K2 WORKING PAPERS 2017:3

Drivers and Barriers for Integrated Mobility Services

A review of research

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Datum: 2017-04-25

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Preface

This research review is a contribution to the project: Institutional Frameworks for Integrated Mobility Services in Future Cities (IRIMS) funded by the Swedish innovation agency Vinnova. Emma Lund, Trivector Traffic, has performed the research with contributions from Johan Kerttu, Trivector Traffic, and Till Koglin, K2 and Lund university.

The IRIMS project aims i) to build knowledge of how existing institutional frameworks (e.g. societal regulations and planning processes, organizational models and cultures, policy instruments, consumption patterns, and individual habits and practices) affect urban transport, and ii) to propose policy recommendations on how the institutional frameworks can be modified to enable new, integrated mobility services that are capable of contributing to a transition towards increasingly sustainable travel. Integrated mobility services have been described as a new paradigm in which the traveller's transport needs are fulfilled by a service integrating the entire transport system into a synergetic ecosystem, but there are a number of challenges that must be addressed if this type of service is to become established. The interdisciplinary project brings together research on institutional barriers and enablers within the mobility domain and the development of new technologies and services. The project is based on case studies of new integrated mobility services that can eventually come to dominate the future urban context. A theoretical framework aids in the identification of institutional barriers and enablers for the development of integrated transport services (published in K2 Working Paper Series as Mukthar-Landgren et al 2016 *Institutional conditions for integrated mobility services. Towards a framework for analysis*). Scientifically based recommendations are developed in collaboration with relevant stakeholders. This report reviews previous research in the field, in order to identify areas of common ground as well as areas where further research is motivated.

Lund April 25, 2017

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Sammanfattning

När alltfler människor väljer att flytta till städer och urbana områden ökar också efterfrågan på transporter i städerna. Detta sätter inte bara stark press på miljö och klimat, utan också på möjligheterna att skapa attraktiva städer med en god livskvalitet. En överflyttning av transporter från bil till mer hållbara färdsätt är därför nödvändig. I detta sammanhang framhålls allt oftare integrerade mobilitetstjänster (på engelska Integrated Mobility Services, IMS, eller Mobility as a Service, MaaS) som en möjlig väg att driva en sådan omställning av transportsektorn. Som begreppet signalerar handlar det om att integrera en rad olika mobilitetstjänster (t.ex. kollektivtrafik, bilpool, lånecykelsystem, taxi etc.) och skapa en lösning som konsumenten upplever som en sömlös tjänst. Om olika mobilitetstjänster integreras på ett sätt som skapar förutsättningar för multimodala resor, ökat utnyttjande av befintliga fordon och högre beläggning skulle integrerade mobilitetstjänster kunna bidra till att lösa problem som trängsel, luftföroreningar och klimatutsläpp från transportsektorn och dessutom öka tillgängligheten.

Denna rapport ger en överblick över litteraturen om integrerade mobilitetstjänster, med särskilt fokus på vad tidigare forskning säger om hinder och möjliggörare för att implementera IMS. För att strukturera resultaten har ett teoretiskt ramverk med utgångspunkt i institutionell teori använts, som tidigare utarbetats i IRIMS-projektet. Här tillämpas ett brett institutionsbegrepp: institutioner sträcker sig från regelverk, planeringsprocesser och konsumtionsmönster till individuella vanor och praktiker. Institutionerna kan identifieras på flera olika nivåer: makronivån innefattar den nationella nivån där nationella visioner, planer och mål skapas, men även lagstiftning, skatteregler och liknande. Mesonivån inkluderar en rad institutioner: offentliga institutioner på regional och lokal nivå, privata organisationer, privat-offentliga hybrider och icke vinstdrivande organisationer. På mikronivå återfinns individen i hennes roll som medborgare och skattebetalare, men främst som konsument och användare av integrerade mobilitetstjänster. På alla tre nivåer (makro, meso och mikro) finns både formella (t.ex. lagstiftning) och informella (t.ex. normer) institutioner som kan fungera som både hinder och möjliggörare.

På makronivån har staten en viktig roll både när det gäller att skapa förutsättningar för implementering av nya integrerade mobilitetstjänster, och för att upprätthålla konsumentskyddet på denna nya marknad. Regelverket kring subventioner av kollektivtrafiken, och vilken roll kollektivtrafikoperatörerna kan ta i förhållande till integrerade mobilitetstjänster, framstår som ett centralt område. En relaterad fråga handlar om nya integrerade mobilitetstjänster i gränslandet mellan subventionerad kollektivtrafik och kommersiellt gångbara tjänster och vad detta innebär för vilka tjänster som bör subventioneras. Staten kan vidta en rad åtgärder för att skapa bättre förutsättningar för integrerade mobilitetstjänster, till exempel genom skattepolitiken (här framstår nuvarande lagstiftning om förmånsbilar som ett hinder), nya finansieringsprogram för pilotverksamhet, samt regelverk kring datahantering, standardisering och tillgängliggörande av data. På samhällsnivå finns starka förväntningar om att integrerade mobilitetstjänster ska kunna bidra till såväl minskad trängsel och reducerad klimatpåverkan från transportsektorn som ökad ekonomisk tillväxt och minskade sociala klyftor. Dessa positiva förväntningar fungerar också som en drivkraft för offentliga aktörer att skapa mer gynnsamma förutsättningar för integrerade mobilitetstjänster.

