A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals

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\textbf{A R T I C L E  I N F O}

\textbf{Keywords:}
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Integration
Value creation
Societal goals
Business models

\textbf{A B S T R A C T}

The purpose of this paper is to shed light on the concept of MaaS and what characterises a ‘MaaS service’, as well as to propose a topology of MaaS as a tool for facilitating the discussion of MaaS, enabling the ‘comparison’ of different services, understanding MaaS’ potential effects, and aiding the integration of societal goals into MaaS services. Based on an exploration of existing definitions and descriptions of MaaS, and an expert workshop identifying key aspects and ascertaining service differentiations accordingly, the resulting proposed topology consists of MaaS Levels 0 to 4 as characterised by different types of integration: 0 no integration; 1 integration of information; 2 integration of booking and payment; 3 integration of the service offer, including contracts and responsibilities; 4 integration of societal goals. The levels are then described in terms of their added value and further discussed regarding implications for society, business, users/customers, and technical requirements. Then, a deeper discussion also delves into the potential in expanding upon Level 4 and ways by which services and societal goals can become more fully integrated. The proposed topology adds clarity to the discussion of such a trending topic and enables the positioning of services along the MaaS spectrum. It also deepens the understanding of why MaaS can take time to establish, and can help support the development of action plans in terms of what needs to be done depending on what type of MaaS one wants to develop. Further analysis is desirable regarding the possibilities and problems linked with the different levels of MaaS. Such an analysis is key to understanding which effects can be achieved via the implementation of different levels of MaaS services in terms of e.g. social, economic and ecological sustainability, and business potential.

\section{Introduction}

Mobility as a Service (MaaS) is often described as an emerging strategy to reorganise transport in order to tackle mobility and sustainability challenges via offering an alternative to private vehicle ownership. It may do so by, for example, combining different types of mobility services as part of a single, seamless offering that is made available to users via subscription-based smartphone applications (Beutel et al., 2014; Goldman & Gorham, 2006; Sochor, Strömberg, & Karlsson, 2015). However, there is currently little agreement on a ‘definition’ of MaaS, on what makes a service a ‘MaaS service’, or on how to ‘compare’ MaaS services. Additionally, MaaS is also commonly referred to using the rubrics ‘combined’ or ‘integrated’ mobility services, etc. Is it possible or desirable to define MaaS at this point in time, and are these concepts – MaaS, combined mobility, and integrated mobility – the same, or are there differences?

As envisioned, MaaS represents a radical innovation that could potentially revolutionise the transport system, both in terms of passenger and goods transportation. Generally, when radical innovations emerge, there is an initial ‘fluid’ phase that is characterised by experimentation with multiple competing product/service designs (Abernathy & Utterback, 1978). At this stage, uncertainty prevails and the applications of the innovation in question are unclear. Uncertainty is resolved in a later, transitional phase, as the market consolidates to select a dominant design (ibid). The fluidity of MaaS poses at least two problems. First, as the hype grows, and as increasing numbers of practitioners engage with MaaS, questions remain about ‘what MaaS is’. Yet defining the MaaS concept in terms of the content of the service and
its applications can be considered, at the present, fluid stage of de-velopment, an unwise and premature undertaking. Second, the fluidity of the concept creates challenges in terms of governing a transition to a MaaS-based transport system. If we do not know what MaaS is, how can we know what a MaaS-based transport system can or will deliver in terms of sustainable outcomes – social, economic, and ecological? One way to deal with this uncertainty is to develop a characterisation of MaaS that embraces the fluidity of the concept.

Hence the purpose of this paper is to develop a topological approach to characterising the MaaS concept in order to: 1) facilitate more meaningful discussions of the MaaS concept; 2) enable the ‘comparison of’ different services; 3) understand MaaS’ requirements and effects in terms of the four perspectives of society, business, users/customers, and technology; and 4) aid in the integration of societal goals. The paper accomplishes this via an exploration of various definitions and descriptions of MaaS (and combined/integrated mobility) and a multi-stakeholder workshop of MaaS experts, resulting in a proposed topology, which is further discussed and analysed.

2. Motivation, material and methods

In light of the current discussion of what MaaS is (or is not) and what characterises a ‘MaaS service’, and after many requests from third parties regarding definitions and classifications, the authors of this paper decided to analyse the concepts and services and propose a topology to attempt to answer these questions. A topology also provides added value in terms of: adding clarity to the discussion of such a trending topic; being able to promote the concept and position a service within the MaaS spectrum; and, when discussing with decision-makers, being able to explain why MaaS can take time to establish by identifying various barriers and enablers for the different topographical levels, and supporting the development of action plans regarding what needs to be done depending on what type of MaaS one wants to develop.

First, the authors explored various definitions and descriptions of MaaS and similar concepts in order to identify commonalities and differences (initially in Karlsson, 2016 and later updated with additional definitions and descriptions), which is summarised in the next section.

Second, a multi-stakeholder workshop was held in order to structure the topology. In order to gather a variety of perspectives and hopefully minimise bias towards any particular stakeholder perspective, invitations were sent to representatives of a range of stakeholder groups in the MaaS ecosystem: MaaS operators, transport service providers, ICT experts, researchers and funders. A total of seven experts participated, representing all the stakeholder groups listed above with the exception of ICT experts (due to illness).

The half-day workshop took place in November 2016 in Gothenburg, Sweden. One of the seven participants acted to generally coordinate the work throughout the day, providing instructions and keeping to the schedule. This coordinator and another participant each took notes to document the work and discussion. Workshop participants were to: identify relevant aspects of MaaS then; analyse existing MaaS or similar services in terms of the identified aspects; and finally, define and describe MaaS levels, as well as place services at the best matching level. Due to the intimate setting, work generally progressed via discussion in one group. After the workshop, the coordinator summarised the results, including making the initial figures, and sent them to the invitee group (i.e. both the participants and those who were not able to attend) for feedback and quality control. Results from both the exploration of definitions and descriptions as well as from the workshop are presented below, cumulating in the proposed MaaS topology and auxiliary discussion.

2.1. Related work

The authors wish to acknowledge related work, most of which has emerged since the nascent of this proposed topology in 2016. Recent attempts to characterise MaaS that demonstrate a similar topological approach have a narrower focus that does not fully explore the how or why or offer multiple perspectives such as that of business, users/customers, technology, and particularly society.

In 2015, Kamargianni, et al. conducted a survey of selected ‘mobility integration projects’, which were loosely categorised under ‘basic integration’, ‘advanced integration’, and ‘advanced integration with tailored mobility packages’. The authors also created a ‘cooperation’ matrix, i.e. if a project did or did not include the following types of

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**Fig. 1. Differentiation of services according to identified key aspects.** Uber, a unimodal service, is included for comparative purposes.

