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The European Roadmap 2025 for Mobility as a Service

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Abstract

This paper is based on a Mobility as a Service (MaaS) project, Mobility as a Service for Linking Europe (MAASiFiE), conducted for the Conference of European Directors of Roads (CEDR). MaaS is an emerging concept aiming to offer user-oriented, multimodal transport services on a one-stop-shop principle utilizing digitalization and mobile applications. This paper presents the main result of the project: the European MaaS Roadmap 2025 defining short- (1-3 years) and medium-term (4-9 years) actions and transitions needed to reach the vision formed in the project. The Roadmap is divided into four functional perspectives: drivers, markets, MaaS services and enablers. Furthermore, each perspective presents the results using the following classification: Academy and R&D, Business, Infrastructure & built environment, Policy & regulation, Technology & data, and Social & culture. This paper concentrates on Policy & regulation aspects, as well as on the role of National Road Administrations (NRAs) in MaaS development.

Keywords: Mobility as a Service; MaaS; Roadmap

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1. Introduction

Current megatrends affecting transportation include urbanization, climate change, globalization, digitalization and demographic shifts (Pöllänen et al. 2015). For example, transport is a major source of greenhouse gas emissions, and urban transport is responsible for 23% of the EU's greenhouse gas emissions (EC 2016), while congestion from road transport causes remarkable inefficiency, and passenger transport is expected to grow approximately 42 % from 2010 to 2050 (EC 2017a). Attempts to mitigate these effects include an action plan for low-emission mobility related to zero or low-emission vehicles, optimizing the transport system and improving its efficiency (EC 2016); and measures for an optimized transport system including multimodality and digital mobility (EC 2016). Also the emergence of new mobility concepts is seen as a significant opportunity to bring about low-carbon mobility (EC 2017a).

Mobility as a Service (MaaS) is an emerging concept of new integrated transport services. The Mobility as a Service for Linking Europe (MAASiFiE) project has defined MaaS as: “multimodal and sustainable mobility services addressing customers' transport needs by integrating planning and payment on a one-stop-shop principle” (MAASiFiE 2016). According to Hietanen (2014), MaaS is “a mobility distribution model in which a customer's primary transportation needs are met over one interface and are offered by a service provider”. MaaS could offer travelers easy, flexible, reliable, price-worthy and environmentally sustainable everyday travel, including for example public transport, carsharing, car leasing, as well as more efficient goods shipping and delivery possibilities (EC 2017b).

There are currently good opportunities to address mobility challenges via new concepts and improved planning, as many cities in Europe are promoting active and sustainable modes of transport, supported by multimodal travel information services offering users a range of mobility options, including bike- and carsharing schemes (EC 2017a). However, mobility challenges are not only restricted to cities, as they also concern social inclusion and the connectivity of rural areas (EC 2017a). To address mobility challenges, Polis (2017) suggests stronger collaboration between the public and private sector, and development of new mobility services in collaboration with private sector and local and transport authorities to support the city and regional transport priorities and policies. As such, MaaS fits well with Polis' suggestions, as MaaS involves an ‘ecosystem’ including several actors from both the public and private sectors. A business ecosystem is a network that consists of a vast number of loosely interconnected participants who benefit from each other and their mutual effectiveness (Iansiti and Levien 2004). The MaaS ecosystem includes transport infrastructure, transportation services, transport modes, and transport information, ticketing and payment services (König et al. 2016). More precisely, the actors involved in the MaaS ecosystem may include transport operators, data providers, technical back-end and IT providers, ICT infrastructure, insurance companies, regulatory organisations, universities and research institutions, and customers (Kamargianni and Matyas 2017).

The MaaS ecosystem also includes actors enabling new digital and sharing services. Digital technologies can make transport more efficient and inclusive, and enable seamless door-to-door mobility and value-added services (EC 2016). Particularly for younger generations, renting and sharing mobility services are increasingly popular and owning a private vehicle is becoming less important (EC 2017a). Several types of sharing services in transportation already exist. There are carsharing companies (e.g. DriveNow, ZipCar), peer-to-peer carsharing services (e.g. ShareIt Blox Car), ridesharing services (e.g. BlaBlaCar) and bike sharing services (e.g. DB/DIMIS including car and bike services) (Eckhardt et al. 2017). There are also ridesourcing services, such as Lyft or Uber, (SUMC 2016), and organized hitchhiking services, such as Rezo Pouce (Rezo Pouce 2017).