På mesonivån har kommuner och regioner möjlighet att skapa bättre förutsättningar för integrerade mobilitetstjänster genom den fysiska utformningen av infrastruktur för kollektivtrafik, bilpooler, lånecykelsystem etc. och genom att se till att dessa integreras på ett genomtänkt sätt. På den informella sidan är en viktig drivkraft för integrerade mobilitetstjänster de upplevda affärsmöjligheterna inom området, inte minst för privata företag. För att integrerade lösningar ska kunna komma på plats behöver dock många aktörer samarbeta. Samarbetet kan organiseras i ett ”ekosystem” av aktörer, där ett flertal aktörer bidrar med tjänster från sin kärnverksamhet till helheten som är den integrerade mobilitetstjänsten. Om en integrerad tjänst ska realiseras inom en rimlig tidsram behöver dock någon

aktör ta initiativet. För att systemet ska kunna överleva på sikt måste alla aktörer i ekosystemet också få ut något av sin medverkan. En intressant dimension har att göra med vad olika aktörer ser som sin roll i ekosystemet, och vilka implikationerna det får beroende på vem som tar kommandot i processen. Det är fortfarande oklart vilken typ av aktör som kommer att ta på sig rollen som tjänsteintegratör och vara ansiktet utåt mot kunden. Denna fråga är intressant inte minst därför att så många olika typer av aktörer är aktiva på marknaden för integrerade mobilitetstjänster – förutom kollektivtrafiken och bilindustrin har såväl telekombranschen som detaljhandeln och mediebolag visat intresse. Det är fortfarande en öppen fråga i vilken utsträckning dessa aktörer konkurrerar med eller kompletterar varandra. Kollektivtrafiken anses i allmänhet utgöra ryggraden i integrerade mobilitetstjänster, och många kollektivtrafikoperatörer vill gärna ta ledningen i utvecklingen av nya integrerade tjänster som de ser som ett komplement till sitt befintliga tjänsteutbud. Samtidigt kan privata tredjepartsaktörer framstå som bättre lämpade att skapa attraktiva erbjudanden som inte fokuserar på traditionella kollektivtrafikresenärer. Kollektivtrafikoperatörerna avgör själva om de är beredda att sälja biljetter till kollektivtrafiken genom kommersiella mobilitetsoperatörer, vilket potentiellt skulle kunna bli ett avgörande hinder för kommersiella aktörer som vill ge sig in på marknaden för integrerade mobilitetstjänster. Integrerade mobilitetstjänster förutsätter också en mobilitetsplattform som kombinerar olika trafikslag till en sammanhängande tjänst, och här fungerar den snabba teknikutvecklingen som en stark drivkraft. En rad sådana plattformar är nu tillgängliga, även om bara ett fåtal har testats i andra sammanhang än mindre pilotstudier.

På mikronivån går det att identifiera flera övergripande samhällstrender som bidrar till att skapa gynnsamma förutsättningar för integrerade mobilitetstjänster. Utvecklingen mot allt tätare stadskärnor skapar incitament för invånarna att överväga alternativ till privat bilägande. Förändringar i kostnaden för att äga och köra bil skulle också kunna påverka efterfrågan på integrerade mobilitetstjänster. Det ökande intresset för ”delandeekonomi” innebär också att tjänster av detta slag får ökad acceptans bland konsumenterna. Forskningen om integrerade mobilitetstjänster identifierar flera olika möjliga fördelar för konsumenten, t.ex. individuellt anpassade tjänster, enklare bokning och betalning, dynamisk reseinformation och möjlighet att ta hänsyn till personliga preferenser vid reseplanering. Den främsta kundgruppen är sannolikt ”flexiresenärerna”, som ofta kan resa med kollektivtrafik men också regelbundet har behov av andra färdsätt. Denna grupp upplever integrerade mobilitetstjänster som ett prisvärt alternativ till att äga egen bil, och har en stor betalningsvilja. Forskning inom beteendeekonomi visar dock att konsumenter generellt tenderar att övervärdera nyttan av en befintlig lösning och undervärdera potentiella vinster, vilket resulterar i status quo-bias. Att attrahera en tillräckligt stor kundgrupp för nya integrerade mobilitetstjänster kommer därför att bli en utmaning.

Summary

As more people move to cities and urban areas are growing, demand for urban transport increases. This leads not only to pressure on sustainability and climate goals, but also on the attractiveness and liveability of urban areas. Thus, it is necessary to decrease the use of private cars and create a modal shift towards more sustainable modes of transport, such as walking, cycling and public transport. In this context, the introduction of Integrated Mobility Services, IMS (or Mobility as a Service, MaaS), is more and more often brought forward as one key driver to enable such a shift. As the term suggests, integrated mobility services integrate a range of mobility services (e.g. public transport, car sharing, bike sharing, taxi etc.) and provides one-stop access to all services through a common interface, hence creating a seamless customer experience. If different transportation modes are combined in a manner that enables multimodal travel and increases vehicle utilisation rates and vehicle occupancy, such services could help cities deal with problems such as urban congestion, transport-related pollution and accessibility.

This paper reviews the literature on Integrated Mobility Services with a focus on what previous research says about drivers and barriers for implementing IMS. To structure the results, the review is guided by the analytical framework of the IRIMS project. This framework draws upon institutional theory, which defines institutions broadly; ranging from societal regulations, planning processes, and consumption patterns, to individual habits and practices. Furthermore, these institutions are found at various levels: the macro level includes the national level where national visions, action plans and goals, as well as legislation, subsidies and taxes are generated. The meso level includes a variety of institutions; public institutions on the regional and local levels, private organisations, public/private hybrids and not-for-profit civil society actors. Finally the micro level includes the individual in her capacity as citizen, as taxpayer, but primarily as customer and user of IMS. At all three levels (macro, meso and micro), barriers and enablers can be both formal (e.g. legislation) and informal (e.g. norms).

On a macro level, government has an important role in relation to integrated mobility services both related to creating preconditions for implementing IMS, and to protecting public interest. The subsidization of tickets for public transport, and the implications of this for the role of Public transport within IMS seems to be a key issue, and a related question concerns the boundaries between state subsidized mobility services and commercially viable services, and how these can be combined in IMS solutions. The government could also use taxation policy, financing programs and regulations concerning data availability and standardization as measures to create an enabling environment for IMS. The discourse surrounding IMS at societal level is a strong driver for action, with IMS being presented as a panacea able to solve problems ranging from urban congestion and climate impact of transportation to economic growth and social inclusion.