<table>
<thead>
<tr>
<th>Integration</th>
<th>Service</th>
<th>Qixxit</th>
<th>Moovit</th>
<th>Hann. Mobil</th>
<th>Smile</th>
<th>Moovel</th>
<th>Whim/Ubigo</th>
<th>Uber*</th>
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<tr>
<td>Policy / goals:</td>
<td>a) information</td>
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<td>b) collaboration &amp; incentives</td>
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<td>Information: a)</td>
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<td>Responsibility &amp; cust. support</td>
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<td>Pricing models, etc. a) Rebates, etc.</td>
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<td>b) Bundling / subscriptions</td>
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<td>Breadth (e.g. no. of modes)</td>
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<td>P2P - producer &amp; consumer</td>
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Table 1

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<th>Reference (Term)</th>
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<th>Key words/concepts</th>
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<td>(A.D. Little, 2018), p. 59 (MaaS)</td>
<td>“The concept of ‘Mobility-as-a-Service’ (MaaS) aims to provide consumers with integrated, flexible, efficient and user-oriented mobility services. It implies a shift away from the personal ownership of individual motorised transportation modes, and non-integrated means of transportation towards the use of integrated multimodal mobility solutions consumed as services. This shift is enabled by combining transportation services from public- and private-transportation providers through an ‘integrated mobility platform’ that creates and manages the journey and integrates planning and payment (based on mobility packages tailored to the needs of each customer segment) on a one-stop-shop principle.”</td>
<td>Service; Multimodality; User-centric; Integration; Platform; Planning; Payment; Packages; One-stop-shop; Public and private; Personalisation; Flexible; Efficient; Non-ownership</td>
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<td>(Atkins, 2015), p. 19 (MaaS)</td>
<td>“MaaS can be defined as: The provision of transport as a flexible, personalised on-demand service that integrates all types of mobility opportunities and presents them to the user in a completely integrated manner to enable them to get from A to B as easily as possible.”</td>
<td>Service; Multimodality; Integration; On-demand; Personalisation; Flexible; Non-ownership</td>
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<td>(Ghanbari et al., 2015) (MaaS)</td>
<td>“MaaS, a multi-actor environment that provides seamless door-to-door services for end users by combining several modes of transportation.”</td>
<td>Service; Multimodality; Ecosystem; Seamless; Door-to-door</td>
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<td>(Heikkilä, 2014), p. 8 (MaaS)</td>
<td>MaaS is “a system, in which a comprehensive range of mobility services are provided by customers to mobility operators.”</td>
<td>Operators; Comprehensive</td>
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<td>(Hietanen, 2014), pp. 1–2 (MaaS)</td>
<td>“MaaS is a mobility distribution model in which a customer’s major transportation needs are met over one interface and are offered by a service provider. Typically, services are bundled into a package.”</td>
<td>Customer’s needs; One interface; Service provider; Bundling</td>
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<td>(ITS Australia, 2018), p. 20 (MaaS)</td>
<td>“MaaS systems offer customers personalised access to multiple transport modes and services, owned and operated by different mobility service providers, through an integrated digital platform for planning, booking and payment.”</td>
<td>Multimodality; Integration; Platform; Planning; Booking; Payment; Personalisation</td>
</tr>
<tr>
<td>(K2 Swedish Knowledge Centre for Public Transport, 2017) (Integrated Mobility Services)</td>
<td>“Integrated Mobility Services mean that in one and the same service, one knits together many ways to move in the city (e.g. carsharing, bus, tram, commuter train, bikesharing, private vehicles) at the same time that one can offer payment of and information about the modes via one and the same interface. These new mobility services contribute to an increased freedom of choice and a reduced need to own a car, especially in larger cities or metropolitan areas.” (translated from Swedish)</td>
<td>One service; Multimodality; One interface; Payment; Information; Choice; Reduced private car ownership; Urban</td>
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<td>(Kamargianni et al., 2015), pp. 11–12 (MaaS)</td>
<td>“The term ‘Mobility as a Service’ stands for buying mobility services based on consumers’ needs instead of buying the means of transport. Via ‘Mobility as a Service’ systems consumers can buy mobility services that are provided by the same or different operators by using just one platform and single payment.”</td>
<td>Service; Consumers’ needs; Operator; One platform; Single payment; Non-ownership</td>
</tr>
<tr>
<td>(Kamargianni &amp; Matyas, 2017), p. 3 (MaaS)</td>
<td>“Mobility as a Service is a user-centric, intelligent mobility distribution model in which all mobility service providers’ offerings are aggregated by a sole mobility operator and supplied to users through a single digital platform.”</td>
<td>User-centric; Aggregation; Single platform; Provider; Sole operator; Intelligent Service; Multimodal; Customer needs; Integration; Planning; Payment; One-stop-shop; Sustainability</td>
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<td>(König, Eckhardt, Aapooja, Sochor, &amp; Karlsson, 2016) (MaaS)</td>
<td>“Multimodal and sustainable mobility services addressing customers’ transport needs by integrating planning and payment on a one-stop-shop principle.”</td>
<td>Service; Multimodal; Customer needs; Urban</td>
</tr>
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</table>
| (MaaS Alliance, 2018a; MaaS Alliance, 2018b) (MaaS) | “Mobility as a Service (MaaS) is the integration of various forms of transport services into a single mobility service accessible on demand.” | Single service; Multimodal; User-centric; Customer needs; | (continued on next page)
cooperation (p. 14): discounts, ticketing integration (i.e. access via one smartcard), payment integration (i.e. single invoice), ICT integration (i.e. interface/app), institutional integration (i.e. multiple modes "owned and operated by one company"), and integration with tailored mobility packages. This ‘cooperation’ matrix can be considered a similar step as the first in our workshop methodology (see Fig. 1), although slightly more limited in scope in terms of content. There is however no further development of a topology or similar, nor in-depth discussion of the how and why, or of the implications from the four perspectives.

In 2017 in a report in Dutch, MuConsult also outlined in a matrix of characteristics, i.e. if a project did or did not include: various modes, multimodal travel information, integrated ticket sales, parking payment, and subscription (p. 5). This report did go a step further to provide a classification of "different ambition levels of integration" (p. 11), but it mainly focuses on aspects of information/planning, booking, and payment and their influence on how ‘travellers’ consume transport, with some ancillary discussion on related technologies for achieving this. Their levels 0–3, although split slightly differently, are fairly congruous to basic aspects of levels 0–2 of our proposed topology, but their level 4 focuses on ‘passengers’ making choices based on service levels (set by governments) instead of modes, and a blurring of public and private transport. In other words, the discussion largely lacks the how and why, as well as the business and societal perspectives.