MaaS is expected to provide several benefits related to low-carbon mobility, such as a modal shift from car to public transport and sharing services, an increase in multimodal trips and resource efficiency, and decreased emissions (Karlsson et al. 2017). In Sweden, the UbiGo MaaS pilot in an urban context showed attitude changes towards various travel modes: participants became less positive towards the private car and more positive towards alternative modes, such as carsharing, bus/tram and bikesharing (Sochor et al. 2016). MaaS potentially improves accessibility to transport and has a positive impact on total travel cost per individual/household (Karlsson et al. 2017). Also, MaaS has the potential to improve the efficiency of existing transport services and public resources (Polis 2017).

2. Project overview and methodology

MAASiFiE was a multinational two-year project (2015-2017) financed by the CEDR (Conference of European Directors of Roads) Transnational Road Research Program (MAASiFiE 2016). The project was coordinated by VTT Technical Research Centre of Finland Ltd., and project partners were AustriaTech from Austria, and Chalmers University of Technology from Sweden. The steering committee consisted of the Finnish Transport Agency and the Swedish Transport Administration.

The project investigated the prerequisites for organizing user-centric and sustainable mobility services to provide consumers with flexible, efficient and user-friendly services encompassing various modes of transport on a one-stop-shop principle. The project also proposed business and operator models, and analysed technological requirements, potential impacts, interoperability issues, and legal enablers and barriers. The main results and contributions were a medium-term European Roadmap 2025 and general recommendations for the implementation of MaaS. The roadmap consists of roles and responsibilities of involved stakeholders, especially national road administrations. Thus, the understanding of various existing and emerging business models, as well as combinations of mobility services in different areas, was essential. Additionally, the project studied the opportunities of merging passenger and freight transport operations, in particular urban delivery and distribution in rural areas.

The project was divided into five work packages (WPs) of which the first concentrated on project management and disseminating project results and information. The remaining four work packages focused on the research work itself. The primary results, Roadmap 2025 for MaaS in Europe, was defined in the second work package, but simultaneously served as an umbrella for exchanging information, contributions and interactions with activities in work packages three, four and five. The roadmap (WP2) includes roles and responsibilities of different stakeholders, and legal enablers and challenges. In work package three (WP3), the current state and future directions of Mobility as a Service concept were studied from different perspectives: multimodal traveler information services, ticketing and payment systems (including mobile systems), and intermodal or sharing concepts and services. WP3 also analyzed MaaS value networks, and developed business and operator models. WP4 performed socio-economic and environmental impact assessments of MaaS and proposed a set of key performance indicators of MaaS. WP5 identified technological requirements and interoperability issues of MaaS, and provided enabling technical recommendations.

The MaaS Roadmap applied the 'LIFE' method, which derives from the methods called The Change Laboratory, Developmental Impact Evaluation and Road Mapping (Halonen et al. 2010). The method as applied in the MAASiFiE project consisted of a series of four workshops (WS) (Figure 1) with the following themes.

- Creating a vision for Mobility-as-a-Service (WS1),
- Impact assessment based on existing cases (WS2),
- Generating national roadmaps (WS3), and
- Implementation, validation and consolidation of MaaS roadmap 2025 (WS4).

Workshops 1-3 were held in three European countries – Austria, Finland, and Sweden – and workshop 4 was an international workshop. Workshop 1 focused on future needs and forming initial visions for MaaS. Workshop 2 assessed possible impacts of MaaS consisting of socio-economic assessments founded on selected MaaS cases and considering the perspectives of different stakeholders. Workshop 3 created Roadmap 2025 for each participatory nation (Finland, Sweden, Austria) exploiting the TAO method – Transition, Actors, and Obstacles – addressing which changes are required to achieve the vision, which are the actors and their roles, and what are the barriers. The last workshop consolidated a European MaaS Roadmap 2025 and set next steps enabling the continuity of MaaS implementation and promoting MaaS implementation at the European level.