On the meso level, regional and local authorities have an important role to create an enabling environment for IMS regarding the physical infrastructure for public transport, bike infrastructure, car-sharing services etc. On the informal side, a major driving force for getting IMS up and running is the perceived business opportunity in the nascent IMS market, not least for private actors. Several actors need to collaborate for a scalable integrated mobility service to materialize. This can be organised in a "business ecosystem", where multiple actors add services from their core businesses into a whole that constitutes the integrated mobility service offering. If an offer of integrated mobility services is to emerge within a reasonable timeframe, one actor within the business ecosystem needs to take the lead, but in order for the system to survive, all required actors in the ecosystem must benefit from its existence. An interesting dimension relates to what different actors in the IMS ecosystem perceive is their role in relation to new mobility services, and the implications of different actors taking the lead. It is yet unclear who will/should take the role as service integrator. The question of different actors finding their role in the IMS ecosystem is made even more interesting by the fact that not only automotive OEMs and public transport operators are looking into ways of innovating using IMS, but also telecom, retail and media organisations. The extent to which these different actors, from different

backgrounds, complement or compete with each other is a question yet to be settled. Public transport is generally seen as a backbone in integrated mobility services, and many public transport operators wish to take the lead in the development of new services, which they see as a complement to their existing services. On the other hand, private third party organisations could be seen as better suited to create service offerings that cater to other customer groups than the traditional public transport customers. The decision to sell public transport tickets through a commercial IMS integrator lies with the public transport operators, which could be a substantial barrier to IMS implementation with commercial IMS integrators. Integrated mobility services require a mobility platform that combines the different modes into one integrated service, and a major enabler for IMS is hence the rapid development within ICT. But although a number of such platforms are now available at the market, only a few of these have been tested in other contexts than smaller pilots.

At the micro level, several trends are supportive of IMS. Increased densification of city centres creates incentives for citizens to consider alternatives to own their own car. Changes in the cost of owning a car could also have a large impact on the demand for IMS. Furthermore, the growth of the "sharing economy" means services such as IMS are gaining more acceptance among consumers. Research on IMS point to several kinds of potential customer benefits, such as personalised service, ease of transaction, ease of payment, dynamic journey management, and journey planning based on personal preferences. The primary customer base is likely to be "flexi travellers" who can often travel by public transport but also need other means of transport on a regular basis. This customer base will experience a well-functioning integrated mobility service as a very price-worthy alternative to private car ownership, and thus have a high willingness to pay for it. However, research within behavioural economics shows that customers generally tend to overvalue current benefits and undervalue potential gains, resulting in a *status quo* bias, which means attracting enough customers to a new type of mobility service will be a challenge.

1. Introduction

Urbanisation is a strong trend all over the world. According to the UN, it is expected that by 2030 nearly 5 billion (61%) of the world's 8.1 billion people will live in cities. As more people move to cities and urban areas are growing, demand for urban transport increases. This leads not only to pressure on sustainability and climate goals, but also on the attractiveness and liveability of urban areas. Thus, it is necessary to decrease the use of private cars and create a modal shift towards more sustainable modes of transport, such as walking, cycling and public transport. In this context, the introduction of Integrated Mobility Services, IMS (or Mobility as a Service, MaaS), is more and more often brought forward as one key driver to enable such a shift. As the term suggests, integrated mobility services integrate a range of mobility services (e.g. public transport, car sharing, bike sharing, taxi etc.) and provides one-stop access to all services through a common interface, hence creating a seamless customer experience. If different transportation modes are combined in a manner that enables multimodal travel and increases vehicle utilisation rates and vehicle occupancy, such services could help cities deal with problems such as urban congestion, transport-related pollution and accessibility.

Integrated mobility services have been high on the agenda for some time now, but has still not been broadly implemented. This working paper was written within the IRIMS project, which takes as its point of departure the need to identify the institutional conditions influencing the establishment of integrated mobility services, including both potential barriers and enablers. The aim of the paper is to review previous literature on IMS in order to give an overview of previously identified enablers and barriers to IMS implementation, drawing upon the analytical framework developed within the IRIMS project for organising the results of the literature review (Mukhtar-Landgren et al 2016).

As IMS has not yet been implemented broadly, empirical research is still rather limited. Hence, the paper grasps both academic and "grey" literature. The authors are aware that other research might have been carried out that is not part of this overview.

1.1. Method

The method used for gathering knowledge was partly a literature search with the following search words:

- "integrated mobility"
- "mobility as a service"
- "combined mobility"

The search was carried out in GoogleScholar in order to gather scientific research articles and papers that deal with integrated mobility services (IMS). Additional literature was identified through tracing the references of the most relevant publications identified in the initial search.

The paper reviews the literature on IMS with a focus on what previous research says about drivers and barriers for implementing IMS. To structure the results, the review was guided by the analytical framework of the IRIMS project, which is presented below.

1.2. Introduction to the analytical framework

The analytical framework of the IRIMS project draws upon institutional theory, which defines institutions broadly; ranging from societal regulations, planning processes, and consumption patterns, to individual habits and practices. Furthermore, these processes are found at various levels: the macro level includes the national level where national visions, action plans and goals (which may or may not be derived from the European Union), as well as legislation, subsidies and taxes are generated. The meso level includes a variety of institutions; public institutions on the regional and local levels, private organisations, public/private hybrids and not-for-profit civil society actors. We have identified collaboration and business models as two aspects that are particularly relevant to understand actors'

motives and relationships at the meso level. Finally the micro level includes the individual in her capacity as citizen, as taxpayer, but primarily as customer and user of IMS. At all three levels (macro, meso and micro), barriers and enablers can be both formal (e.g. legislation) and informal (e.g. norms). The analytical framework is summarised in *Figure 1* below.

