Mobility as a Service (MaaS): A Thematic Map of Challenges and Opportunities

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**ABSTRACT**

Mobility-as-a-Service (MaaS) has many advocates suggesting that it could evolve to the cornerstone of a new mobility paradigm since in theory it can tackle many of society’s grand challenges referring to environmental degradation, increased traffic congestion and reduced accessibility. However, little evidence exists to confirm that this is achievable; in reality, a consensus is yet to be reached even in terms of what exactly classifies as MaaS and what the MaaS priorities should be. Few cities have piloted digital interface-based schemes integrating in a holistic way public, active and shared use mobility services, and have measurable results about their impacts; thus, there may be a significant gap between MaaS’ actuality and potential and a need to elaborate on this dichotomy. This study is a critical narrative review of the literature that contextualises the key dimensions of MaaS and then identifies, categorises, and discusses its possible implications. These are presented in 11 diverse thematic areas mapping out the opportunities and challenges of MaaS that may possibly underpin its business establishment, functional management, user adoption and long-term sustainability.

**Key Words:** Mobility as a Service; MaaS; Integrated Mobility; Actuality vs Potential; Narrative Literature Review
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Literature Review
1. Introduction

Mobility as a Service (MaaS) can be defined a holistic transport provision mechanism that meets transport user needs by offering tailor-made mobility solutions enabled through access to and integration of a wide range of vehicle types, journey experiences and complementary services over a single digital interface. MaaS is an intervention that through its digitisation, connectivity, information and sharing merits intends to inspire and support the transition to a more sustainable mobility paradigm (Alyavina et al., 2020). Although the body of MaaS research is continuously growing, MaaS is still at an early stage in its development with a lot of experimentation and pilot programmes underway (Arias-Molinares & García-Palomares, 2020; Goodall et al., 2017; Karlsson et al., 2016; Lund, 2017; Samsel et al., 2017). Actually, there is no clear consensus as yet on what exactly MaaS is and what should be its defining goals (Lyons et al., 2020; Nikitas et al., 2017). MaaS for now has been predominantly developed in urban areas with strong public transport networks serving as a backbone of the MaaS offerings but may also become a solution for rural areas (Liimatainen & Mladenović, 2018).

This paper discusses the concept of MaaS and identifies, categorises, and contextualises the implications of shifting to MaaS transport paradigm as well as the opportunities and challenges reflecting and affecting MaaS delivery, adoption and long-term use. In the following sections, the paper will discuss the characteristics that make MaaS a unique and novel transport concept, identify the key elements and their respective roles in MaaS ecosystems, present the most likely business models affiliated with MaaS and review recently developed MaaS topologies. More importantly perhaps our analysis serves the purpose of creating a thematic map of the potential benefits and complications that could define the transition to a MaaS-centric paradigm for transport users, businesses, the society, and the environment.

2. Background and Context: MaaS at a Glance

MaaS is a complex phenomenon, a novel concept with a multitude of features difficult to reflect in a single definition. Although the definitions of MaaS are many, they are often case-specific and, thus, inconsistent. There is also a dichotomy between researchers and developers thinking of MaaS primarily as a ride- and car-sharing scheme facilitator, and others advocating that MaaS should only describe superior holistic multimodal systems (Nikitas et al., 2020). For this reason, before explicitly discussing MaaS’ implications, and the opportunities and weaknesses they bring to the table the authors deemed important to describe and explain what is implied by the term MaaS in this paper. So, the following sections introduce the concept of MaaS, list its core features, the key stakeholders involved in the MaaS
development, the potential ways of managing MaaS, or in other words MaaS business models, and the MaaS topologies.

2.1. MaaS Core Elements

A number of studies have already tried to provide a comprehensive list of available MaaS definitions (Jitrapirom et al., 2017; Sochor et al., 2018; Oliveira Cruz & Miranda Sarmento, 2020), summarise the existing MaaS knowledge and list its distinguishing characteristics (Arias-Molinares & Garcia-Palomares, 2020; Casady, 2020; Giesecke et al., 2016; Jitrapirom et al., 2017; Mulley, 2017; Utriainen & Pöllänen; 2018; Wong et al., 2020). Generally, these authors identify the following MaaS distinguishing features:

- **Consolidated Transport Offering**: the idea behind MaaS is to seamlessly integrate conventional public transport services with commercial shared use mobility alternatives, such as taxi and ride-hailing, car-sharing and car rental, ridesharing and carpool, bike-sharing and other micromobility options, such as e-scooters, and even walking, all to overcome the need to own a private car.