In 2018, a Traffic Technology International Issue (Traffic Technology International, 2018) included a two-page ‘technology profile’ titled “Defining levels of MaaS” (p. 72). With levels 0–6, their focus is on technology with higher levels entailing not only integrated information/planning, booking, ticketing and payment, but open data and standards, artificial intelligence and behavioural profiling (i.e. automating the decision-making process), and finally integration with other digitised services, the Internet of Things (IoT), smart buildings, etc. As this magazine targets industry, there is no description of method, nor does the article include a discussion of the how or why, or

Table 1 (continued)

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<th>Reference (Term)</th>
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<tr>
<td>(Maas Global, 2018) (Maas)</td>
<td>“Maas, short for Mobility as a Service, brings all means of travel together. It combines options from different transport providers into a single mobile service, removing the hassle of planning and one-off payments.”</td>
<td>Service; Multimodality; Planning; Subscriptions; Payment; Information; Remove hassle; Service; Easy; Flexible; On-demand; Personalisation; Bundle; People and goods; Integration; Multimodal; Common interface; One-stop access; Information; Single service; Platform; Integration; Demand-driven; Personalisation</td>
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<td>(Urban Mobility Services)</td>
<td>“We adopt the term ‘integrated mobility service’ (IMS) to describe a service that not only integrates a range of mobility services, both public and private, but also provides one-stop access to all services through a common interface (hence creating a seamless customer experience, i.e. the service). The service component could be more or less developed, ranging from simply the possibility to find travel information and pay for different mobility services within one technical system, to providing more far-reaching mobility service offers such as subscriptions to different mobility packages, perhaps also involving other service components such as goods delivery or bicycle repair services.”</td>
<td>Flexible; Service; Multimodal; Integration; Common interface; Information; Payment; One-stop access; Service; Payment; Other services; People &amp; Goods; Public and private; Seamless; Service; Multimodality; Planning; Subscription; People &amp; Goods; Way of thinking; Sustainability; Reduce private car dependency</td>
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<td>(Transport Systems Catapult, 2016), (Maas)</td>
<td>(p. 6) “The Transport Systems Catapult has defined Maas as using a digital interface to source and manage the provision of a transport related service(s) which meets the mobility requirements of a customer.” (p. 10) “The (mobility) service model is associated with understanding the ‘who’ and ‘why’ of customers’ mobility requirements and only then is the transport solution offered as a ‘how’?.”</td>
<td>Multimodality; Service; Integrated; Digital interface; Plan; Customer needs; Business model; Seamless; Service; Multimodality; Planning; Subscription; People &amp; Goods; Way of thinking; Sustainability; Reduce private car dependency</td>
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<td>(UITP, 2011), (Combined mobility)</td>
<td>Combined mobility is &quot;carsharing, taxis and shared taxis, bicycle and bike-sharing, car-pooling, demand-responsive transport, car-rental, etc., are services that can complement the classic fixed-line and timetable-bound public transport services and, together with walking, they form a complete and coherent mobility solution.” (N.B. private cars are not mentioned as part of the complete solution with the exception of carpooling, i.e. shared use.)</td>
<td>Multimodality; Comprehensive; Shared use</td>
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</table>
of the implications of their classification scheme, particularly from the business, users/customers, and societal perspectives.

The work conceptually closest to ours is a ‘MaaS taxonomy’ proposed by Lyons et al. (Lyons et al., 2019), although theirs focuses almost exclusively on a different aspect of the user perspective, namely on the cognitive user effort which decreases with increasing levels of integration. The higher the level (0–5), the greater the integration in terms of: operations (i.e. lowering ‘interchange penalties’ and increasing the degree of seamlessness, in other words the door-to-door experience); information (i.e. journey planning and execution information via one interface); and transactions (i.e. booking, ticketing, and payment via one interface). As pointed out by Lyons, et al. (ibid), who were kind enough to credit us with making the first attempt to make sense of MaaS in this way (i.e. a topology or taxonomy): their own “alternative interpretation helps elaborate [the multifaceted nature of a mobility system beyond the private car] while serving to provide some reinforcement... in terms of similarities” between their and our interpretations of MaaS.

3. Results: Exploration of definitions and descriptions

The purpose of this exploration of definitions and descriptions is to gain an understanding of how MaaS (and combined and integrated mobility) is comprehended by the research community and transport industry. This knowledge, as initially gathered (Karlsson, 2016), served as a step in the development of the proposed topology, which is described and discussed in Sections 4 and 5. Thus, despite other, now existing work providing a review of (partly other) definitions (e.g. (Jittrapirom et al., 2017)), we have chosen to keep this section on definitions as it can aid the reader in understanding the development process of our proposed topology. However, please note that when updating this paper, there was a need and opportunity to broaden the search, so we chose to look beyond attempts at strict and concise ‘definitions’ and include some newer and more descriptive depictions as well. The purpose of this is mainly to incorporate a broader range of stakeholder understandings of MaaS into our own, yet, in our judgment, it has not significantly changed the general findings. Thus, this discussion of definitions is not meant to be, nor can it be, exhaustive; rather it is meant to be illustrative yet informative. A table of definitions and descriptions together with key words and concepts complements the text by providing a quick overview (see Table 1).

3.1. Combined mobility (CM)

Already before the term ‘Mobility as a Service’ was coined in 2014 (Heikkilä, 2014; Hietanen, 2014), UITP (UITP, 2011) described the concept Combined Mobility (CM) as the non-competitive combination of public transport (the main focus) with other shared-use and active modes:

“...carsharing, taxis and shared taxis, bicycle and bike-sharing, carpooling, demand-responsive transport, car-rental, etc., are services that can complement the classic fixed line- and timetable-bound public transport services and, together with walking, they form a complete and coherent mobility solution” (UITP, 2011, p. 1).

However, this definition does not give any guidance as to how these modes can be combined (i.e. the collaborative model) in order to complement public transport. Note that privately owned cars are not mentioned as part of the complete solution with the exception of carpooling, i.e. shared use.

In Sweden, one of the pioneers of MaaS, CM is generally considered a synonym of Mobility as a Service, perhaps due to a lack of pithy translations of the phrase ‘Mobility as a Service’ and the acronym ‘MaaS’. Samtrafiken, an organisation of 38 transport providers in Sweden, developed a White Paper (Samtrafiken, 2017) which describes CM and/or MaaS as:

a way of thinking where “mobility is something that can be purchased as a service and does not require owning a private car” (p. 18). Also, “services that facilitate traveling from A to B by different means of transport” … “the services can be anything from a multimodal travel planner to a full mobility subscription. The services can also include transport of goods as a complement to personal mobility. The common starting point is that the services should inspire and attract travellers to more sustainable travel and to reducing private car dependency” (p. 4).

