational arrangement is less likely to be the public authority, indeed for some public authorities this would not be allowed since it would present competition with other operators. Government is most likely to put the aggregator/integrator role out to competitive tender. This is the form that Jittrapirom et al. (2018) identified as the most likely outcome following a Delphi study. Hensher (2017) argues that this organisational form will require the Government to re-assess and re-define their relationships with operators, changing their contract format from the current mode specific to a mode agnostic contract whereby operators are required to provide a required level of accessibility by whatever mode is chosen. Thus, in the future, one might refer to these as mobility contracts. As an impact on their business model, public transport operators will be free, indeed encouraged, to be innovative about partnerships between different mode operators to deliver the required access (specified most likely as a number of trips).

Having a public sector integrator will mean that all operators will need to open their APIs if the ecosystem is to be workable so that the integrator can offer a wider variety of mobility services to customers. Indeed, this could be identified as one of the more critical factors affecting the delivery of MaaS.

### *Regulated utility MaaS*

In this organisational form, the third party platform is set up under rules defined by the Government and acts as the platform for others to build their MaaS services. This permits competition between the different integrators in offering customers MaaS offerings. However, unlike the commercial aggregator/integrator of the Walled Garden, the regulated utility MaaS third party platform contracts with the mobility providers and would provide the same terms to each of the integrators. For this to work, all operators would need to open their APIs and this can lead to data sharing and data protection issues. Ensuring interoperability between ecosystems is a further critical delivery issue.

For public transport operators, this organisational form is likely to lead to the least change to their business models, provided the third party platform behaves in a similar way to the Government (which is likely as the government defines the rules of engagement for the platform).

### *Mesh-y MaaS*

As identified above, this organisational form is unproven in a comprehensive system-wide application as the technology which underpins it is not yet available at scale (although a successful but limited trial has occurred in the Netherlands (see above). The Government role will remain similar to current practice with the regulation of market entry and transaction rules. However, this would be an "all change" for all parties with public transport no longer at the "core" of the MaaS operations. Public transport operators would need to consider how to alter their business models to allow self-executing contracts between themselves and customers as the aggregator/integrator, as conceived in the other organisational forms, is absent. More than the other organisational forms, some mechanism for the allocation of revenue between suppliers may be necessary and this could impact on the viability of public transport operations unless some way of introducing the subsidy, currently delivered to mass transit.

# Subsidies and a MaaS ecosystem

MaaS, as conceived, is a mix of modes which are a combination of market-provided modes (e.g. taxis, e-bikes) and the mass transit public transport modes which typically benefit from a supply-side subsidy from government (e.g. bus, train, tram). Whilst it is understood that many of the new mobility forms are underwritten by commercial subsidy or sponsorship, this is not the focus of this section.

How the public transport business model might need to be reorganised in a future with MaaS depends on the extent to which MaaS dominates the market, the extent to which the mass transit public transport are at its core and the willingness of governments, who provide the existing supply-side subsidy, to be inventive about how this is delivered. This section first considers the ways in which supply-side subsidy is currently given before turning to the implications of subsidy for society since any change to business models should ensure that distributional aspects are in line with objectives. Some alternatives to a supply-

side subsidy are identified in the context of how public transport business models might change in the presence of MaaS.

## Existing subsidy models and their relation to business models

### Franchise

"Public transport franchising (franchising) refers to a process where governments expose public transport services to contestable supply so that the best operator delivers the services." (Infrastructure Australia, 2017, p. 2). Generally speaking, the motivation behind franchising is to deliver improved services for users and savings for taxpayers. A typical franchise (such as a bus or rail contract) involves the transfer of operational responsibilities from government for the delivery of services for an agreed period of time (e.g. seven years for rail in the United Kingdom). Franchises may occur at either area (as with bus services in London) or route level (as with rail services in the United Kingdom). In an area-based contract, an area is allocated for the specific operation of a single operator. The government seeks tenders for the area franchise and the appointed – usually, the lowest cost – operator has the freedom to provide service within the area subject to minimum service levels. Route based contracting occurs where a specific alignment and associated service level are determined and contracted out (Currie, 2016).