- **Access via Digital Platform**: The access to a multitude of transport options in the MaaS paradigm is facilitated by the use of an all-in-one digital platform that can be web-based or (most likely) run via a smartphone application.

- **Intermodal Journey Planning**: The digital MaaS platform in itself is an intermodal journey planner enhanced with booking and ticketing, and payment for a multimodal journey all in one place, as well as provision of real-time information necessary to plan and execute the trip as well as overcome issues arising on-route.

- **Bundles of Services**: The services in MaaS can be offered in a bundle form, where the volume of use of different transport modes is customised to specific user needs.

- **Payment Options**: MaaS user needs can be served on a pay-as-you-go basis as well as in the form of a periodic subscription for mobility service bundles.

- **Decision-making Support**: A MaaS system may be able to influence end user trip decisions by, for instance, promoting active or environmentally friendly travel through informational campaigns and financial incentives, thus contributing to overall societal goals.

- **Inclusion of Extra Services**: A MaaS system may also include other types of services, such as parking or delivery of goods.

- **Multi-Stakeholder Cooperation**: All the above is built through cooperation of multiple stakeholders.
2.2. *MaaS Ecosystem and Business Models*

To come to life and, ultimately, offer end users a seamless travel experience MaaS requires a number of stakeholders to cooperate with each other. These stakeholders define a MaaS ecosystem (Kamargianni & Matyas, 2017), while the ways in which they cooperate contribute to the development of various business models for MaaS. According to a number of sources (Kamargianni & Matyas, 2017; König et al., 2016), the core MaaS ecosystem includes:

- **A MaaS Provider**, or Operator, who cooperates with all stakeholders to create a diverse service offering for customers.

- **Transport Service Providers** who sell their capacity, or access to fleet of vehicles, to a MaaS Provider and share their data.

- **Enabling Technology and Services Providers**, including Data Providers who offer MaaS Operator data management and analytical capabilities, and Technology Providers who offer technological solutions, such as journey planning, ticketing and payment, cloud computing and ICT infrastructure, and support the MaaS Operator in developing its own business intelligence and platform.

- **National and Local Authorities** who provide regulations for open standards and interoperable data formats, as well as policy frameworks and recommendations for the sustainable development of the market, and

- **Customers**, or End Users, who consume mobility solutions, provided by the MaaS Operator, on individual or company level.

Kamargianni & Matyas (2017) also describes other stakeholders who may complement the MaaS development. These include: investors providing financial support to the development of truly integrated MaaS systems; insurance companies supporting end users in claiming passenger rights; and Universities and Research Institutions providing scientific evidence regarding different aspects of MaaS in order to assist the regulators in developing the enabling frameworks, facilitate innovation, and contribute to the development of the business models, the financing structures, the insurance schemes and the revenue allocation models.

The types of MaaS business models are bound to develop according to the stakeholder who takes on the role of the MaaS Operator. The literature (Aapaoja et al., 2017; König et al., 2016; Polydoropoulou et al., 2020; Smith et al., 2018a; Wong et al., 2020) generally talks about three types of MaaS Business models:

- **Commercial model**, also referred to as market-driven, where the role of the MaaS Operator is undertaken by a private stakeholder, e.g. transport service provider, technology provider, or a MaaS focused start-up organisation. In this scenario the private actor is responsible for making contracts and agreements with all the stakeholders in a MaaS ecosystem and creating bundles of mobility services.
• **Public controlled model**, where the role of the MaaS Operator is absorbed by public transport authorities. In this scenario the public transport authorities take on responsibility of procuring and reselling services from private actors as well as traditional public transport services; and

• **Public-Private Partnership model**, where the brokerage functions of the MaaS Operator are shared. Here, the public transport authorities are responsible for transport services procurement, while the private actor takes on responsibility for developing MaaS platforms and reselling the procured by public transport authorities services.