Samtrafiken’s rather broad definition emphasises services (likely influenced by MaaS), but leaves open what that service could entail. However, that their definition addresses societal goals of reducing car dependency and more sustainable travel is something many other definitions do not do, even if the general rhetoric claims that these new strategies will lead to reduced (private) car ownership and use.

3.2. Mobility as a service (MaaS)

Many already well-established phenomena, e.g. carsharing and taxis, can be described in terms of mobility services. However, the ‘new’ MaaS concept shifts the focus from specific modes to other significant elements of the Service, as illustrated in this section.

In two of the earliest definitions of MaaS, it is defined as:

“...mobility distribution model in which a customer’s major transportation needs are met over one interface and are offered by a service provider. Typically, services are bundled into a package.” (Hietanen, 2014), pp. 1–2, and “a system, in which a comprehensive range of mobility services are provided by customers to mobility operators” (Heikkilä, 2014), p. 8).

Now, the customer’s/traveller’s transport needs are central for the service instead of the modes. These two early definitions focus on more organisational and technical elements, such as ‘one interface’, a ‘service provider’ (cf. a MaaS ‘operator’), and ‘bundling’, as well as a ‘comprehensive’ range of modes. The company MaaS Global works according to these definitions, although their own, later definition is less specific and also mentions value to the customer in terms of removing hassle. MaaS:

“brings all means of travel together. It combines options from different transport providers into a single mobile service, removing the hassle of planning and one-off payments.” (MaaS Global, 2018).

In the 2016 report “Mobility as a Service. Exploring the opportunities for mobility as a service in the UK” (Transport Systems Catenal, 2016), MaaS is defined as:

“using a digital interface to source and manage the provision of a transport related service(s) which meets the mobility requirements of a customer”. (p. 6).

The report especially emphasises ‘as a service’ and ‘mobility’ (rather than transport) as the specific dimensions that differentiates the MaaS concept from e.g. multimodal or seamless journeys. MaaS, according to the report, involves a business model centred on the customer – traveller and his/her need of a transport solution:

“The (mobility) service model is associated with understanding the ‘who?’ and ‘why?’ of customers’ mobility requirements and only then is the transport solution offered as a ‘how?’”. (p. 10).

Kamargianii, et al., in a feasibility study from 2015 on introducing MaaS in London, utilised the following definition, also including consumers’ needs as well as one platform and payment, although it emphasises an alternative to ownership.

“The term ‘Mobility as a Service’ stands for buying mobility services based on consumers’ needs instead of buying the means of transport. Via ‘Mobility as a Service’ systems consumers can buy mobility services that are provided by the same or different operators by using just one platform
and single payment” (pp. 11–12).

Later in 2017, Kamargianni and Matyas (Kamargianni & Matyas, 2017) provided the following definition, which, although different, still emphasises the ‘consumers’ needs’ and a single platform, but now includes only one operator, as well as attributes some type of ‘intelligence’ to the distribution model:

“Mobility as a Service is a user-centric, intelligent mobility distribution model in which all mobility service providers’ offerings are aggregated by a sole mobility operator and supplied to users through a single digital platform.” (p. 3).

The definition from Ghanbari, et al. (Ghanbari et al., 2015) uniquely (among the definitions presented here) emphasises the ecosystem, instead of particular players, e.g. operator, provider, etc. Also, the door-to-door experience.

“MaaS, a multi-actor environment that provides seamless door-to-door services for end users by combining several modes of transportation.”

Some definitions emphasise elements central to the value offering to the customer, and the ability to personalise the service. For example, Atkins’ report “Journeys of the Future: Introducing Mobility as a Service” (Atkins, 2015) states:

“MaaS can be defined as: The provision of transport as a flexible, personalised on-demand service that integrates all types of mobility opportunities and presents them to the user in a completely integrated manner to enable them to get from A to B as easily as possible.” (p. 19).

With similar emphases, the Dutch report by MuConsult (MuConsult, 2017) defines MaaS as:

“the range of flexible, partly demand-driven, multimodal mobility services in which tailor-made integrated travel options are offered to travellers via a digital platform.” (p. 4) (translated from Dutch).

According to the MaaS Alliance, the MaaS interest organisation hosted by Ertico, MaaS is:

“the integration of various forms of transport into a single mobility service accessible on demand” (MaaS Alliance, 2018a).

Furthermore, the key concept behind MaaS is to:

“...put the users, both travellers and goods, at the core of transport services, offering them tailor-made mobility solutions based on their individual needs. This means that, for the first time, easy access to the most appropriate transport mode or service will be included in a bundle of flexible travel service options for end users.” (MaaS Alliance, 2018b).

A clear difference in this description, compared to most others, is that MaaS can also entail goods transport (cf. Samtrafiken’s definition of CM in Section 3.1).

The MAASiFIE project defined MaaS as:

“Multimodal and sustainable mobility services addressing customers’ transport needs by integrating planning and payment on a one-stop-shop principle” (König et al., 2016).

Noteworthy here is the dimension of sustainability (cf. Samtrafiken’s definition of CM in Section 3.1). That MaaS services should contribute to achieving increased sustainability can perhaps be considered obvious, but it is far from an obvious goal, or an obvious effect.

Of interest is that some more recent reports have taken the route of explicitly stating there is no definition of MaaS. For example, Polis takes the approach that it is a general term to describe many things (Polis, 2017), p. 4), while ITS Australia states that although there is no consensus as to a definition, “there is of course a substantial amount of consensus on what MaaS could be and what it could offer customers” (ITS Australia, 2018), p. 20). They, however, go on provide a definition based on other definitions covered here:

“MaaS systems offer customers personalised access to multiple transport modes and services, owned and operated by different mobility service providers, through an integrated digital platform for planning, booking and payment." (p. 20).

Finally, the description that perhaps encompasses the widest range of aspects discussed throughout this section comes from A.D. Little’s report “The Future of Mobility 3.0. Reinventing mobility in the era of disruption and creativity” (A.D. Little, 2018):

“The concept of ‘Mobility-as-a-Service’ (MaaS) aims to provide consumers with integrated, flexible, efficient and user-oriented mobility services. It implies a shift away from the personal ownership of individual motorised transportation modes, and non-integrated means of transportation towards the use of integrated multimodal mobility solutions consumed as services. This shift is enabled by combining transportation services from public- and private-transportation providers through an ‘integrated mobility platform’ that creates and manages the journey and integrates planning and payment based on mobility packages tailored to the needs of each customer segment on a one-stop-shop principle.” (p. 59).