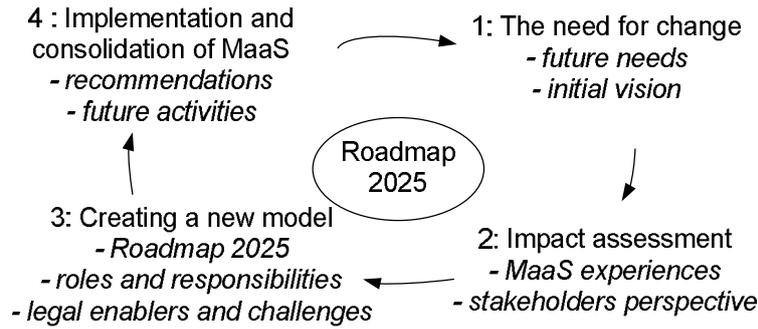


Fig. 1 Roadmap methodology (modified from Eckhardt et al. 2017)

3. Results

3.1. MaaS Roadmap 2025

The European MaaS Roadmap 2025 defines short- (1-3 years) and medium-term (4-9 years) actions and transitions needed to reach the vision formed in the project. The simplified roadmap with the four functional perspectives – drivers, markets, MaaS services and enablers – is presented in Figure 2. To help clarify the roadmap, the results were organised into subcategories after the consolidation workshop. These six subcategories are: Academia and R&D, Business, Infrastructure & built environment, Policy & regulation, Technology & data and Society & culture. Table 1 presents the Roadmap 2025 results of the one subcategory Policy & regulation, and the main aspects prioritized in the final consolidation workshop are indicated in *italics*.

European MaaS Roadmap 2025

	Status Quo	+1-3 years	+4-9 years	Vision 2025
Drivers	Tightening efficiency and environmental requirements	Urbanization and change of urban structures		High efficiency and utilization rate
	Goals for increasing the share of PT	Decreasing public funding	Automation and changes in vehicle fleet (shared, electric, connected)	Cross-cutting collaboration and coordination
	Digitalization develops	Incentives on all levels		Accessible and sustainable transport for all regions
Markets	MaaS hype and uncertainty	Steadily growing and stabilizing MaaS market		Profitable MaaS markets
	Few MaaS offers and low market share	Mobile services becoming more common and intelligent		Strong demand for MaaS services
	Uncertainty regarding legal possibilities	Change of user demands: safe, easy, fast, flexible, comfort	New forms of collaboration and cross-financing (e.g., PPP)	Strong demand for MaaS
MaaS services	Increasing number of pilots, of which best will scale-up	One-stop-services combining all purposes of mobility and activities		Minimum SLA for MaaS defined
	Expanding service integration and combinations			
	Imbalance between transport modes	Combined public and private sector ; private cars as part of public transport (i.e., redefined PT)		PT carried out as DRT
	Opening up data and interfaces proceeding	Defined My data concept enabling efficient data analysis		
Enablers	R&D funding available	Principles for cost/profit/subsidising	Systematic research; MaaS integrated into academic domain	
	Extensive national and international networks	Cross sector operation models incl. all transport modes; viable business models (B2B, B2C, P2P, B2G...)		
	Roadmaps and strategies under development	Standards for data, ticketing...	Pol. and econ. steering promoting sustainable society development	
		Incentives for using MaaS; changed mind-set (public/private...)	Guidelines for city/infra planning	
	International MaaS platforms	MaaS as a part of combining societal services		

Fig. 2 MaaS Roadmap 2025 (Eckhardt et al. 2017)

From the ‘drivers’ perspective, the subcategory *Policy & regulation* is seen as the most significant for enabling MaaS and its development, since reregulation should blur the existing silos between MaaS stakeholders and transport modes, and facilitate collaboration and the development of new business models. Policy and regulation should encourage and guide the development of the transport sector in using more efficient and sustainable mobility solutions to achieve sustainability targets. Insufficient public funding also presses the need to find new ways of organizing transport services.

Although Policy & regulation is seen the most significant driver of MaaS development, other subcategories also push towards MaaS development. *Infrastructure & built environment* aims at reduced parking infrastructure, as well as land use and urban structures that consider MaaS development. From the *Technology & data* side, digitalization increases the availability of data and services, and automation can bring new services into the MaaS ecosystem. The *Business* sector could enhance collaboration, integrate more sustainable solutions into their businesses and improve efficiency. Regarding the *Society & culture* aspect, the sharing economy and end-users' demand for personalized services are considered as important drivers of MaaS development.

For the transport '**markets**', *Policy & regulation* does not play as large a role. However, policy and regulation need to create preconditions for collaboration among modes as well as between the public and private sectors. Authorities can also affect markets by building public awareness of and trust for new mobility services, as well as promoting the sustainable market.