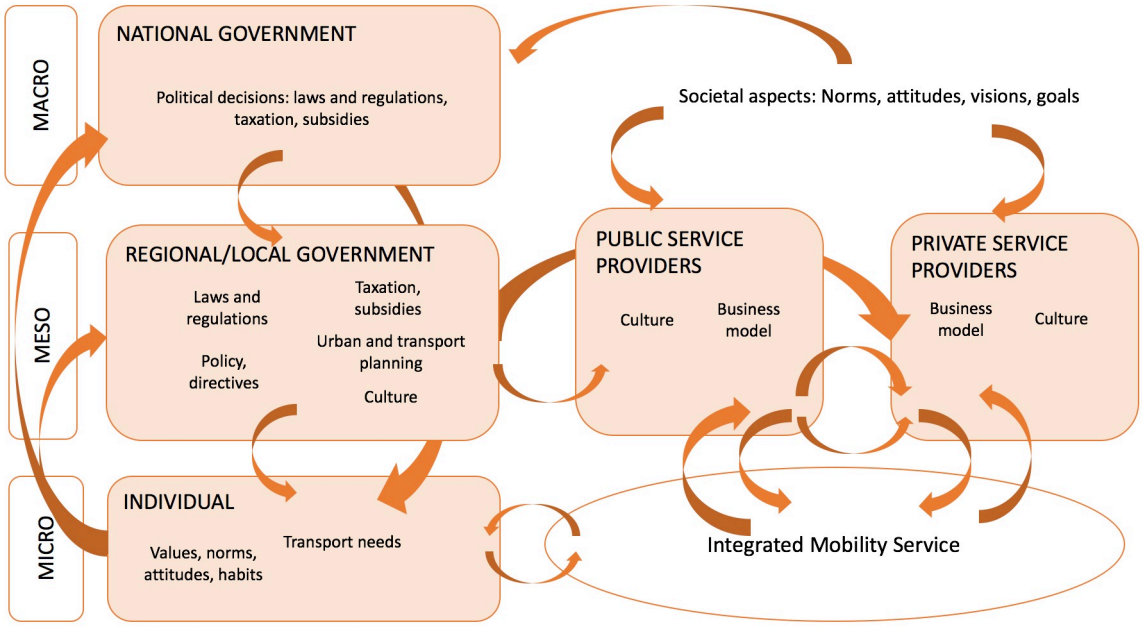

Figure 1. Summary of analytical framework of IRIMS project. Source: Mukhtar-Landgren et al 2016.

1.3. Outline of the paper

The paper is structured in accordance with the analytical framework presented above, with section 2 focusing on what previous literature says about drivers and barriers at macro level, section 3 focusing on drivers and barriers on meso level and section 4 on micro level. Section 5 concludes.

2. Drivers and barriers at macro level

2.1. Formal dimension

2.1.1. Legislation

Government has an important role in relation to integrated mobility services both related to creating preconditions for implementing IMS, and to protecting public interest. Goodall et al. (2017) point to the importance of the government to safe-guard safety and security as well as addressing environmental concerns. However, it is key to find the right level of regulations, where the public interest is served, but where the private sector still finds it easy to participate and innovate (ibid.). According to König et al. (2016), the focus of regulation should be in "ensuring transparent market conditions and fair market performance and securing the legal position of consumers and travellers".

Legislation in many countries today acts as barrier for innovation and change in the transport sector, with regulations concerning e.g. the taxi market, who has the right to sell tickets for public transport etc (Trafikanalys 2016).

An important issue relates to the subsidization of tickets for public transport. In Sweden as well as in many other countries, public transport tickets are subsidized by the state, which has implications for how public transport operators are allowed to sell their tickets. Furthermore, if IMS means that many different forms of mobility services are combined, the boundaries between public transport and other services such as taxi, carpooling etc become blurred, which may have implications for which mobility services it is reasonable for the state to subsidize (Trafikanalys 2016). An important question hence concerns the boundaries between state subsidized mobility services and commercially viable services, and how these can be combined in IMS solutions (Finger et al, eds., 2015). In the case of the Ubigo trial in Gothenburg in 2014, one of the main barriers for continuing the service after the pilot phase was that due to present laws and regulations the public transport operator could not continue as a service provider in a regular business context (Karlsson et al. 2016).

In Sweden, many municipalities perceive national legislation does not give them the right to allow car-sharing stations on public land, as this would violate the principle of treating all citizens equally (Trafikanalys 2016). This creates a barrier for municipalities who wish to support the spread of car-sharing services, allegedly an important part of most IMS solutions being discussed. However, a recent public inquiry on measures to promote circular economy in Sweden suggests that this legislation should be changed (SOU 2017:22).

2.1.2. Taxation

The extent to which the development of IMS is perceived to be a threat to the current models for taxation and financing of infrastructure, as well as models for collecting revenue from existing transport services, may constitute a barrier for supporting innovation. However, new transport services are likely to present new opportunities for revenue and tax income, perhaps based on data from connected travellers' actual infrastructure use and time of use (McKinsey&Company, Bloomberg New Energy Finance 2016).

In Sweden, several investigations are right now looking into the implications of the new sharing economy (Trafikanalys 2016). The Swedish Tax Agency has performed a mapping of tax-related effects of the sharing economy, and concluded that on the one hand there is no reason to tax peer-to-peer services at a lower level than traditional services, but that on the other hand there is a risk that complex regulations increase the risk for mistakes, especially as control of peer-to-peer transactions is low (Skatteverket 2016).

Tax legislation could also create barriers for behavioural change. In Sweden, current tax-legislation for subsidized company cars constitute a significant lock-in factor for commuters to continue travelling by

private car (Holmberg et al. 2016). This legislation is now up for change, with suggested alterations in the proposed budget for next year increasing the costs for individual users with potentially hundreds of Euro/month (DN 2017-03-27). Such a change may contribute to increased demand for new mobility services

2.1.3. Financing

König et al. (2016) identify a major role for the public sector as an enabler of IMS pilots. Goodall et al. (2017) also point out the opportunity for governments to support the development of new, integrated mobility services through establishing governmental programs. Karlsson et al. (2016) conclude that for the Ubigo trial in Gothenburg, one of the barriers for continuation was the lack of financial support. Although the pilot was successful, and a company was formed, neither of the stakeholders involved, nor governmental financial bodies were able to support further development, primarily because of institutional barriers.

2.1.4. Availability and standardization of data

The rapid development within IT and smart cities, with integration of different forms of open data is a necessary precondition for the development of integrated mobility services (Hultén, ed., 2016). König et al. (2016) similarly point to working ICT infrastructure and open APIs as vital elements in making IMS a reality, but also intelligent and connected infrastructure. Standardization of data is hence one important role for the state to enable the development of IMS (Finger et al, eds., 2015).