Although not in their main description, they later point out that MaaS can be applied to the mobility of goods as well as people, and that one benefit of implementing MaaS is “the ability to orient transport policy towards more sustainable mobility modes” (p. 59). The report goes on to identify three types of integration that are required for comprehensive MaaS deployment, namely integration of physical services, integration of digital services, and integration of tariffs and risk governance models.

3.3. Integrated mobility services (IMS)

The term Integrated Mobility Services (IMS) is often used in limited reference to integrated information services, i.e. services that integrate information about different modes and from different service providers. This is in a way unfortunate as this phrasing, IMS, could potentially best capture the central elements of these ‘new’ concepts (cf. the previous section on MaaS).

K2, The Swedish Knowledge Centre for Public Transport, writes that:

“Integrated Mobility Services mean that in one and the same service, one knits together many ways to move in the city (e.g. carsharing, bus, tram, commuter train, bikesharing, private vehicles) at the same time that one can offer payment of and information about the modes via one and the same interface. These new mobility services contribute to an increased freedom of choice and a reduced need to own a car, especially in larger cities or metropolitan areas.” (K2 Swedish Knowledge Centre for Public Transport, 2017).

This definition, as in the above section on MaaS, emphasises integration, i.e. multimodality, and information and payment via a single interface, but it also mentions the urban environment – cities – as the context of IMS.

The IRIMS project has chosen to define IMS as services that:

“...not only integrates a range of mobility services, both public and private, but also provides one-stop access to all services through a common interface (hence creating a seamless customer experience, i.e. the service). The service component could be more or less developed, ranging from simply the possibility to find travel information and pay for different mobility services within one technical system, to providing more far-reaching mobility service offers such as subscriptions to different mobility packages, perhaps also involving other service components such as goods delivery or bicycle repair services.” (Mukthar-Landgren et al., 2016).

Yet again it is about the integration of different types of transport
services that are accessed by what is described as a common ‘interface’, but the definition leaves the service content open. Based on this definition that includes the mobility of people and goods, the service can comprise a level that entails integrated multimodal information and payment, but also a level that includes mobility services or even other transport-related services. Discussions regarding being able to expand MaaS’ service content and therefore the offer to the customer are ongoing within various consortia.

3.4. Conclusions from the exploration of definitions and descriptions

There is currently no established definition of MaaS (or CM or IMS), and, as discussed above, it is likely premature to provide ‘one definition’ at this early stage of MaaS development. The definitions and descriptions covered above highlight some common and some different central elements related to e.g. technology, organisation, function, value offering, and society. However, no matter the definition or description, it is most generally about:

- Offering a service with customer/user/traveller/consumer transport needs as the main focus;
- Offering (multimodal) mobility rather than transport;
- Offering integration of transport services, information, payment and ticketing.

In terms of integration, there needs to be a clearer characterisation of different types of integrated services. The challenges faced in the development of integrated services are at least partially related to which types of service elements are to be integrated and to which degree. Despite this, and although various analyses have explored barriers of MaaS (e.g. Holmberg, Collado, Sarasini, & Willander, 2015; Mukhtar-Landgren et al., 2016; Sochor, Eckhardt, König, & Karlsson, 2016; Transport Systems Catapult, 2016), there is not yet any thorough analysis of the connections between the different types of integrated services and the services’ challenges and potentials. Integration can, for example, comprise:

- Integrated information services / multimodal travel information. This, together with integrated payment services, can be considered MaaS’ ‘core’;
- Integrated booking or ticketing, e.g. a ‘smartcard’ or a mobile app that can provide access to different modes;
- Integrated payment or invoicing;
- Organisational integration. Collaboration between different transport providers (car- and bikesharing, taxi, bus, train, etc.) is a prerequisite for integrated mobility, but how that collaboration occurs will differ between MaaS services.
- Bundling, which entails e.g. a subscription to trips with different modes. This type of integration has so far been the exception rather than the norm, but this may change in the future. Analyses of the success factors of the UbiGo pilot in terms of both customer satisfaction and behavioural change showed the importance of developing the service and its offer to the customers (Sochor, Karlsson, & Strömberg, 2016).

4. Results: Workshop and the development of the proposed topology

During the workshop, aspects of different perspectives – societal, business, user/customer, and technical – were first identified and discussed. Then the aspects were collectively narrowed down via group discussion to a limited number of key aspects (underlined below) in terms of both overall importance and differentiation in service levels (i.e. how do different services differ from each other). Due to time constraints, the workshop did not further delve into more specific stakeholder perspectives, e.g. employers, tourism, housing.

From the societal (or policy) perspective, the aspects considered most relevant were the effect on: private car ownership (current and potential), private car use (congestion and emissions), use of resources (materials, energy, etc.) and existing infrastructure, sustainable accessibility, urban planning and, in the long term, a city’s attractiveness and livelihood, management of traffic and mobility, attitudes and awareness, equitable access (social and geographical), innovation, employment, and, in the future, automated vehicles.

For business, the following were considered important: new customers (number and type, i.e. new markets), new business models, bundling and pricing, becoming a market player, reduced costs (e.g. recruitment, support, management), integration costs, changes in mode use, influencing use, exclusivity (competitively neutral), the customer relationship and ‘owning’ the customer, branding, contracts, burden of responsibility, liability and guarantees. Certain aspects may be more or less important if the MaaS service is a ‘brokerage’ versus a mobility marketplace (as discussed in Section 5).

From the user/customer perspective, identified important aspects included: how well the service meets one’s entire mobility needs (including accessibility and door-to-door solutions), what transport services are included and where they are located (breadth of service), bundling/packaging, flexibility (easy to modify, minimal lock-in effects, etc.), low-risk trialability, cost and price worthiness, burden of responsibility, liability and guarantees, customer support, personalisation and customisation, decision support (e.g. travel planning), ticketing and payment solutions (easy to book/modify/authenticate and pay), usability (both the interface and how easy it is to understand the offer, pricing, etc.), and data security and protection (ownership, sharing, etc.). For B2B, even easy administration and improved accessibility for employees, customers and visitors.

From the technical perspective, the following were identified as relevant: information/planning function at different levels (a) ‘only’ centralised information, (b) multimodal travel planner, and (c) assistant i.e. taking one’s schedule into account), payment solutions, APIs, platforms (both front- and back-end solutions), data analysis, integration with existing systems, and user interfaces.

Next in the workshop, participants identified a range of examples of MaaS or similar services based on both their own knowledgeability regarding the services’ value offerings and business models, and on likely familiarity to a wider audience at the time. In other words, this step was intended to be illustrative yet informative, rather than exhaustive. Then, to the best of their knowledge, the participants attempted to break down how the services differed based on the above, identified key aspects (underlined); see Fig. 1. Among the range of existing services were identified: travel planners (with or without real-time information), travel planners with ticketing and payment functions (e.g. Moovit), travel planners with booking and payment functions (e.g. SMILE), mobility marketplaces (e.g. in the Netherlands), ‘public transport plus’ (e.g. Hannover Mobil), and ‘MaaS operators’ (e.g. UbiGo, Whim/MaaS Global). For comparative purposes, a unimodal service (Uber) was included.