The *Business* and *Society & culture* subcategories play significant roles in developing the MaaS market. Regarding *Business*, the market is expected to grow and new market players to arise. MaaS will include new services, integrated with the automotive industry, and transport data will become a business of its own. From the *Society & culture* point of view, attitudes towards MaaS are changing, which is important for creating acceptance and attraction for new services. In addition, user needs are changing, and more services will come to people (instead of people to services). *Technologically*, digital and mobile services are increasing, and virtual services and more optimized systems are developing.

Table 1. Policy & regulation aspect of the European MaaS Roadmap 2025 (Eckhardt et al. 2017).

	Status quo (2016-2017)	+ 1-3 years	+ 4-9 years	MaaS vision 2025
Drivers (social, technological, financial, ecological, political)	<ul style="list-style-type: none"> - Demand for efficiency improvements in public sector - Tightening environmental requirements - Goals for large increases in PT modal share - Deregulation 	<ul style="list-style-type: none"> - Public funding either decreases or is not sufficient - Incentives on all levels - Disincentives for private car use and ownership - Environmental requirements developed, e.g. zero emission zones, clear sustainability goals tied to transport, company image (transport, parking and travel policy) - New updated regulation 	<ul style="list-style-type: none"> - Public funding continues to decrease 	<ul style="list-style-type: none"> - <i>Energy consumption, emissions and congestions have decreased</i> - <i>Increased collaboration and coordination, e.g. concerning subsidized transport and trips, between different public functions</i> - Norms and attitudes toward car usage and car ownership are changed - Limiting regulation has been adjusted or/and deregulated
Markets	<ul style="list-style-type: none"> - MaaS hype (redefining transport & mobility, servitization) - Fear of losing control (transport providers) - Unclear ecosystem (roles & responsibilities) - Uncertainties regarding legal possibilities 	<ul style="list-style-type: none"> - Building public awareness and trust - Blur the walls of modal silos 	<ul style="list-style-type: none"> - Preconditions in place for innovation and new forms of collaboration (could this come earlier?) 	<ul style="list-style-type: none"> - Both commercial and subsidized MaaS services, and public private collaboration (cross-financing) - Impact for non-servitized sustainable markets: e.g. biking and cycling

MaaS services (incl. additional services, required technology)	<ul style="list-style-type: none"> - Imbalance between transport modes (e.g. private car prioritized) 	<ul style="list-style-type: none"> - Best practices for open data regulation - Remove regulatory bottlenecks (which identified and challenged) 	<ul style="list-style-type: none"> - <i>Combining public and private sector transport</i> 	<ul style="list-style-type: none"> - Common minimum service level agreement for MaaS needed - Redefined public transport - International roaming - PPPs commonly used
Enablers (funding, networks, know-how, operation models etc.)	<ul style="list-style-type: none"> - National and international networks; e.g. national ITS organizations, MaaS alliance - Roadmaps and strategies are under development 	<ul style="list-style-type: none"> - <i>Clear regulatory framework, adjustments to regulation, e.g. permission to resell PT tickets</i> - <i>Standardisation of and/or common ticketing/ payment system for public transport, data, service interfaces, APIs etc.</i> - <i>Change towards goal achievement (functional specifications)</i> - Collaboration between service providers, sectors, administration levels (e.g. municipalities and state) - Increased coordination between different public functions concerning subsidized transport and trips - Developing new procurement & PPP models and procedures, and know-how about their application - Emerging international MaaS-collaboration (service and knowledge networks, conferences) - Develop national/regional political incentives to support MaaS - Marketing to public and politics → Financing to incentivize using MaaS - New ways of funding investments in e.g. metro - MaaS goals tied to policy goals and national goals 	<ul style="list-style-type: none"> - Green mobility and green transport - Established procurement knowhow, models and regulation - Legislation facilitating robotization and automation in place 	<ul style="list-style-type: none"> - <i>Clear short- and long-term goals for MaaS services tied to societal goals</i> - Clear roles and responsibilities of stakeholders - Holistic long-term coordinated planning and decision-making - Modified political and economic instruments and steering to promote sustainable societal development

Regarding ‘**MaaS services**’ in the short-term, *Policy & regulation* need to remove identified regulatory bottlenecks, and collect best practices regarding open data regulation. The main aspect identified from the policy and regulation side is combining public and private sector transport in the medium-term. A re-definition of ‘public transport’ to shared/collective transport could potentially include shared private cars as part of public transport. Another aim is to make public-private-partnerships more common. Minimum service level agreements are needed for MaaS, and clear responsibilities. For international MaaS, roaming issues need to be solved.