2.2. Informal dimension

2.2.1. Framings of IMS at societal level acting as drivers and barriers

Important drivers for integrated mobility services at societal level include urbanisation, congestion and environmental issues in cities. Integrated mobility services are by many seen as part of the solution to these problems (Finnish Transport Agency 2015). IMS is also seen as potentially contributing towards increased mobility by other means than car, which would also create opportunities for growth (Movia 2017). IMS could also be seen as a first step towards harvesting the potential benefits of autonomous vehicles, which will be attained only if vehicles are shared and publicly available (Movia 2017).

On the other hand, a potential barrier for policy makers at different levels to support the development of IMS is the risk that private actors will tend to perceive a strong customer demand for car travel, and therefore develop services that focus on a high degree of car access and travel. Such services will likely counteract contemporary transport policy and measures to reduce car travel and increase the share of more sustainable transport modes (Transport Systems Catapult 2016).

A parallel discourse that acts as a driver for public actors to support IMS is the perceived potential for IMS to contribute to economic growth. This is obvious not least in the Finnish context, where public authorities have taken a very active role in promoting IMS (or MaaS), with the purpose of turning Finland into a “MaaS living lab” to promote innovation and attract investments (see e.g. Finnish Transport Agency 2015).

3. Drivers and barriers at meso level

3.1. Formal dimension

3.1.1. Providing the physical infrastructure

One important challenge for creating a well-functioning IMS is institutional coordination, which is needed to integrate information, ticketing, scheduling and physical planning to create a seamless travel experience for passengers (Feng 2014). Feng (2014) uses the term "seamless intermobility" to describe this ideal, distinguishing between the four dimensions Seamless information, Seamless time (reduced waiting times), Seamless space (short distances between modes) and Seamless service. Also Goodall et al. (2017) point out integration of physical infrastructure as an important enabling factor. Franckx and Vito (2015) point out the provision of necessary infrastructure for bike-, ride- and carsharing in the neighbourhoods of important public transport hubs as one important role for public authorities to support the development of integrated mobility services. In most countries, regional and local actors are responsible for implementing these types of measures, often in close collaboration with public transport agencies and operators, and this is an area where public actors at local and regional level could do a lot to enable IMS.

3.2. Informal dimension

3.2.1. The business opportunity

At meso level, a major driving force for getting IMS up and running is the perceived business opportunity in the nascent IMS market, not least for private actors. Comparisons with other industries, which have already undergone a similar transition due to digitalisation are frequently made (Finger et al, eds., 2015). Another driver for investment in IMS is the amount of money that households spend on mobility. In Great Britain the average household spends £300/month on mobility, which means there is a large market to exploit for actors that are able to attract customers through new, innovative transport solutions (Transport Systems Catapult 2016). Another driver for both public and private investors and operators in the IMS market is the fact that many of today's journeys involve travellers experiencing some type of frustration, such as parking problems when driving a car and lack of personal space when using public transportation. As many as 75 % of journeys today involve issues that travellers find frustrating (ibid.).

Many car manufacturers feel that they need to position themselves on the new market, and have begun developing new services themselves or established collaboration with e.g. car sharing companies (Trafikanalys 2016). Kessler and Stephan (2013) provide an interesting analysis of the motives for the automotive industry to diversify into services such as IMS. However, their conclusion that this transition in 2013 was not yet happening, as the automotive industry did not connect their services to the hardware business, today seems obsolete. A barrier for IMS development and innovation within the automotive industry is the fact that hardware engineers currently outnumber software engineers in the work force of automotive OEMs, 11 to 1. This presents a challenge for companies interested in shifting their offer to consumers, from private cars to mobility services (McKinsey&Company, Bloomberg New Energy Finance 2016).

The electrification of personal transportation also creates a synergy effect with shared vehicles, as electric vehicles (EVs) have a high up front cost but a low marginal cost for each kilometre travelled. This favours the more intensive vehicle use that sharing results in. Vehicle sharing thus motivates investing in EVs, which in turn boosts development of new batteries and electric engines, making new EVs, as well as vehicle sharing, cheaper and more affordable to consumers (McKinsey&Company, Bloomberg New Energy Finance 2016).

3.2.2. Collaboration and coordination

Several actors need to collaborate for a scalable integrated mobility service to materialize (Holmberg et al. 2016). Especially in bigger countries, coordination is also a big challenge. If long-distance and urban services are to be combined, this requires separate negotiations with a large number of operators (Finger et al, eds., 2015).

Among the respondents to a questionnaire sent out by researchers in the MaaSiFiE project, most of the stakeholders believed that a lack of cooperation and lack of available business models are potential barriers to the implementation of IMS, and that there is a need to refine available business models and support public-private partnerships in order to setup an appropriate framework (König, Sochor and Eckhardt 2016). This can be organised in a "business ecosystem", where multiple actors add services from their core businesses into a whole that constitutes the integrated mobility service offering (Holmberg et al. 2016). If an offer of integrated mobility services is to emerge within a reasonable timeframe, one actor within the business ecosystem needs to take the lead, but in order for the system to survive, all required actors in the ecosystem must benefit from its existence (Holmberg et al. 2016). This is true also for local authorities, who are often in charge of local public transport, and whose support therefore is necessary to bring IMS alive (König et al. 2016). Experience shows that strong support from a city's top management is critical for the establishment of broad partner ecosystems and the successful implementation of integrated mobility solutions (Van Audenhove et al. 2014).

The risk of losing brand exposure and a direct relationship with the customer if joining an IMS scheme is perceived as a threat to many service providers, both public and private (Holmberg et al. 2016; Sochor et al. 2015). On the other hand, participating in an IMS scheme means there is a potential to access new customer groups, which may also be more strongly linked to the service providers participating in the scheme (Holmberg et al. 2016).