With franchising, the infrastructure on which the service operates remains in public ownership and co-ordination of timetables, fares and aspects of passenger information is placed in the hands of government, or the regulator. For example, in London, Transport for London (TfL) specifies what bus services are to be provided and decides the routes, timetables and fares. The services themselves are operated under contract by private companies through a competitive tendering process. For the transport authority, franchising gives better levels of connectivity, the opportunity to use cross-subsidy to develop a more unified and better integration (Urban Transport Group, undated).

Franchising provides an opportunity to incentivise service improvements by contracting for specific performance outcomes. For the operator, franchising allows them to concentrate on service delivery (Urban Transport Group, undated). Contracts with Key Performance Indicators (KPIs) are typically used to hold an operator to account. In Australia for example, whilst public transport patronage in cities consistently increases, the performance of services in terms of punctuality and reliability varies across services and between locations. Financial penalties may be applied for poor performance while sometimes bonuses can be paid for exceeding agreed standards (Infrastructure Australia, 2017).

Bus franchising offers benefits to the user, particularly in the form of integrated ticketing, co-ordinated and planned network planning, cross-subsidy across bus services and other modes and unified marketing.

### Competitive tendering

London provides a typical example of tendering for the award of franchises, where bus operators compete for contracts to provide specified services for up to seven years (five years, with a potential 2-year performance-related extension available to the operator). Contract payments are related to the mileage operated and overall reliability of the service. Comprehensive quality measurements are used across all aspects of delivery. The key features of London Buses' tendering and contracts system can be summarised as follows (Transport for London, 2015): contracts are designed to provide incentives to operators to improve quality. Routes are generally tendered individually, but often at the same time as other routes in the same area to facilitate service changes. TfL maintains a continuing programme of tendering, with between 15% and 20% of the network typically tendered each year. Tender evaluation is based on best

value for money, taking into account quality and safety as essential features. Outside London (and in other places outside the United Kingdom), competitive tendering is used on a single route basis rather than a collection of routes, as it typical in a franchise.

In tendering, different types of contract may be used according to the way in which risks are allocated between operator and regulator. Gross Cost contracts pay the operator a specified sum to provide a specified service for a specified period. All revenue collected is for the authority. Net Cost contracts transfer the revenue risk to the operator. The operator provides a specified service for a specified period and retains all revenue. The introduction of incentives in contracts (e.g. London's Quality Incentive Contracts) has blurred the gross/net cost dichotomy and introduced far more complex regimes with the shared distribution of risk (Wong and Hensher, 2017).

Hensher (forthcoming) argues that where there has been demonstrated cost-efficiency under contracts which are either negotiated or tendered, there should be a case made to retain the incumbent operator via negotiation, provided agreed standards are met going forward. Looking to the potential future mode-agnostic regulation, where all modes are treated on a "level" playing field regardless of vehicle type, ownership structure or how services are funded, is a key reform for facilitating MaaS implementation (Hensher et al., 2020). The move to mode-agnosticism will require the definition of more complex performance measures (e.g. related to customer accessibility rather than vehicle kilometres) but developments in technology make this possible[5].

### Direct subsidy

Abrantes (2015) provides three examples of direct subsidy bus services: free travel for elderly and disabled people; fuel subsidy; and subsidy of non-commercial bus services. Whilst many jurisdictions provide free travel for elderly and disabled citizens, other jurisdictions provide a wider range of direct subsidies to citizens with reduced ability to pay, such as the unemployed. Fuel subsidy and subsidy to non-commercial bus services are discussed here briefly. Incentive Payments per Passenger (IPP) is another form of direct subsidy which is discussed in more detail in a later section.

*Fuel duty rebate* (known as the Bus Service Operators Grant or BSOG in the United Kingdom) is a discretionary grant paid to operators of eligible local bus services to help them recover some of their fuel costs. The amount each bus operator receives is based on the amount of fuel they use. Abrantes (2015) notes that while operators may prefer to use the fuel subsidy to increase frequencies rather than to reduce fares, fare reductions are likely to be much more effective in increasing demand and generating economic benefits. However, this is not supported by Currie and Wallis (2008) who argue that better quality of service (of which frequency plays a big part) is most important in growing patronage.