In addition to the above, more simplistic business models with less potential for a genuinely holistic service provision exist, with “MaaS-Lite” being an example (Nikitas et al., 2020). The schemes employing a MaaS-Lite business model do not depend on MaaS Operator functions (Pickford & Chung, 2019). These schemes usually integrate only some transport services whose major aim is to provide first- and last-mile travel solutions.

2.3. **MaaS Topologies**

To this day no consensus has been reached with regards to what level of integration within a mobility system means the system can be labelled as MaaS. Sochor et al. (2018) and Lyons et al. (2020) argue that mobility systems with very basic as well as very advanced integration of services can be regarded as MaaS systems, only of different integration levels, and propose MaaS topologies with five and six levels of integration accordingly.

Both topologies account for Level 0 MaaS, or the “no integration” level, where various transportation modes serve user needs independently of each other, and the information, booking, ticketing and payment services are mode-specific. Level 1 MaaS is referred to as “integration of information” (Sochor et al., 2018) or “basic integration” (Lyons et al., 2020) and, according to both topologies, provides the traveller with information services that cover several, and possibly all existing, transportation modes within a given mobility system.

Therefore, the user is only given information about the available transport modes, combined into a multimodal chain where applicable, as well as possible routing, cost and booking options for a trip in question; the booking, payment and ticketing functions are left aside.

The two topologies, however, differ in the way further levels of MaaS integration are explained. So, Sochor et al. (2018) talks about Level 2 MaaS as the “integration of booking and payment”, where the user can not only get information services across several modes of transport but also book and pay for individual trips at a single digital platform, for example a smartphone application. Level 3 MaaS, representing the “integration of service offer”, covers more than just individual trips: it offers the user an option to subscribe to MaaS offering and,
for a periodic payment, receive bundles of mobility services that cover full daily mobility needs, thus offering an alternative for individual car ownership. Level 4 MaaS, according to Sochor et al. (2018) is the most advanced level of MaaS integration, that focuses not only on the needs of the user but also on societal goals, such as liaising between the demand for and supply of mobility, reducing the use of cars or promoting liveability in cities, and therefore is referred to as the “integration of societal goals”.

The topology of Lyons et al. (2020) sees Level 2 MaaS as less advanced than that of Sochor et al. (2018) topology. Described as “limited integration”, Level 2 MaaS offers a combination of information provision, booking and payment services for one transportation mode and only information provision for other available modes. The latter means that the user, while receiving a multimodal proposition for a full trip in question, may be able to book and pay for only a part of that trip using a single digital platform. Further levels of MaaS integration in the topology of Lyons et al. (2020) all incorporate planning, booking and payment features across a multitude of transport modes, but are also described through the lenses of geographic area coverage and the number of transport modes offered. So, Level 3 MaaS, or “partial integration”, allows the user to plan, book and pay for trips using more than one transport mode, however the geographical area where multimodal trips can be done is limited, and the transportation offering does not incorporate all the modes available within that geographical area. At Level 4, “full integration under certain circumstances” is achieved: the transportation offering within MaaS system covers all the modes available within a given geographical area, however the MaaS system itself is not able to serve user needs beyond that geographical area (e.g. only local trips, or the modes offered do not sufficiently cover all the parts of that geographical area). Level 5 MaaS is then referred to as “full integration under all conditions” but also described as an “unrealisable ideal”, where all transport modes are integrated in a way that completely covers user daily needs for both local and domestic travel and is able to compete with a private car.

3. Methodology

3.1. Defining MaaS for the Present Study

The previous discussion demonstrates the multidimensionality and complexity of the MaaS phenomenon. To be labelled as MaaS the system or service does not necessarily need to possess all the presented features or comprise of all the described above stakeholders; even when lacking a MaaS Operator, who is generally considered the core player, the scheme could still be considered MaaS. For the purpose of this paper, the authors consider MaaS as any mobility scheme that tries to integrate at least two (excluding walking) transport modes and provides journey planning, booking, payment and ticketing functions for those within a single
digital interface. The latter also means that anything beyond the Level 1 integration, as per
Sochor et al. (2018), or beyond Level 2 integration, as per Lyons et al. (2020) in this paper is
considered to be MaaS.