Regarding Fig. 1: this figure is mainly based on the perspectives of the customer, provider and business, as, if a service does not deliver value to the customer or provider, and if the value cannot be captured by the business, then the service is not particularly relevant or economically sustainable. Regarding the ‘(x)’ versus ‘x’ marks under ‘Brand & customer relationship’: in the cases of (x), the parentheses are due to the argument that these services may have a brand, but not necessarily a direct customer relationship with the end users (travellers) as these services primarily act as intermediaries. In future versions, it may be better served to split ‘brand’ and ‘customer relationship’ into two separate items, as one could also argue in the case of ‘responsibility’ and ‘customer support’. Regarding the ‘x’ marks under ‘pricing models a) rebates’: rebates alone do necessitate collaboration above and beyond commissions, but they are perhaps not enough to qualify as a pricing model and could therefore potentially be moved to a special case of
5. Explanation and discussion of MaaS topology levels

### 5.1. Level 1

This level represents integration of information. This level can be further classified by functionality, as in Fig. 1 above, according to a) ‘only’ centralised information, b) multimodal travel planner, and c) assistant. The added value of Level 1 is decision support for finding the best trip, on a trip by trip basis.

Level 1 has users rather than customers, as the end users are typically not prepared to pay for travel information, targeted or not, no matter the perceived value. As such, most travel planners or other types of mobility information sites or apps are currently financed by ads or taxpayers’ money. However, if the information in the Level 1 service also consists of e.g. price and reservation information, then, upon forwarding a user to their chosen provider, an ‘information market platform operator’ has the chance to earn a small commission.

Transport service providers contribute by supplying open, standardised data for free, which is the case for many public transport authorities. The Level 1 market will most likely be controlled by a few global players with user bases large enough to attract advertisers, e.g. Google, but there is a clear niche for local, publicly operated travel planners and traffic information sites. With a large online user base, the information collected by global actors can be sold to cities for traffic management or infrastructure planning (which is an already established revenue source for such actors). It will however be hard for small companies to keep up, as users will expect more and more of ‘smart’ travel assistants that integrate both personal planning information and relevant data from a broad spectrum of sources.

A Level 1 operator will not be responsible for the quality of the service about which it provides information, and in a legal sense not for the information itself. However, users will likely turn away if they find (or perceive) that the information cannot be trusted or is hard to understand.

### 5.2. Level 2

This level represents integration of booking and payment. A Level 2 service focuses on single trips and could be a natural extension to a travel planner, adding public transport ticketing, taxi, or other transport services where possible. In fact, a booking and payment service needs to tie in to a travel planner or some other information service in order to help the user identify and choose between options. Level 2 is sometimes referred to as a bottom-up approach (Architura, 2017).

The added value of Level 2 for the end user is easier access to services – such as a mobility marketplace or a one-stop shop where the user can find, book, and pay with the same app (e.g. with a pre-registered payment card). Such a service will make travel easier for those who are already multi/intermodal, but the offer is probably not holistic enough to convince households to actually sell their first or second car and, in that way, create new customers for the transport service providers.

This level can be used by registered and/or ad hoc customers

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**Fig. 2.** Proposed topology of MaaS including Levels 0–4 (left) and examples (right).
depending on the mode (e.g., carsharing requires registration), or perhaps by third parties such as a mobility ‘brokerage’. However, it is unlikely that users will be willing to pay extra for the assistance in buying a trip if it is not combined with some extra service. Thus, the revenue will come from brokering fees, commissions, and/or from fixed supplier memberships. Also, like an information service with a large user base, aggregated and anonymised data on users’ behaviour may perhaps be sold to cities for traffic and mobility management.

For the transport service provider, the added value of Level 2 is to gain exposure to more customers. However, although the providers gain a cost-effective exposure to the user base, they will also be offered side by side with competitors, meaning that the added value will likely be highest for new, small, or niched services that can win market shares. It is possible that some of the more established providers will be less interested in being included in a Level 2 service, especially if participation comes with a cost, but this of course depends on how dominant the service is.

For the Level 2 operator, the cost and complexity of integrating many suppliers can be high, depending on the level of standardisation. More suppliers also means more contracts. Furthermore, if the Level 2 service/platform is operated by a public entity, e.g. a public transport authority, it will likely need to be open to all transport service providers or be subjected to a quite complicated procurement process.

The Level 2 operator takes responsibility for valid tickets, accurate bookings, and the purchase, but not for the actual travel services. However, users may expect the operator to take responsibility for the services they in fact have bought from the operator (even when supplied by a provider), thus a Level 2 operator may need to offer first-line support to maintain user satisfaction.

Low margins, high cost of integrating many services, and cost of first-line support can make it hard to run a Level 2 service – as a separate business, that is. It could however add value to an already existing, non-mobility-based business. If hotels, event companies, shopping malls, etc. could integrate transport into their offers to their customers, the perceived value of their services may be much higher than the cost of integration. One transport service to include in tickets, campaigns, and other travel or rental services is public transport. In that case, commission is not really fitting, which means that there may be a niche for a B2B aggregator, a clearinghouse that offers easy access to multiple transport services for businesses. It would be similar to Amadeus for air travel, but with much smaller transactions, and many more and local suppliers, often with different price models.

5.3. Level 3

This level represents integration of the service offer, including contracts and responsibilities. The added value of Level 3 is the comprehensive alternative to car ownership, with a focus on the customer’s complete mobility needs, and the transport service providers’ increased attractiveness to customers they cannot reach as single services. The Level 3 service is bundled, possibly subscription-based, and there is full, two-way responsibility from end user to supplier and vice versa. It is most likely financed by the bottom-line difference between the packaged services and the volume agreements with the transport service providers.

A Level 3 MaaS service typically focuses on the total need of a household – it is about getting from morning to evening, Monday to Sunday, and spring to winter, rather than single trips from A to B. It is positioned towards offering a comprehensive alternative to car ownership in order to attract customers with larger mobility budgets and willingness to pay for quality and ease of use. It involves a mutual commitment, at least on a monthly basis. As the service is bundled in some way, MaaS should, in this case, be Mobility as a (unified) Service. Level 3 is also referred to as a top-down approach (Architura, 2017).