In the *Business* sector, there will be an increased number of pilots, of which the best ones will be selected and scaled up. Various one-stop-shop services will be available in the medium-term, and finally freight will be integrated to MaaS and more demand-responsive transportation will become available. The main action related to *Technology & data*, is to open up data, interfaces and APIs (Application Programming Interface), as they are building blocks for interoperability and combining services on a one-stop-shop principle. Personal data issues need to be solved for secure information sharing among involved organizations. From the *Society & culture* aspect, the main points in the short-term include offering useful and easy-to-use services supporting everyday life and

fostering accessibility, and having shared private cars (i.e., shared resources) become a part of public transport. The tendency is moving from owning towards sharing and “prosuming” (producing and consuming), e.g. providing private cars to car- and ridesharing networks. Later on even more useful, targeted and customer-oriented services will arise.

The fourth functional perspective in the MaaS Roadmap is ‘enablers’, where *Policy & regulation* play a major role, especially in the short-term. A clear regulatory framework is needed, and possibly adjustments to current regulation. For example, a MaaS operator may need permission to resell public transport tickets – especially publicly subsidized tickets – in order to integrate them into their offer. Interoperability needs to be ensured too. This refers to common or standardized ticketing and payment systems for public transport, and open data, interfaces and APIs. Development should aim at goal achievement, and functional specifications set accordingly.

Broad collaboration is needed between service providers, public and private sectors, and different administrative levels, such as national, regional and municipal. Also increased coordination between different public institutions and authorities concerning subsidised transport/trips is required to achieve efficiency and enable ridesharing. New innovative procurement and PPP models need to be developed, and procedures and know-how for applying them must be increased. E.g. innovative procurement concentrates meeting customers’ problems and aims instead of concentrating on the predefined solution. New funding instruments for investments are needed, e.g. alliance model. International MaaS collaboration is required, e.g. in the form of conferences, to share information on services and exchange knowledge. National and regional political incentives should be developed to support MaaS implementation. In addition, marketing to the public and to politicians is needed.

Medium-term actions refer to further developing green mobility and transport. Procurement know-how, models and regulation will be established. Also legislation regarding robotization and automation should be in place. The primary aim of *Policy & regulation* is to have clear short- and long-term goals for MaaS tied to societal goals. Stakeholders need to have clear roles and responsibilities, and coordinated planning and decision-making is required. Also, political and economic instruments and steering should promote sustainable societal development.

In the *Business* sector, defined principles regarding costs and subsidies are needed. Collaboration is also essential at different levels, first at the national and cross-sectoral levels, and in the medium-term at the international level. Regarding *Academia & R&D*, research institutes should benchmark MaaS services, identify best practices and perform impact assessments. Later, living lab test environments could be developed. Finally, an impact assessment framework should be in place, and MaaS integrated into education. From the *Technology & data* side, digital public transport tickets should be in wide use in the short-term. Privacy and data protection issues need to be solved and common platforms developed. *Infrastructure & built environment* should aim to provide guidelines for city planning and infrastructure considering MaaS. Regarding *Society & culture*, a changed mind-set related to public/private (e.g. “prosuming”) and mobility/transport is expected in the medium-term.

3.2. The role of National Road Authorities

National Road Authorities (NRAs) play an important role in enabling MaaS. The roles and responsibilities of NRAs in the context of MaaS, described here, were proposed in the MAASiFiE project (Eckhardt et al. 2017). They include implementation of transport policy; strategy and investments; plans and guides for the national development of transport services; the ownership of national transport infrastructure; providing available/open transport data; promoting collaboration between different transport modes and stakeholders; issuing permits, licenses and tolling. The roles may vary in different countries, thus they need to be adapted accordingly if interpreting them for a specific national context.

MaaS needs to be integrated into the transport policy & strategy implementation, and investments aligned with the strategy. Funding programmes would be useful to develop and test MaaS in different contexts. As quantitative data is needed for decision-making, thorough and objective evaluations should be a requirement for funding. The evaluations would help establish the potential contribution of MaaS to meeting additional national policy goals, e.g. emissions reduction. NRAs could create funding strategies for areas with less immediate commercial potential, such as rural areas. New service types, and new incentives and disincentives could be tested. Evidence from service and pilot evaluations need to be collected for decision-making and measuring policy achievements.