In a deregulated framework, or where franchising is undertaken on a route by route basis, the d*irect subsidy of non-commercial bus services* is useful for supporting socially necessary services. While it is often thought that tendered services are mainly justified on social equity grounds, many tendered services (see previous section), particularly in metropolitan areas, are also likely to represent good value for money.

### No subsidy

Commercial bus services in a deregulated or free market are examples of no subsidy services. In the United Kingdom, any service outside of London can be operated (subject to minimum safety and operating standards) provided they can be operated commercially. Operators choose the fares they charge and the vehicles they use. In practice, operators focus on the most profitable journeys, with transport authorities having to fill the gaps in the network by paying operators to run journeys and some routes that are socially

necessary. Other examples of bus services operating without subsidy may be found in Hong Kong, China, where the transport operator, the MTR, makes a profit from their air space metro property developments that cross subsidises metro operation.

### Free public transport models

A number of cities or countries have introduced partial or full free public transport models. It perhaps should be identified at the outset, that there is no such thing as cost-free public transport as public transport consumes real resources, which have to be "paid" for in some way.

Experimental schemes have met a somewhat chequered history. An experiment of free fares in Rome in the 1970s was introduced to try to control congestion: it did not work. Seattle is a more recent example where a free city centre bus service was withdrawn in 2012, after 40 years of operation. NSW, Australia introduced a number of free buses in key town centres as a way of increasing pedestrian circulation and reducing cars.

Estonia made public transport free for its residents in 2013 in its capital Tallinn and in 2018 provided extended free bus travel across the country coupled with extended subsidies to trains (although public transport in other Estonian cities still attracted fares). Paid for by central taxation the motivation was to boost the job opportunities for lower-income and unemployed residents. Cats, Susilo and Reimal (2017) showed an increase in the use of public transport (including for the low paid and unemployed) but only mixed evidence that the policy had improved their job opportunities. Luxembourg is the most recent country to experiment with free transport (2020). Unlike Tallinn, free fares in Luxembourg will apply to residents and non-residents alike (although this is not surprising since a very great number of non-residents are commuters who cross the border into Luxembourg to work) and have been introduced with the objective of reducing environmental ills associated with cars and underwritten by the central government. There is no peer-reviewed evidence as yet on this "experiment" and it will be "contaminated" with the impact of the Covid-19 pandemic.

How subsidies are paid for impacts on their distributional implications. Subsidies to provide free transport can be provided out of direct taxation, which is more likely to be progressive given that a high proportion of central government taxation comes from income tax which is generally progressive (although more progressive in some places than others). This is also likely to be the case if subsidy is paid for by local income tax. The alternative, utilised initially in NSW, Australia, is for the free service to be paid for out of local taxation, raised by taxes raised on properties (rates) which are notoriously regressive.

## Implications of public transport subsidy for society

### Supply-side subsidies

Subsidy is a transfer of resources from the state to the public transport organisation. Typically, the provision of subsidy moves the supply function to the right leading to a lower equilibrium price, even when the subsidy is designed to meet a gap between revenues and costs, as is habitually the case for public transport. A public transport subsidy is typically a transfer from direct taxation (normally progressively raised) or, sometimes, from borrowing and this has distributional implications.

As indicated above a move towards a more competitive distribution of subsidy in the public transport context through competitive tendering has been motivated by the way in which increasing operating deficits have imposed an increasing financial burden on public funds. Network subsidies (provided for the

collection of services which comprise the network) were found to provide a lack of incentive to operators to ensure sustainable finance and arguably, because of the cross-subsidy thus engendered in the system, put the decision of which services should be subsidised in the hands of the operator (rather than as one might expect in a democratic environment, the politician) (see, for example, Gwilliam, Nash and Mackie, 1985). High levels of subsidy were also identified as leaking into wages (Bly, Webster and Pounds, 1980) which, in the United Kingdom, provided another motivation for the movement towards increasing market competition in the form of regulation.