An interesting dimension relates to what different actors in the IMS ecosystem perceive is their role in relation to new mobility services, and the implications of different actors taking the lead. It is yet unclear who will/should take the role as service integrator. The question of different actors finding their role in the IMS ecosystem is made even more interesting by the fact that not only automotive OEMs and public transport operators (perhaps the most obvious IMS operators, given the consumer demand for car travel and the central role of public transportation in large cities) are looking into ways of innovating using IMS, but also telecom, retail and media organisations (Transport Systems Catapult, 2016). The extent to which these different actors, from different backgrounds, complement or compete with each other is a question yet to be settled.

3.2.3. The role of public transport

Public transport is generally seen as a backbone in integrated mobility services, and experience shows that ride- and car-sharing works best in areas where public transport is strong. Similarly, Uber and taxi have the highest pick-up rates in areas where public transport is a good option as well (UITP 2016). Some public transport operators wish to take the lead in the development of new services, which they see as a complement to their existing services. In Germany, the main railway provider has been working for years towards becoming a true mobility provider, also offering car- and bike-sharing Finger et al, eds., 2015). Those who have already been active in the market of intermodal transport for some time have experienced various problems, such as legal uncertainties, coordination problems as well as lack of real business cases for combined offers (ibid.). Other public transport operators still take a more hesitant position, waiting to see how the market develops. Public transport could in principle sell their tickets through the commercial IMS integrator on a concession basis, which (at least in a Swedish setting) does not seem to meet any legal barriers. However, the decision to sell public transport tickets through a commercial IMS integrator lies with the public transport operators, which could be a substantial barrier to IMS implementation (Holmberg et al. 2016).

Based on interviews with relevant actors in the Greater Copenhagen area, Rooijakkers (2016) concludes that public transport companies seem to prefer a model where public actors play an active role in getting IMS up and running, either in the form of a new public actor taking the role of IMS integrator, or in the form of a public-private partnership where public actors create the IMS platform and private actors use this platform to provide a variety of IMS solutions. There are two main reasons that public actors prefer a public entity to take the lead in this process. One is that they believe collaboration will be smoother as a public actor will enjoy more trust among other public actors. The second reason is that they doubt there would be an interest from the part of private actors to set up an IMS scheme in Copenhagen within the near future (Rooijakkers 2016). However, results from Movia's Request for Information-process carried out in October 2016 indicate that the market was more mature than expected, and that several actors are available to step in as service provider, platform provider, or both (Movia 2017).

3.2.4. Implications of different actors taking the lead

Depending on who takes the role of IMS integrator, implications differ. As public transport is generally seen as the backbone of IMS, it could be perceived as a natural step that an existing public transport operator or a regional transport agency would take this role. On the other hand, an external and independent actor would not have previous commitments and would thus be more free to arrange new service combinations as they deem appropriate (König et al. 2016). It might also be easier to attract new customers to a new integrated mobility service if the service is less connected with existing mobility providers (e.g. public transport) but instead is branded as a new, smarter mobility service (Holmberg et al. 2016). However, Trafikanalys (2016) point out that if the market for mobility services turns out to include a large number of various services without interconnections, there is a risk that the individual traveller perceives the system to be too complicated. If public transport takes the role as coordinator of the integrated mobility service, the service would most likely be designed to maximise use of the existing public transport system, rather than maximising customers' service satisfaction (Holmberg et al. 2016). The advantages of public transport taking the lead is that this would guarantee a longitudinal stability to the service, and a regional coverage (Holmberg et al. 2016). If a commercial actor takes the role as integrator, there would probably be more focus on maximising the number of subscribers (Holmberg et al. 2016). It is not evident that cities' drivers for implementing IMS match with expectations of all participating service providers. From the perspective of e.g. a car-sharing company, it might become problematic if customers use their services less than expected. This was the case in the Ubigo trial, where participants in average purchased 30 % more car hours than used (Sochor et al. 2015).

As IMS is a new area to most actors, participating mobility providers may experience a large amount of uncertainty as they do not know what their participation in an IMS scheme might lead to in the long run. In relation to the Ubigo case, Karlsson et al. (2016) conclude that participation in such a scheme could potentially involve modifications in terms of pricing, change of identity and new types of customer relationships (Karlsson et al. 2016).

3.2.5. Technical preconditions: platform, availability of data etc.

Integrated mobility services require a mobility platform that combines the different modes into one integrated service. A major enabler for IMS is hence the rapid development within ICT. Traditional software platforms and solutions can now be replaced by software services hosted on a third-party cloud infrastructure delivering end-to end functionalities (Ambrosino et al. 2016). Smartphones and tablets, as well as the outbreak of apps, is a related enabler, that allows the creation of complex apps for travel planning, booking and ticketing which helps improve transport accessibility (Ambrosino et al. 2016). A third major enabler for IMS is the development of open data, and not least the growing adoption of open data services by both public authorities and private service providers. The number of cities which are providing open access to transport data and services is growing and now include cities

as Lonfon, Paris, Rome and Amsterdam. Similarly, private service providers within e.g. car-sharing and bike-sharing are also providing open data for integration in third-party services. This enables the creation of multimodal services (Ambrosino et al. 2016).

One important question concerns who should be responsible for setting up such platforms. Many transport operators have set up similar services before, but IT manufacturers are also getting into the market. From a technical perspective, the solutions needed in order to implement IMS solutions on the ground already exist (Finger et al, eds., 2015; Movia 2017). However, Laurell (2017) concludes that although a number of such platforms are now available at the market, only a few of these have been tested in other contexts than smaller pilots.

The availability of data might still imply some difficulties, not least when it comes to establishing the necessary trust between data providers and data users (Finger et al, eds., 2015). As individual service providers are not likely to share their app data, having a third party involved as intermediary data provider can potentially remove some of the barriers to cooperation (Goodall et al. 2017).

Solving integrated payment in cases where one trip spans several modes of transportation with multiple providers has proven to be complicated, not least because of the complicated fare structures of participating mobility providers. One stumbling block is to be able to ensure that each mode is being appropriately compensated for its share in the trip (Goodall et al. 2017).