4 3.2. The Literature Search and Analysis

The following discussion is the product of a narrative literature review that used some key
principles of a systematic literature review (i.e., keyword search; material selection criteria;
narrow down process) as described in Van Wee and Banister (2016), Knowles et al. (2020),
and Nikitas et al. (2020; 2021) and is reflecting on MaaS emerging opportunities and
challenges. We specifically examined all accessible peer-reviewed MaaS research literature
published between 2014 and 2021 and a selection of relevant, though not peer-reviewed,
items, such as conference papers and industry reports. A search in Scopus, conducted using
the terms ‘Mobility as a Service’ and ‘MaaS’, returned 262 English language journal articles
and conference papers. Thus, a total of 262 abstracts were read by the authors, after which
165 sources were retained as relevant to our research aim that was about thematically
contextualising the MaaS dimensions, opportunities and challenges. These sources were read
in full to, first, understand whether the idea of MaaS in the source conformed to the one
developed by the authors, and then used by each author to create independent conceptual
maps of the key MaaS strengths and weaknesses. After this step, the three authors compared
and synthesised their independent written outputs to create a single, more comprehensive,
narrative. This work in its final form includes references to 63 journal articles, conference
papers and industry reports. The selection criteria were based on the subject-specific
relevancy and recency of the research output to the narrative of our study, and for the Scopus-
indexed articles also the journal impact factor and ranking quartile score. For the inclusion of
some “older” papers we used as a proxy the output’s impact as measured by the number of
its citations.

4. Results

The sections below provide a detailed account of each of the identified via literature search
implications of shifting to a MaaS transport paradigm. These at present are largely
hypothetical; where possible, though, empirical support is provided. Interestingly, each of the
implications could be seen as both an opportunity but also a challenge, a drawback to MaaS
introduction; hence, the discussion below is presented in a format where the positive and
negative aspects of each implication are highlighted.
4.1. Market Visibility

By allowing a MaaS Operator to resell their services via integrated platforms, public transport operators may benefit from the opportunity of exposing their services to a wider range of end users and, also, of shifting the general public’s view from public transport being an isolated and outdated service to it being part of an innovative transport model (Smith et al., 2018b). Smaller, private providers of mobility services, such as car-sharing and ride-sharing companies, may also benefit from being a piece of a MaaS Operator’s integrated offering by gaining more end user visibility, but also by creating partnerships with bigger players to fill gaps in their service provision (Polydoropoulou et al., 2018).

This, however, would also mean transport service providers’ own brands would be sold under the brand of the MaaS Operator and, thus, would not get enough exposure or recognition (Smith et al., 2020; Sochor et al., 2015). For public transport providers, especially in the case where commercial or public-private cooperation business models are adopted, this could lead to a loss of control over their own brand and the quality of their services (Smith et al., 2018b).

4.2. Centralised Data Gathering

Having a MaaS Operator in place provides the capacity to centrally gather, with the help of a MaaS digital platform, mobility data coming from transport users themselves. This data can be analysed in a way that would help transport providers better understand the demand for their services, to serve transport user needs more effectively (Transport Systems Catapult, 2016), and to allocate existing transportation resources based on real-life evidence (Mulley et al., 2018). For public authorities, access to centralised mobility data means better visibility over their localities - something that potentially can allow them to make more demand-centric policy decisions (Serafimova, 2020).

However, the standardisation and exchange of data among the many MaaS stakeholders thus far appears problematic (Polydoropoulou et al., 2018). While many public transport operators have already made their real time data available, at least for providers of digital services, such as traveller information, private transport operators rarely open their data to third party organisations (Li & Voege, 2017). To be willing to share data and cooperate rather than compete with each other would possibly require a series of trust-building exercises but also guaranteed fair marketplaces for all the MaaS stakeholders (Serafimova, 2020).

4.3. Vehicle Utilisation

Organising effective transportation in rural areas is often a challenge due to long distances and narrow flows of people (Eckhardt et al., 2018), and conventional public transport may not
be the right fit for cost-efficiency purposes. Shared use mobility services integrated within
MaaS, could cater for rural and unpopulated areas with limited public transport access, for
example, by substituting underutilised public transport vehicles (Becker et al., 2020).
Such approach, however, could cause public resistance as, although possibly bringing
more efficiency, the substituting shared use mobility services may not live up to the
convenience and cost-effectiveness a fixed public transport service can offer to the user
(Jittapriom et al., 2020). In the eyes of transport users, the availability of public transport is
also a symbol of guaranteed accessibility for such areas (Wong et al., 2020).