However, despite the movement towards a more competitive approach to subsidy policy, there are still distributional issues suggesting that supply-side subsidy is not always able to meet the multifaceted objectives of subsidy policy (support lower-income citizens and inclusion of the socially excluded, promote sustainable city outcomes, reduce congestion and environmental ills). Fearnley and Aarhaug (2019), for example, find in Oslo that the higher income groups, because of the modes they use (regional trains and high-speed ferries) benefit from high per passenger and high per km subsidy whereas the lower-income groups receive the opposite in using buses, metros and local trains. However, overall, the Oslo subsidy profile is mildly progressive because of the socio-demographics of the public transport user compared to the population as a whole. This is confirmed by Börjesson, Eliasson and Rubensson (2020) for Stockholm, Sweden where the average subsidy per person was about the same for all income groups, other than for the highest quintile who benefited more, suggesting that the subsidy policy was regressive. More importantly, Börjesson, Eliasson and Rubensson (2020) found greater spatial variation in subsidy with average subsidy per person five times higher and subsidy per trip ten times higher in the regional periphery as compared to the regional core.

## Demand-side subsidies

Most jurisdictions provide demand-side subsidies in the form of concessional fares to older persons, the disabled and younger persons and, in some cases, to other identifiable groups such as the unemployed. These targeted subsidies are not the focus of this section. This section is concerned with two more potential demand-side subsidies – the incentive payment per passenger and a person-centred payment.

### *Incentive Payment per Passenger*

This is not strictly a demand-side subsidy *per se,* as it is a payment made to the operators of public transport. An incentive payment per passenger (IPP) is a payment made to the operator, per person carried. It could replace the subsidy per passenger inherent in most contractual arrangements between public transport operators and the government supporting them. This provides an environment in which operators have the incentive to seek ways to increase their patronage.

Different modes of public transport have different fixed and variable cost characteristics, and the incentive payment can be modified to reflect these differences. It could also be tiered so as to reflect different length journeys by passengers.

As identified above in the supply-side subsidies, there are likely to be spatial differences in subsidy need. In the United Kingdom, for example, a "rural safety net" was proposed alongside the potential introduction of an IPP, designed to replace an operator fuel subsidy (Cfit, 2009). Cfit (2009) found the benefit-cost ratio from moving to an IPP was ten, in contrast to the then current fuel subsidy benefit-cost ratio of around seven.

*Person-centred payments*

In a number of jurisdictions (e.g. Australia, the United Kingdom), person-centred payments (PCP) are made or are planned in several spheres, particularly for the older and disabled people domains. The rationale has grown out of the human services sector aiming for greater personalisation in services.

In the basic formulation, PCP are typically made to cover the needs of an individual and would normally include a mobility element. Scaling up to a population would in principle give each individual a "travel budget" equivalent to an amount of subsidy to spend on public transport. If applied globally to each citizen, a PCP could be managed through the taxation system and/or benefit system, tailored to each citizen's need. However, such personalisation would not come without a cost, as matching need to citizens on an individual basis is likely to identify very many permutations. A disadvantage of a PCP would be when the level of government responsible for providing public transport subsidy is different from the level of government responsible for collecting taxes. Implementation in this context would need to take this into account.

### Supply-side or demand-side subsidies?

The evidence suggests that supply-side subsidies are either neutral or regressive (Fearnley and Aarhaug, 2019; Serebrisky et al., 2009). To improve income distribution, user-based – and targeted user-based – subsidies do better. However, whilst demand-side subsidies may have advantages in terms of redistribution aims, their complexity may add additional costs and work against its possible introduction.

An IPP on the other hand has a number of practical advantages, particularly in the current public transport environment where counting passengers is no longer the issue it used to be. The prevalence of automated fare payments and/or information from the big data coming from digital applications allows accurate counting of passengers by as many categories as the public transport system needs to identify. Indeed, some APIs are already being developed to support such a change. In addition, if Mesh-y MaaS becomes a reality then this becomes a practical way of developing MaaS that does not depend on scale. An added advantage of an IPP is that it could be made up of a number of different elements. Whilst supply-side public transport subsidy is clearly a second-best solution in encouraging a modal switch from cars to public transport (a first best would be the introduction of road pricing – for a review of the arguments see Emmerink et al, 1995), in a MaaS context, an IPP could include an element of incentive for the passenger for the amount of public transport they use. Using the amount of public transport used as a proxy to a reduction in car use means an increase in public transport usage could be accompanied by a discount on their MaaS bundle, thus allowing a MaaS offering to more closely meet the sustainable goals of its objectives.