Melis et al. (2017) look into the risk of insider threats to IMS schemes, and concludes that an IMS platform involving many different operators and users is particularly sensitive to insider threats. Potential threats involve e.g. data leakage, data manipulation, fake data injections and denial of service, due to sabotage, espionage, misuse of fraud. However, a range of strategies for reducing these risks exist, and problems should be possible to handle.

3.2.6. Business model

A critical factor for achieving a functioning business is to reach a critical mass of users. Here, a customer base needs to be identified which on the one hand has sufficient spending power, but on the other hand is big enough to provide the critical mass needed to make services work (Finger et al, eds., 2015).

If schemes are kept at a regional level, the low level of margin on revenues from the sale of tickets makes it likely that local public transport authorities will have to take the role of integrated mobility platform provider (Van Audenhove et al. 2014). If schemes are carried out at national level, there are numerous candidates to take on the role of mobility platform operator, such as connectivity providers, internet businesses, automotive OEMs, financial institutions and payment providers. Here, first mover advantage will prove a key success factor (Van Audenhove et al. 2014). In order to succeed, the actors who wish to turn the vision of integrated mobility into reality need both creativity and entrepreneurship (Van Audenhove et al. 2014). In practice, however, it is often difficult to take the step from pilot to market. In the Ubigo case, the participating actors most likely considered the pilot a project, which they expected to end (Karlsson et al. 2016).

As integration becomes deeper, passenger rights and liability issues become more important. What happens if something goes wrong at one point in the travel chain? Here, IMS solutions can learn from the airline industry, which has put some effort into clarifying the rights of travellers that book over online platforms or travel agencies (Finger et al, eds., 2015).

3.2.7. Drivers at city level

For cities, an important driver for implementing IMS is congestion, and the space used for parking as cars are in average used only 4 % of time. Some cities also see IMS as a way to use resources in the transport system more efficiently, and thus as a way to save money (Finger et al, eds., 2015).

A Transport Systems Catapult report (2016) suggests IMS may support the traffic impacts of new developments, having to do with the ability of cities to initiate infill projects that densify city centres without adding to congestion problems and demand for parking involving wasteful land use and/or high costs for parking structures. The report also points out the potential social benefits of IMS, as a part of the sharing economy, in contributing to social cohesion through ridesharing and carsharing. One might also think of IMS as a way to reduce social exclusion, by offering affordable access to a richer supply of means of transport for households lacking the financial means to access car travel by means of private ownership.

Initially, IMS is most likely to be implemented in urban areas, as this is where the biggest demand is. However, if IMS is to support social objectives of accessibility and social inclusion, coverage of IMS must grow over time to include also suburban and rural areas (Holmberg et al. 2016). In rural areas, IMS could potentially be combined with subsidized transportation such as school transportation and statutory social service transportation (König et al. 2016).

4. Drivers and barriers at micro level

It is not evident to distinguish between formal and informal institutions at micro level, that is at the individual level. Formal institutions are mainly laws and regulations, and although individuals interact with these institutions at micro level, the institutions are implemented at macro and meso level. This section will hence focus solely on the informal dimension.

4.1. Societal trends driving demand for IMS

The current trend towards increased densification of city centres creates incentives for citizens to consider alternatives to own their own car. Changes in the cost of owning a car could also have a large impact on the demand for IMS. Car sharing companies are now experiencing an upsurge with number of members increasing, especially in bigger cities (Trafikanalys 2016).

Another enabling trend is the growth of the "sharing economy" which is getting more acceptance among consumers, creating better conditions for new services such as IMS. The recent economic downturn has also worked as a driver towards more sharing of resources, not least within the transport sector (Trafikanalys 2016). Among young generations, the car is no longer a status symbol, which makes IMS a more attractive alternative. Furthermore, social media are also making physical connectedness less important among young people (Finger et al, eds., 2015). The rise of the sharing economy and likely reduced number of privately owned cars were also identified as two main enablers for IMS among the respondents to a questionnaire sent out by researchers in the MaaSiFiE project (König, Sochor and Eckhardt 2016).

In a report for Samtrafiken (a Swedish association for public transport operators), Laurell (2017) identifies a number of trends in customer behaviour that should be taken into account when developing new mobility services:

- Customers are always connected, not least through their smart phone
- Customers are used to being able to search for information and buy services directly through their smart phones
- Customers are used to have access to a broad supply of services where you sometimes pay-as-you go, and sometimes subscribe, depending on what you prefer
- Customers want easy and individualized solutions
- Customers are part of a range of social networks, and are potentially influenced by what their peers do, feel and believe.

Goodall et al. (2017) state that to work effectively, IMS would require widespread penetration of smart phones on 3G/4G/5G networks. Although smart phone penetration in Sweden is high and increasing, Trafikanalys (2016) conclude that a fair share of people over the age of 75 still do not have access to a smart phone, which reduces their possibilities to use new services. In other national contexts, the share of population having access to a credit card could also be a factor limiting the uptake of new IMS solutions.

4.2. The added value of IMS from a consumer perspective

Research on IMS point to at least five different kinds of potential customer benefits (Kamargianni et al. 2016):

- Personalised service, building upon a relationship between the customer and the MaaS provider in anticipating and providing the relevant travel choices
- Ease of transaction, convenient access to different transport operator services by a range of devices (e.g. smartphones)
- Ease of payment, customers can pay for mobility by many different schemes (such as pay-as-you-go, pre-pay, post-pay or monthly subscription)

- Dynamic journey management, providing customers with real-time information on their journeys
- Journey planning, services allowing customers to plan their journeys based on personal preferences (eg. cost, time, comfort)

Previous studies show that the integration of ticketing and payment between different public transport operators has had a positive effect on ridership in public transport systems in e.g. London and Paris (Kamargianni et al. 2016). The integration of different travel options into one service was also appreciated by customers in the Ubigo field trial (Sochor et al. 2015). Access to carsharing site nearby critical factor to make IMS an attractive alternative. This is difficult to provide in residential areas, with uneven capacity demand (Sochor et al. 2015).