4.4. Accessibility

A fully integrated MaaS service offers the potential to improve accessibility in both rural and
urban areas (Pangbourne et al., 2018). In cities, MaaS-based shared use mobility options
could serve as top-up services to conventional public transport during peak hours when
demand for it outweighs the offered capacity (Kamargianni & Matyas, 2017; Wong et al.,
2020). Shared use mobility services may also function as feeders to public transport this way
improving accessibility for those residing in places where the public transport schedule is
infrequent or infrastructure is limited (Smith et al., 2018b). For instance, the users of NaviGoGo
Maas in rural Scotland have reported the service to facilitate their connectivity to employment
and training (ESP Group, 2018).

More often, however, it is only in urban, densely populated neighbourhoods with low car
ownership rates where sharing schemes have chances to succeed (Celsor & Millard-Ball,
2007). At present, at least, there is little to no shared use mobility alternatives available to the
rural and sometimes even suburban transport users; for example, ride-hailing services serve
primarily dense urban areas and city centres with good public transport provision rather than
poorly connected areas with limited transport options (Barajas & Brown, 2021).

4.5. Transport Affordability

A MaaS Operator, having access to customers of all transportation services
simultaneously, could negotiate lower prices for individual trips (Sochor et al., 2015). Thus,
with MaaS, transport user could benefit from getting aggregated services at a better price than
the one obtained by purchasing equivalent services individually and directly from transport
providers (Sochor et al., 2015), which means the transport becomes more affordable.

In the long run, however, a shift to a MaaS paradigm could lead to the creation of monopoly
(Polydoropoulou et al., 2018) where the MaaS Operator prevents new transport service
providers from entering the market by, for example, deploying exclusion tactics related to the
ownership of data or by simply having an exclusive provider for each of the services on offer
(Pangbourne et al., 2020). This monopoly based on exclusive relationships with the transport
service providers could lead to a shortage of transportation alternatives for the end user and offer the potential to the MaaS Operator to its raise prices. With the prices of services rising and the paying capacity of end users remaining the same, the above would negatively impact the overall affordability of transportation (Pangbourne et al., 2020).

4.6. Digital Access

Flicking between the screens to purchase individual mobility services and create multimodal itineraries is a complex procedure that at present discourages end users from travelling by combinations of transport modes (Kamargianni et al., 2016; Pickford & Chung, 2019). Without MaaS, the transport user needs to have, for an instance, a public transport app and a local taxi app, a bike-sharing app, and a car-sharing app, to be able to combine all the desired modes into one itinerary. By giving easy access via a single digital interface to not just a multitude of transport options but to fully integrated travel experiences that cover people’s daily needs, MaaS platforms can make multimodal travel appear more convenient and attractive as they remove the need to purchase mobility services individually (Sochor et al., 2017; Pickford & Chung, 2019). This could thus give the integrated service a competitive advantage over the use of the private car.

With its distribution channel being a digital platform such as a smartphone app, MaaS, however, becomes highly reliant on technology, meaning that transport users of lower digital literacy, such as, for an instance, older individuals with no previous exposure to mobile technology, could be left out when shifting to a MaaS-centric paradigm (Jittrapirom et al., 2020; Alyavina et al., 2020).