## Subsidy options for public transport operators in the different MaaS organisational arrangements

This section revisits the different organisational arrangements discussed above to consider potential subsidy options for public transport operators. In each case, the subsidy option would need to be embedded in the business case. The options for subsidy also will depend on whether or not MaaS remains niche or whether it becomes scalable.

### MaaS remaining niche

In the Walled Gardens, Public MaaS and Regulated Utility MaaS organisational arrangements, MaaS remaining "niche" is akin to the status quo. Thus, the only option would be to subsidise the mass transit in the same way as currently, either by franchise and/or using a method of tendering (with or without incentive contracts) for single routes or for an area of service. Each aggregator/integrator would then offer a mix of services to customers using the subsidised cost of public transport services as the input cost to their bundle or PAYG service.

Despite MaaS remaining niche, there is scope for the development of mode agnostic mobility contracts (Hensher, 2017) that could pave the way more seamlessly to MaaS growing in take-up. The planning and responsibility for the different modes are typically separated with one organisation or part of one organisation being responsible for bus, another for tram, yet another for train. Following this planning and responsibility lead, contracts are typically constructed to reflect the single mode. Converting mode-specific contracts to mode agnostic mobility contracts requiring the delivery of certain trips and a certain number of trips, where the operator decides what mode should be used could allow MaaS to scale from a niche product to something more pervasive. Each aggregator/integrator could offer a mix of services to users using the subsidised cost of public transport services as the input cost to their bundle or PAYG service.

For public transport operators, continuing as now or maybe updating to mode agnostic mobility contracts would be "business as usual", providing subsidy in a form in which they are comfortable with the rules. For the level of government responsible for subsidy (whether this is local or central, state or federal in a federated jurisdiction), moving to mode agnostic contracts would be a new venture. Mode agnostic contracts would give public authorities greater flexibility in their contracting, extending the definition of public transport to include more sharing options, such as carsharing, as a way of meeting policy goals for example, on sustainability (Hensher et al., 2020; p. 120).

### MaaS scaled up

In the Walled Gardens organisational form, because there are multiple platform operators, each aggregator/integrator will make arrangements/contracts with the service/mobility providers, balancing their portfolios with mass transit (requiring subsidy) and other mobility offers (typically unsubsidised). Whilst the status quo would certainly work, extending to mode agnostic contracts between the public authority providing the subsidy and the public transport operator, as discussed above, provides potential opportunities and benefits to society. It also provides an incentive for public transport operators to be innovative with the partners they choose to provide the required level of mobility. The risk of this business model is that the incentive for aggregator/integrators to scale up their operations is not so great as the value add comes only from providing a set of integrated services. The profitability for the aggregator/integrator will rely to a certain extent on the degree to which they can access subsidised services at a discount whereby some of the discount can be passed to customers and the rest retained as profit. If no discount is forthcoming, even for bulk purchase and particularly for public transport tickets, then the aggregator/integrator will find it more difficult to provide attractive packages for those customers who need to see a price tag better than their current arrangements. A constraint to this business model is that giving discounts for "good" behaviour, either for greater public transport use or for switching from car to public transport is difficult for the aggregator/integrator to offer, unless there is a separate subsidy stream to underpin this. The same constraint applies to the introduction of a road pricing element to the MaaS package.

The *Public MaaS* organisational form benefits from having the aggregator/integrator as either the public transport operator or possibly the public authority. All the discussion in relation to the Walled Gardens organisational form applies in terms of the status quo for contracting and the development of mobility contracts. However, if the aggregator/integrator is the public authority, they could choose to provide discounts for bulk purchase of trips to the platform provider and could provide the platform provider with incentives to generate more sustainable travel by their customers. This would be more difficult if the aggregator/integrator is the public transport operator, unless this is built into their operational contracts with the subsidising authority. The risk in the Public MaaS organisational form is that the lack of competition will lead to a lower level of innovation. In the case of a public authority being the aggregator/integrator, there is a risk that there is not sufficient trust between operators and aggregator/integrator to open up their APIs.