As the MaaS operator takes responsibility for the service delivered to its customers – and for its customers towards the suppliers – it is more than a broker or an open marketplace. The MaaS operator (of which there may be more than one competing with each other) typically works more closely with preferred suppliers, often one per mode, in order to not only attempt to run a profitable business, but also to create value for (and attract) the suppliers and, with that, better deals for its customers. For example, running a carsharing operation is a tight business; if the cars at a site are used too little, they generate a loss, but if the usage is too high, the users will complain, and the company will need to add a car (that may be used too little). If the MaaS operator can grow the total customer base and increase the overall usage of the shared cars, this could mean the difference between profit and loss.

The MaaS operator’s business is based on a ‘swings and roundabouts’ principle, i.e. some trips or modes are resold with high margins and some at a loss. The pricing is non-transparent – what the customer pays to the MaaS operator is not directly linked to what the operator pays to the supplier, and the price models can be different from what the suppliers themselves market to their own customers. It is much like an all-inclusive charter trip as opposed to the travel agency approach in Level 2, as the traveller does not know the cost for the separate items included in the charter trip (flight, hotel, dinner, tours, etc.). For an operator that is skilled at negotiation and understanding customer needs, this opens up for a higher average margin. The bundled service could also be offered to companies as mobility packages to employees.

In a Level 3 service, an ICT-platform is needed to run the business, but in a Level 2 service, the platform is the business. Interestingly, the complexity of the technical integration can be lower for a Level 3 service than for a Level 2 service due to fewer suppliers and less interaction. A Level 1 information service could be more or less a common, global business, as long as there exists some standardised open data. A Level 2 service needs local presence due to more interactions and business agreements with regional or local suppliers. A Level 3 service is local – it needs to find the best supplier(s) of each mode with whom to develop the service, and it needs to find politically acceptable contract models with the regional or local public transport authorities. However, the platform can be shared among networked operators, also opening up for roaming, where customers in one local service can use their native mobility subscription when visiting other places.

5.4. Level 4

This level represents integration of societal goals. The added value is reduced private car ownership and use, a more accessible, livable city, etc. Incentives are implemented in the MaaS service (or implemented in individual services, as a Level 4 approach could be integrated at any level), reflected by how well local, regional, and/or national policies and goals are integrated into the service. For example, the addition of economic transactions on Levels 2 and 3 (compared to Level 1) entails an additional opportunity to mediate economic incentives for choosing more sustainable modes of transport, changing travel times to off-peak hours, etc.

The public authorities on a city, regional or national level can influence the societal and ecological impacts of mobility services, i.e. influencing users’ behaviour by setting conditions for the operators (and individual transport service providers) so that they will create incentives for desired behaviour. Two important public actors are cities that dictate the use of infrastructure and public space, and public transport authorities that often control the ‘backbone’ of mobility. In the long run, cooperation with these actors is a ‘must-have’ for potential MaaS operators and the transport service providers. For public actors, their monopoly position should be used to make sure mobility solutions not only fulfil citizens’ needs, but the city’s goals as well. For instance, a public transport authority can set a hard, but wide framework for the operations of the local public transport authorities that often control the ‘backbone’ of mobility. In the long run, cooperation with these actors is a ‘must-have’ for potential MaaS operators and the transport service providers. For public actors, their monopoly position should be used to make sure mobility solutions not only fulfil citizens’ needs, but the city’s goals as well.
planning purposes, reach a certain conversion rate, or forward incentives such as benefits for shifting to off-peak public transport trips.

Mixing public, often subsidised, services with commercial services into customisable packages poses different challenges. Public transport is a one-size-fits-all service with non-flexible price models, while an attractive MaaS offer needs to be perceived as a unified, flexible service. It is the public transport service that needs to be integrated rather than the existing public transport 'products' such as single tickets or monthly cards. To be politically acceptable, resellers need to prove that the pricing of public transport, as part of a MaaS service, is revenue, tax, and price neutral compared to the direct sales of tickets. A MaaS service run by a public transport authority/operator will experience the same problem – if the service should be attractive enough to compete with car ownership.

It is also important to understand that a business model is connected to the organisation that owns it. The possible offers, revenue streams, relationships, partnerships, and agility all depend on who runs the service, as do the effects on the transport system. Will MaaS make it easier for public transport users to use a car or for car owners to use more public transport? Level 4 is really about how to balance the demands on transport service providers and MaaS operators against the possibilities to run a ‘profitable enough’ business. This means developing contractual models for private-public cooperation, as well as understanding how changes in a policy framework will affect users' behaviour with transport service providers and MaaS operators as intermediaries.

6. Discussion on achieving a transition to a sustainable MaaS-based transport system

MaaS has the potential to revolutionise the way we travel. The proposed transformation is radical in scope, and may be described using the notion of a socio-technical transition. The latter is defined as "...a gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) transforms" (Rotmans et al., 2001). A transition to MaaS may be considered sustainable if MaaS contributes to the fulfilment of societal goals, such as the need for decarbonisation of the transport system, reduced congestion, innovation, and better accessibility. In other words, a transition to MaaS services that integrate societal goals (Level 4) may be considered sustainable. In this section, we address the question of how a transition may be governed, such that barriers and obstacles to change are overcome, by referring to the field of transition management. The latter outlines four activities that are key to the governance of sustainable transitions: strategic, tactical, operational, and reflexive activities (Kemp, Loorbach, & Rotmans, 2007; Loorbach, 2007, 2010).

- **Strategic** activities are collaborative, multi-stakeholder processes, which aim to ensure that long-term visions (i.e. societal goals) are shared and embedded among collectives.
- **By contrast**, tactical activities serve to link individual actor strategies to the shared long-term visions created via strategic activities, aiming to overcome short-termism within different societal sectors (e.g. politics, business). They also aim to tackle the difficulties in implementing solutions by acknowledging complex sources of inertia within regimes, as well as by directing activities such as corporate political action and lobbying towards the reformation of such structures.
- **Operational** activities aim to link everyday activities such as innovative experiments to long-term visions, broader policies and change agendas.
- **Reflexive** activities include the ongoing monitoring, assessment and evaluation of policies and practices as a means to revise overarching visions and plans where necessary.

In the current ‘fluid’ phase of MaaS development, which is characterised by experimentation with multiple competing product/service designs (Abernathy & Utterback, 1978), we argue that operational, tactical, and reflexive activities are the primary focus for MaaS practitioners (and other stakeholders) at Level 4. Generally, operational activities aim to link everyday practices (e.g. innovative experiments conducted by MaaS practitioners) to broader visions and change agendas. Here the term ‘vision’ refers to relevant societal goals, including transport policy objectives (decarbonisation, reduced congestion, improved accessibility, innovation, etc.) or other societal trends such as digitalisation and the shift to a more circular economy. By contrast, tactical activities: link individual actor strategies to shared long-term visions; aim to tackle the difficulties in overcoming institutional barriers to change; and lobby for and experiment with new institutional arrangements. The overarching point is that the capacity for MaaS to support transport policy objectives and other societal goals is essential to its success. Operational, tactical, and reflexive activities are all needed to demonstrate this potential, and all require engagements from MaaS practitioners within the public and private sectors.