4.7. Modal Shift

It is MaaS’ potential ability to reduce travellers’ dependency on cars (Polydoropoulou et al., 2018; Reck et al., 2020; Sochor et al., 2015) where a lot of its benefits derive from. Given access to integrated mobility services through digital platforms offering customised door-to-door trip planning and payment options, people may no longer choose to own and use individual modes of transport but instead choose to purchase mobility services that cover their travel needs (Durand et al., 2018; Giesecke et al., 2016; Nikitas et al., 2017). A pay-as-you-go MaaS scheme in Vienna, Austria and a bundle MaaS scheme in Gothenburg, Sweden have already shown that MaaS in both forms has potential to lower transport users’ dependency on private cars at least. As many as 21% of study participants in Vienna (Smile Mobility, 2015) and 64% of study participants in Gothenburg (Karlsson et al., 2016; Sochor at al., 2015; Sochor et al., 2016) used their personal cars less because of MaaS. A pilot study in the UK region of West Yorkshire, which is only 25% urban, has also demonstrated the potential of MaaS to reduce private car use (Harrison et al., 2020).
Some examples, however, demonstrate that the potential of MaaS to reduce transport users’ dependency on cars is rather poor. A pilot study in Ghent, Belgium has, in contrast to the above, shown that complacent car users are unlikely to change their driving habits when faced with MaaS services (Storme et al., 2020). Some studies also suggest that MaaS may allow the current non-car-owning individuals gain access to car-based shared use mobility services, thus enabling a shift away from public transport (Alyavina et al., 2020; Hensher, 2017; Smith et al., 2018; Wilson & Mason, 2020). MaaS may likewise encourage people to travel more (Jittrapirom et al., 2018) when given transport options to reach places they might have not been able to reach before.

4.8. Market Shares

Provided that MaaS stimulates shifting away from private car use, the private car travel market is likely to move into the hands of transport service providers reselling their capacity via MaaS. The newly established attractiveness of MaaS to current private car users would mean significantly increased market shares (Ho et al., 2020; Smith et al., 2020), and, therefore, higher revenues and profits (Hensher, 2017; Mulley et al. 2018) for both the public transport and shared use mobility services. Juniper Research (2020), for example, has found that the revenue generated by MaaS platforms are likely to exceed $52 billion by 2027. Increased market shares, revenue turnout and profits for transport service providers, and particularly public transport, would inevitably take pressure off government subsidies (Hensher, 2017) and contribute to increased cost-effectiveness of public spending (Smith et al., 2018).

Though, the MaaS operator may emphasise the less environmentally friendly mobility services such as car-sharing and ride-hailing as reselling these via MaaS platforms is more likely to generate profits than reselling public transport access (Sochor et al., 2015). Therefore, if the MaaS Operator is to pursue financial success, which seems to have become the case with active MaaS schemes where the transportation bundles are largely built around monetisable modes like car-sharing (Pangbourne et al., 2020), public transport market share is likely to be cannibalised and move into the hands of car-based shared use mobility providers (Smith et al., 2018; 2020).

4.9. Environment

Private car trips accounted for 62% of all passenger trips in the UK in 2018 (NTS, 2019) and this level of modal share exists in many countries worldwide. Private cars hold major responsibility for congestion levels and can be generators of environmental degradation, air and noise pollution, health and wellbeing quality reduction, and traffic accidents (Nikitas, 2019; Vergragt & Brown, 2007). With MaaS enabling modal shift from private cars to public transport
and multimodal travel, congestion levels could reduce significantly (Polydoropoulou et al., 2018). By reducing the share of trips with fossil-fuelled private cars, MaaS also offers potential to cut emissions and pollution, thus improving air quality (Sochor et al., 2015).

However, the possible cannibalisation of public transport market shares, caused by a more profitable car-friendly MaaS that facilitates modal shift away from public transport and onto car-based shared use mobility services, on top of the unchanged levels of car ownership and private car use could, as a matter of fact, increase car agglomeration in the areas where MaaS is implemented. Higher number of smaller vehicles on roads could result in significantly greater vehicles kilometres travelled, with implications for congestion and air quality (Pangbourne et al., 2020).

4.10. Health and Wellbeing

Having a variety of transport modes integrated within its offering, MaaS could raise transport user’ awareness of modes not thought of previously (ESP Group, 2018) and encourage the use of active travel modes, such as walking and cycling (Polydoropoulou et al., 2018), this way improving public health and wellbeing.

The availability of car-based shared use mobility services alongside active travel options could, however, result in transport users replacing walking or cycling with motorised transport when, for example, chaining trips with public transport modes (Wong et al., 2018). The Whim MaaS user already combines taxis with public transport more often than a regular Helsinki traveller (Ramboll, 2019). For some individuals, walking or cycling to reach public transport might be the only opportunity to undertake physical activity throughout the day and maintain their physical and mental wellbeing – an opportunity MaaS may cause its users to neglect (Pangbourne et al., 2020).