In the *Regulated Utility MaaS* there is competition between the aggregator/integrators and so there is the opportunity for innovation in the mixes of mobility that can be provided to customers/users. Here, because the platform provider is regulated by the public authority, there is the opportunity, as with Public MaaS, to introduce discounts and incentivise arrangements for more sustainable outcomes. A potential problem, however, is to ensure the fair distribution of trips from the platform to the aggregator/integrator. As the platform provider is likely to be a public entity, it will be important that its creation is not subject to regulatory capture and that it is provided through a competitive process. As aggregator/integrators are likely to work with different softwares, as with Public MaaS, APIs will need to be shared for interactions to be made between the different softwares in use. Otherwise, other aspects, as discussed above under Walled Gardens, would apply.

It is difficult to see how a business model based on the status quo would work with *Mesh-y MaaS*, relying as it would on blockchain for payment with the potential for transactions between customers/users and mobility providers. Here, demand-side subsidy would be necessary, which could be integrated into the blockchain process. For public transport operators, this would require a steep learning curve to a new form of operation and a market approach to connecting directly with customers, which is not in today's framework. However, for society, it provides the opportunity to have subsidy also linked to behaviour change policies aimed at improving sustainability or other goals of the public authority.

There are other mechanisms to delivering subsidy (discussed in the previous section) which are more appropriate as MaaS becomes ubiquitous as the central means of mobility. First, an IPP could be made to the aggregator/integrator who would build this into the bundles. The customer need not notice any difference if the IPP reflects the average current trip subsidy. An incentive scheme could be devised so that customers would become better off if more public transport trips are made, thus providing an incentive to travel by public transport as the more sustainable mode. Second, and as an alternative, there could be a PCP made to citizens through a mechanism such as the tax return, the benefit process to provide the subsidy currently provided to public transport operators through contracts. In both these cases, the public transport operators would operate without subsidy and aggregators/integrators would contract for their services at full cost. This would, on the supply side, put all operators on a level playing field.

Removing subsidy from public transport operators may make the transport system more efficient but would require the public transport operator to have a good grasp of their costs. It is a risk that public transport operators, particularly in environments where there are many operators, do not understand their costs properly. In this context, a decision-based costing approach using avoidable cost would be the way in which the cost should be identified. Taking a fixed and variable cost approach to costing ignores the non-constant average cost of provision.

### What does "MaaS scaled up" mean?

The above discussion provides a polarity of viewpoints in terms of the pervasiveness of MaaS and associated business models. However, when might MaaS be considered as scaled up is an important question and one that will be influenced by local context.

Scaling up MaaS has at least three dimensions: a spatial dimension, quantity dimension and a mobility provider dimension. From a spatial perspective, MaaS could be considered as scaled up when it covers at least a labour market, for example, the metropolitan area of Helsinki or the Greater Sydney metropolitan area. For the quantitative dimension, MaaS will be considered scaled up when it passes some threshold of users. Quite what this threshold might be is difficult to identify but must be in excess of 50% of all trips in the spatial area. As far as mobility providers, MaaS should certainly be considered as scaled up when all mobility providers are providing services to users through at least one aggregator/integrator or platform. Stakeholder relationships are likely to be a critical influencer on the extent to which all or any of the above dimensions of scale are achieved.

To be considered scaled up would require all three of the above dimensions to be satisfied. This suggests that a transition will be necessary from the status quo to more demand-side subsidies as the scaling up of MaaS eventuates (if it does). The IPP and the PCP opportunities of demand-side subsidies offer considerable societal benefits over simply contracting operators by public authorities, even with mode agnostic contracts and contracts with incentive payments.