4.3. Who is the main customer?

Hinkeldein et al. (2015) build on previous studies to identify 6 different mobility typologies, with different likelihood to start using IMS. Among the six typologies (Traditional car-lovers, Flexible car-lovers, Urban-oriented public transport-lovers, Conventional bike-lovers, Ecological public transport- and bike-lovers, Innovative technology-loving multioptionals) three groups stand out as especially inclined to use integrated mobility services: Ecological public transport- and bike-lovers; Flexible car-users and Innovative technology-loving multioptionals. These three groups account for 17 % , 21% and 20 % respectively of total population in the sample (n = 2400).

These results are confirmed by results from the Ubigo trial in Gothenburg, which show that the primary customer base is neither families that are daily dependant on the car, nor the customers whose mobility needs are well catered for by public transport, but rather the "flexi travellers" who can often travel by public transport but also need other means of transport on a regular basis. This customer base will experience a well-functioning integrated mobility service as a very price-worthy alternative to private car ownership, and thus have a high willingness to pay for it (Holmberg et al. 2016).

4.4. Drivers and barriers for take-up of IMS

Sochor et al. (2014) performed interviews with users of the Ubigo service in Gothenburg before, during and after the field operational test in 2014, and concluded that the most common initial motivation for participants to take part in the test was curiosity, but that after the test convenience/ flexibility was experienced as the most important motivating factor. Economy was another motivation, but environmental concerns was rarely mentioned as primary motivating factor. Among potential users who received information about the service but decided not to join the trial, the most important barriers were economy (Ubigo would have been more expensive than the current transport solution), that they travelled too little, mainly biking and walking, and that the closest car-sharing site was too far away. For families with small children, access to child seats in carsharing cars was also an issue (ibid.).

Pankratz et al. (2017) draw upon behavioural economics to explore potential barriers for customer adoption of new, integrated mobility services (also including autonomous vehicles). How we choose to go from A to B is influenced by a multitude of factors, from obvious factors such as cost and convenience to more obscure such as perceived prestige and peer pressure. Research within behavioural economics shows that customers generally tend to overvalue current benefits and undervalue potential gains, resulting in a *status quo* bias. Perceived risks with new solutions also tend to be overvalued. Moving from owning a car – a durable product – to using an intangible mobility service – is also a profound change compared to switching one tangible product for another, which makes the change even harder to achieve. To overcome these barriers, Pankratz et al. suggest several strategies, such as recasting losses as foregone gains and gains as foregone losses, aggregate costs and risks in communication with potential customers, create "social proofs" through e.g. pilots, and work with setting default options.

5. Concluding remarks

Although IMS has still not been implemented at broad scale, and empirical evidence of drivers and barriers for IMS implementation hence still is lacking, this review of literature has identified a number of thematic areas that seem to be of importance.

On a macro level, government has an important role in relation to integrated mobility services both related to creating preconditions for implementing IMS, and to protecting public interest. The subsidization of tickets for public transport, and the implications of this for the role of Public transport within IMS seems to be a key issue, and a related question concerns the boundaries between state subsidized mobility services and commercially viable services, and how these can be combined in IMS solutions. The state could also use taxation policy, financing programs and regulations concerning data availability and standardization as measures to create an enabling environment for IMS. The discourse surrounding IMS at societal level is a strong driver for action, with IMS being presented as a panacea able to solve problems ranging from urban congestion and climate impact of transportation to economic growth and social inclusion.

On the meso level, regional and local authorities have an important role to create an enabling environment for IMS regarding the physical infrastructure for public transport, bike infrastructure, car-sharing services etc. On the informal side, a major driving force for getting IMS up and running is the perceived business opportunity in the nascent IMS market, not least for private actors. Several actors need to collaborate for a scalable integrated mobility service to materialize. This can be organised in a "business ecosystem", where multiple actors add services from their core businesses into a whole that constitutes the integrated mobility service offering. If an offer of integrated mobility services is to emerge within a reasonable timeframe, one actor within the business ecosystem needs to take the lead, but in order for the system to survive, all required actors in the ecosystem must benefit from its existence. An interesting dimension relates to what different actors in the IMS ecosystem perceive is their role in relation to new mobility services, and the implications of different actors taking the lead. It is yet unclear who will/should take the role as service integrator. The question of different actors finding their role in the IMS ecosystem is made even more interesting by the fact that not only automotive OEMs and public transport operators are looking into ways of innovating using IMS, but also telecom, retail and media organisations. The extent to which these different actors, from different backgrounds, complement or compete with each other is a question yet to be settled. Public transport is generally seen as a backbone in integrated mobility services, and many public transport operators wish to take the lead in the development of new services, which they see as a complement to their existing services. The decision to sell public transport tickets through a commercial IMS integrator lies with the public transport operators, which could be a substantial barrier to IMS implementation with commercial IMS integrators. Integrated mobility services require a mobility platform that combines the different modes into one integrated service, and a major enabler for IMS is hence the rapid development within ICT. But although a number of such platforms are now available at the market, only a few of these have been tested in other contexts than smaller pilots.

At the micro level, several trends are supportive of IMS. Increased densification of city centres creates incentives for citizens to consider alternatives to own their own car. Changes in the cost of owning a car could also have a large impact on the demand for IMS. Furthermore, the growth of the "sharing economy" means services such as IMS are gaining more acceptance among consumers. Research on IMS point to several kinds of potential customer benefits, such as personalised service, ease of transaction, ease of payment, dynamic journey management, and journey planning based on personal preferences. The primary customer base is likely to be "flexi travellers" who can often travel by public transport but also need other means of transport on a regular basis. This customer base will experience a well-functioning integrated mobility service as a very price-worthy alternative to private car ownership, and thus have a high willingness to pay for it. However, research within behavioural economics shows that customers generally tend to overvalue current benefits and undervalue potential

gains, resulting in a *status quo* bias, which means attracting enough customers to a new type of mobility service will be a challenge.

For future research on IMS, more empirical studies on IMS pilots being implemented on the ground would be of great value, as well as studies on combined mobility services that may not be fully-fledged IMS-solutions, but still have some aspects in common. Issues of data security and consumers' willingness to share data with IMS operators also need to be taken into account.

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