Plans (also long-term) and guides for the national development of (new) transport services could include the use of best practices based e.g. on MAASiFiE results and other areas/countries, and disseminate information. The

MaaS vision should be adapted to the local and regional contexts. This could be done by organizing awareness-raising events. Also, interactions with different services and areas, e.g. cities, in the form of workshops, seminars, visiting teams, etc., could be arranged. This could result in investments and enable possibilities to provide alternative transport modes. These events and interactions are also important for motivation and commitment. NRAs could also help with practicalities, such as informing about and assisting with how to set up MaaS services and the procedures required (e.g. procurement).

As the owner of the national transport infrastructure or infrastructure operator, digitalization and automation should be taken into account. Also carsharing and alternative modes could be promoted via pricing. NRA's should provide available/open transport data for all, or according to national policy. Added-value services based on the transport data, public transport schedules, routes, open interfaces, maps and route planners could be provided. NRAs could assist in deploying data, thus promoting how data from MaaS can be shared to help other MaaS services and how to contribute to performance evaluation according to policy goals.

For promoting collaboration between different transport modes and stakeholders, best practices should be collected and disseminated. Also thematic and targeted workshops could be organised covering e.g. opening APIs and (innovative) procurement. The NRAs issue permits (e.g. robotization, automation, operating permits) and licenses, and conditions should be set in a way that the issuing promotes MaaS and sustainability. MaaS could be integrated with tolling and incentivised to encourage more sustainable transport choices.

4. Discussion and conclusions

During the last few years, the MaaS concept has achieved relatively high status and gained media visibility in the transport and mobility sectors. The overall idea is to enable inter- and multimodal service offerings on a one-stop-shop principle by integrating different mobility and transport services into one package. It offers stakeholders an opportunity to blur modal silos and to study the transport sector as an entity, N.B. both at the service offering level and at the market level. As a novel and holistic approach, MaaS is expected to present global market opportunities, tempting existing and emerging actors to join. To some extent, there seems to be a hype surrounding MaaS, which is boosting start-up companies to develop and expand their business from small local pilots towards national and international services in collaboration with transport service providers and other actors within the sector. But MaaS development appears to be starting to shift to the next phase, in which the public sector and consumers will have significant roles, since the public sector procures and regulates in many cases, and consumers are the ultimate decision-makers in the value chain in terms of accepting and adopting new service.

MaaS development strongly depends on what will happen within policy and regulation, since the current regulation has been identified as one of the barriers for MaaS service development – e.g. regulation sets obstacles for combining goods and passenger transport – in some countries. Regulation and policy can also act as a first incentive to encourage transport stakeholders to collaborate, which is essential for MaaS development. Smart and innovative procurement methods can be used to assist collaboration in the transport/mobility sector and hence support MaaS development.

According to the European MaaS Roadmap 2025, national and international interoperability is needed, since it provides companies an opportunity to scale up their businesses. Without international standards and regulation it is challenging for companies to grow and expand to other market regions, and there is a significant risk that solutions remain at the local level even if they have the potential to become world-wide solutions. A lack of standards and interoperability also works against the MaaS vision in which users or consumers should be able to travel smoothly across countries and borders. To enable this, standardization and harmonization of regulation must be performed at all levels of MaaS development (e.g. technology level, technical architecture level, service level, regulation level, data sharing level, service agreement level, responsibility level, insurance level).

However, while MaaS development has received much interest, including investments from the big automotive OEMs, MaaS is still in an early stage. Therefore, a lack of data and empirical evidence is the primary challenge to carry out more comprehensive impact analyses as well as service and technology forecasts. Currently, available data is gathered from small, local-level pilots with a limited number of users. Pilots of this kind typically attract users who are more aware (i.e., early adopters) and more interested in their mobility habits than the average person and hence they cannot comprehensively represent heterogeneous user groups. Small pilots usually combine a limited number of modes, a few parts of the entire service ecosystem and limited geographical coverage. They are

also mostly enabled and partly financed by public funding and authorities. Thus, it is challenging to analyze and predict what kind of influence MaaS will have in the future at the societal level and what kind of MaaS business models will be established and used. Therefore, it is recommended to shortly follow up with a similar roadmap study as presented in this paper and update the current state and future predictions with more data, empirical evidence and knowledge.

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