## Impacts of the pandemic for MaaS and the business models of public transport operators

It is important to consider the implications for MaaS business models, and indeed the future roles of public transport and shared mobility as a fall-out of the Covid-19 pandemic. Anticipating what is likely to happen in short, mid and long-term timescales in transport service provision is fraught with difficulty at the best of times. In the pandemic era, it is difficult to be certain when the "new normal" (which has been defined as occurring when we discover how the pandemic changed us) will be reached (in any location) and timescales have been disrupted by the arrival of second waves (as has been experienced in parts of Europe and in Victoria in Australia) and decisions about local versus national lockdowns. Is the long term when vaccines are sufficiently in use that social distancing is not needed? However, given the already elapsed time since the first peak and the subsequent rush for vaccines, this may be a very long way off.

This section first looks at the implications for public transport operators before turning to considering the impact on MaaS business models. The final part looks at the impact of autonomous vehicles since these will inevitably have an impact on the mobility landscape of the future.

## Implications for public transport operators

The onset of the Covid-19 pandemic in March 2020 led to a sudden collapse in trip making behaviour for all modes. The initial "stay at home directive" resulted in public transport usage collapsing to around 80% of pre-pandemic levels (although in April bus use in New York was down 97% compared to 12 months previously (Kamga et al., 2020)). This dramatic downturn has been accompanied by a consequent collapse in revenue for public transport with different parties shouldering the burden depending on the contracting regime. Ultimately, though most of the risk will fall on governments and this has important implications for the future of public transport. In the short-term, as the lockdown restrictions eased and the emphasis shifted from a stay at home focus to a staying safe one, the emerging trend has been one of private travel recovering rapidly and public transport struggling. By mid-June, Sydney as an example had returned to pre-pandemic levels of private car use but public transport was still down by around 50%[6]. Two months later public transport patronage has not recovered further on account of fears of a second wave of Covid-19. Biosecurity fears around the use of public transport are a significant explanatory factor for public transport patronage in the pandemic era. Beck and Hensher (2020) in their study of the impact of Covid-19 on household travel, work, activities and shopping in Australia conducted in early May 2020 report on the changing attitudes towards public transport hygiene: 58% reporting that they were Extremely Concerned over public transport hygiene, compared to 5% pre-Covid-19.

Another significant mobility trend associated with the pandemic has been an uptake in active travel with cities like Montreal removing some parking in downtown areas and transferring this space to pedestrians, while London has closed major central arterial routes to all but bus traffic to provide more space for pedestrians and cyclists. It should be noted though that micromobility modes such as shared bikes and scooters are reporting that their business models are struggling in the current environment.

## Implications for MaaS business models

This section discusses what the impacts of the pandemic may be for business planning for MaaS in the short, medium and long term, and how plans may need to be adapted not only for MaaS providers but also for public transport operators.

Since it is widely agreed that a strong public transport offer is the backbone of MaaS, any decline in public transport provision and use has a profound effect on the potential for MaaS and the viability of public transport operators. Thus, it is crucial that the decline in public transport seen in lockdown does not become much more permanent. In the short-term coming out of lockdown must be associated with public transport being still the mode that provides the greatest chance of a sustainable urban future. As public transport recovers, there could be a role for MaaS platforms to facilitate a potential booking system for public transport, and to apply different fares and priorities for different categories of traveller (Tirachini and Cats, 2020).

In the longer-term, mobility in our cities must change and with this, there are clear opportunities for MaaS and for public transport operators if public transport trips are the backbone of MaaS platforms. An important consequence of the pandemic is that there is strong evidence that working from home has been a hugely successful natural experiment showing that it is not necessary for many to travel each day. It may be that a person who previously commuted by public transport 5-days a week prior to Covid-19 will now only go to the office 2-days a week and will choose to do this by car. Whilst lost to public transport as a regular commuter, there is opportunity to ensure that their local travel needs (both work and non-work)

can be met by sustainable means. Thus, in the longer-term mobility policies need to be tailored to different age segments with land use planning addressing the demand for housing choice and different land uses.

For MaaS, in this time of uncertainty, it may be now that the non-mobility components and the non-mobility operators become important in order to preserve the vitality of the MaaS ecosystem thus widening the operators beyond public transport and other mobility operators. In this case, it is more appropriate to talk in terms of multi-service rather multi-modal MaaS. Given the pressure on public finances which has been precipitated by Covid-19 the Walled Gardens model, where the platform providers/integrators each have arrangements with the mode or mobility operators and (are in the longer run) supported by mode agnostic contracts, would seem to be the most suitable to encourage recovery.