In terms of operational and reflexive activities, there are several things MaaS practitioners can do to link innovative experiments to broader visions and political goals. One example is to demonstrate how MaaS services (including pilots) contribute to reduced congestion and emissions, improved accessibility, and sustainable travel behaviour of users. A further example, as noted in previous sections, is to show how non-sensitive user data generated via MaaS can be sold to cities for traffic management purposes to improve the sustainability of the transport system. In future, developments in connected vehicles and other digital technologies could allow for real-time traffic management of ‘smart’ cities, allowing for further sustainability gains. Demonstrating the benefits of experiments such as these can help to garner financial and political support for a transition to a MaaS-based transport system. Operational and reflexive activities may focus on other types of innovative experiments for the same purpose, including: the further integration of transport modes within MaaS business models; the scaling of MaaS business models to new geographical areas; roaming; the integration of incentives for sustainable travel behaviour into MaaS services (i.e. incentives such as nudging and gameification to promote shared mobility and sustainable modal choices); the further introduction of environmentally benign technology into vehicle fleets (e.g. electric drives) as a means to reduce transport emissions; and so on. Operational activities ensure that experiments and innovations are directed towards the resolution of societal problems, and reflexive activities evaluate and assess the way in which MaaS generates sustainable value for different societal stakeholders.

In terms of tactical activities, transition management involves making it clear how the strategies of individual MaaS practitioners can collectively contribute to the sustainable development of the transport system. Similar to operational activities, linking individual strategies in the private and public sectors to broader visions provides MaaS with credibility and legitimacy among societal stakeholders, and can help to garner financial and political support. In practice, this means that MaaS practitioners should establish organisational strategies, goals and targets that collectively aim to improve the sustainability of the transport system (e.g. by attracting X numbers of new users, our company aims to reduce transport system emissions in city Y by Z percent in five years).

MaaS practitioners can engage in a further type of tactical activity, which is to engage a set of key stakeholders with the mandate to provide the types of support necessary to allow MaaS to flourish. In practice, these actors may be financial investors, who are willing to provide capital to support successful business models; civil society organisations that can champion MaaS by shaping public opinion; and public authorities, who are willing to create a set of supportive institutional arrangements given the demonstrated sustainability benefits of MaaS. Examples of such institutional arrangements include the revision of fiscal policies and the redistribution of subsidies on a municipal, regional, or national level. Public authorities can also influence...
the social and ecological impacts of mobility services by placing demands on operators to create incentives for desirable travel behaviour; and they can support the diffusion of MaaS by providing exemptions from congestion charges, altering parking regulations, allowing shared cars to travel in bus lanes, etc. Further, public authorities can integrate MaaS into local transport policy objectives by, for example, using dynamic road charging in dense areas.

In practice, mixing public, commonly subsidised, services with commercial services into customizable packages poses significant challenges. Public transport is a one-size-fits-all service with inflexible price models, whereas an attractive MaaS offer is designed as a unified, flexible service, which may be commercially driven. To gain acceptance, MaaS practitioners must demonstrate to one another that their business strategies and practices will not encroach on others' customer base and brand. Also, (particularly commercial) MaaS operators must ensure that public transport is priced at a revenue-, tax- and price-neutral level compared to the direct sales of tickets. Cities also have large role to play in that they dictate the use of infrastructure and public space; and public authorities commonly control the ‘backbone’ of mobility. Private sector engagement is also needed to unlock the innovative potential of MaaS, which spans the transport, telecom and energy industries (Spickermann et al., 2014). And in situations where the public and private stakeholders and practitioners cannot overcome the barriers to collaboration, including fragmentation and protectionism/risk aversion, it may become necessary to engage relevant third-party actors that can act as neutral gatekeepers and orchestrators of collaboration. To summarise, engaging different types of stakeholders is critical for two reasons: 1) it can provide a platform for MaaS practitioners to lobby for and experiment with new institutional arrangements; and 2) it can aim to tackle the difficulties in overcoming institutional barriers to the development and diffusion of MaaS.

7. Concluding remarks

There are currently many examples of different mobility services, from multimodal travel information (including park&ride, parking, etc.) to integrated ticketing services, to ‘MaaS operator’-type services. However, lumping all these services together under one loosely defined concept such as MaaS creates confusion and potentially undermines the concept as it can then be perceived as merely the latest buzzword; a new name for the same old thing. As illustrated and explained above, not all services are or should be ‘equal’ in the MaaS topology, as they target different customer needs. The innovation in MaaS, but also the challenge, likely lies not only in the integration entailed in the levels above, but the organisational integration (not least between public and private actors) and the ‘bundling’ required to achieve Levels 3 and 4. Understanding the MaaS topology and its implications can help nuance the conversation, deepen the understanding of barriers and enablers for different levels, and facilitate the development of MaaS, e.g. in the form of action plans tailored to the intended MaaS level and goals.

Regarding the topology per se, it could be argued that it may be too ‘simplistic’, as there can exist hybrids between levels. Also, as pointed out above regarding matching services to levels, there are always issues of interpretation; e.g. does one classify multimodal public transport with a travel planner and some degree of integrated ticketing/payment, e.g. Västrafik in Gothenburg, as Level 0 or as Level 2? There may also exist additional aspects that have not been applied to the levels, e.g. geographical context (urban, suburban, and rural MaaS); and Level 4 could potentially be further broken down into the three types of sustainability – social, economic, and ecological – and applied in a third-dimensional layer across all levels, including trade-offs between types of sustainability, e.g. accessibility/social and ecological. However, the purpose of developing this topology was not to present an exhaustive and static description of MaaS, but rather to provide a straightforward and dynamic tool as a basis for discussing, understanding, and comparing different types of services, their viability and effects. In other words, we posit that the topology may be a useful fundament for a set of tactical, operational and reflexive activities that can assist in a transition towards a sustainable, MaaS-based transport system.

As a next step in deepening the understanding of MaaS, further analysis is desirable regarding the possibilities and problems linked with the different levels of MaaS, preferably based on thoroughly evaluated case studies, more of which are needed (Karlsson, Sochor, Aapaoja, Eckhardt, & König, 2017). Such an analysis is key to evaluating and understanding which impacts and effects can be achieved via the implementation of different levels of MaaS services in terms of e.g. social, economic and ecological sustainability, as well as business potential. That is, there is a strong need for reflexive activities that assess and evaluate the utilities of MaaS as an operational phenomenon.

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Declaration of interest

None.

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