### Implications of autonomous vehicles

Autonomous Vehicles (AVs) represent one of the anticipated developments of the future mobility landscape. As such, future trajectories for MaaS must be considered under both the presence and absence of autonomous vehicles (AVs) (Hensher et al., 2020, Chapter 8). Allied to this is the extent to which society can be encouraged to adopt a sharing culture towards transport provision. This is something that is likely to be influenced by the Covid-19 pandemic, which is changing user perceptions surrounding the safety of sharing smaller vehicles. An important potential impact of AVs for public transport operators is the decrease in operating costs leading to better cost recovery (although at the expense of employment in the sector). This could be important in a post-Covid world, as the decoupling of labour costs from service quantity will bring a step-change in the cost-effective provision of public transport. Furthermore, the inclusion of AVs has specific implications on the impact that the modal mix, offered through a MaaS subscription plan, has on the performance of the transport network (Hensher et al., 2020). The implications of AV for MaaS is thus an important area for further research.

## Further research

This paper has identified strategic issues in the development of Mobility as a Service (MaaS) and the implications for public transport operators' business models as a consequence. This paper has looked at different organisational permutations of stakeholders to seek answers to business planning for MaaS operators and public transport operators in a MaaS environment. It is clear that business model discussions are very much in their infancy, with key discussions and future research needing to be directed at understanding better the links between business models and organisational forms and governance.

A second important research question is what the transition between MaaS as niche and MaaS being pervasive might be. Alongside this, it is important to have more of an evidence-based discussion as to how other aspects of the business model -in particular different kinds of subsidy approaches – can help and reinforce the process. To date, the MaaS vision is predicated on public transport offerings being at the core of the MaaS concept but this established view is under threat by the Covid-19 pandemic. It is early days to know how the return to car use and the avoidance of public transport will affect long-term business model development.

In summary, research on these questions is necessary to resolve the added complexity to remaining questions around stakeholder relationships in the MaaS ecosystem and their organisational permutations (each of which need to be supported in terms of legislation and governance): the future role of subsidy for public transport including the important issue of scalability; the changing nature of the transport supply (both mobility and non-mobility providers) and the changing attitudes and preferences of customers.

# Notes

1 https://enfuce.com/enfuce-powers-payments-in-maas-globals-revolutionary-mobility-app/

2 https://www.sony.net/SonyInfo/News/Press/202004/20-030E/document.pdf, April 23, 2020.

3 A mode agnostic mobility contract is one where all modes are treated on a "level" playing field regardless of, inter alia, vehicle type, ownership structure or how services are funded (Hensher et al., 2020, Chapter 6). Or, in other words, public transport authorities should refrain from stating what modes an operator should utilise to deliver mobility (Hensher et al., 2020, Chapter 7).

4 https://www.news.com.au/technology/innovation/uber-unveils-new-feature-for-sydney/news-story/908f3d38d7e1c8691b4bb574f490e5eb, September 11th 2020.

5 It is not possible to do justice here to the different types of contract that could be issued by tendering and the type of contract clearly has a critical impact on the public transport operators' business plan. The Thredbo Conference series has been devoted to this topic since the 1989 and is a rich source of information, see https://thredbo-conference-series.org/.

6 Data generated by counting the number of requests made to Apple Maps for directions in select countries/regions, sub-regions, and cities. See https://www.apple.com/covid19/mobility/.

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International Transport Forum

# How Mobility as a Service Impacts Public Transport Business Models

To be successful, Mobility as a Service (MaaS) will need a model that can accommodate public and private transport providers in a financially sustainable way. This paper discusses MaaS systems led by the government and by the market. How can different business models provide better mobility for citizens, while also delivering on other objectives? The paper considers different methods of financing public transport operators and alternative ways of supporting services with subsidies. It concludes with a discussion of the possible long-term impacts of Covid-19 and the disruptive potential of autonomous vehicles in public transport.

All resources from the Roundtable on Integrating Public Transport into Mobility as a Service Roundtable are available at: www.itf-oecd.org/integrating-public-transport-mobility-service-maas-roundtable.

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