4.11. Financial Support

For the initiation of MaaS, particularly in a pilot form, no significant investments, public or private, into developing transport infrastructure are required as the integrated service can be operated solely by combining, via a MaaS Operator, the already existing transportation systems and services (Jittrapirom et al., 2018). The MaaS pilots and live schemes, such as Smile (Smile Mobility, 2015), UbiGo (Sochor et al., 2016), NaviGoGo (ESP Group, 2018) and Whim (Ramboll, 2019) all resell the already existing transport services, but offer the enhancement in the form of real-time information provision, trip chaining, ticketing, payment, and in some cases bundling of services.

However, as discussed previously, to be profitable in the long run a MaaS Operator is likely to put emphasis on reselling access to more expensive and profit-generating mobility services, such as car-sharing, rather than focus on improving affordability and accessibility of public
transport and reducing transport’s negative impact on environment, health and wellbeing. Therefore, MaaS Operators require policy-based enforcement but also continuous financial support from public authorities in the form of subsidies for less profitable but more environmentally friendly transport modes (Jittrapirom et al., 2018). The lack of financial support has, however, already become the reason why many MaaS schemes do not develop beyond the pilot stage.

4.12. A Thematic Synopsis of the Key Implications of MaaS

Table 1 synthesises and systematises the key messages of the present work. It is a reference tool that identifies, categorises and contextualises the opportunities and challenges that for now seem to characterise MaaS adoption and long-term use. The table provides a ‘thematic map’ for transport academics and practitioners who want to appreciate better the diverse dimensions of this novel, emerging and sophisticated mobility phenomenon drawing attention to the fact that the transition to MaaS is a complicated process that has technological, socio-economic, policy and governance dimensions that are yet to be entirely demystified.

**Table 1 Opportunities and Challenges linked to MaaS**

<table>
<thead>
<tr>
<th>MaaS Opportunities/Strengths</th>
<th>MaaS Challenges/Weaknesses</th>
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<tbody>
<tr>
<td><strong>Market Visibility</strong></td>
<td>- Less recognition for transport service providers’ own brands</td>
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<td>- Exposure to a wider customer range for transport service providers</td>
<td>- A partial or even full loss of authority for public transport providers</td>
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<td>- Shift of the general public’s view of public transport being an isolated service to it being part of an innovative transport ecosystem</td>
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<td>- Creation of partnerships with bigger players for shared use mobility providers</td>
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<tr>
<td><strong>Centralised Data Gathering</strong></td>
<td>- Private transport operators rarely open their data to third party organisations</td>
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<tr>
<td>- Better understanding of service, more effective management of transport user needs and evidence-based allocation of existing transportation resources for transport service providers</td>
<td>- Requires a lot of trust building exercises and guaranteed fair marketplaces for all the MaaS stakeholders to be willing to share data and cooperate rather than compete</td>
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<td>- For public authorities, visibility over their localities to make more demand-centric policy decisions</td>
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<td><strong>Vehicle Utilisation</strong></td>
<td>- Public resistance to substitution as new services may not live up to the convenience and cost-effectiveness of a fixed public transport service</td>
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<td>- Substitution of underutilised public transport vehicles by shared use mobility services in rural areas for better utilisation of resources</td>
<td>- View of public transport as a symbol of guaranteed accessibility for rural areas</td>
</tr>
<tr>
<td>Accessibility</td>
<td>In cities, shared use mobility options could top-up conventional public transport during peak hours.</td>
</tr>
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<tr>
<td></td>
<td>Shared use mobility to be used as feeders to public transport improving accessibility in areas with infrequent public transport schedule or limited infrastructure.</td>
</tr>
<tr>
<td></td>
<td>Generally, it is only in urban, densely populated areas with low car ownership rates where sharing schemes have chances to succeed.</td>
</tr>
<tr>
<td>Transport Affordability</td>
<td>Negotiation power of MaaS Operator to obtain lower prices for services, due to having access to customers of all transportation services.</td>
</tr>
<tr>
<td></td>
<td>A shift to a MaaS paradigm creates a monopoly that may lead to a shortage of transportation alternatives and rising transport prices as a consequence.</td>
</tr>
<tr>
<td>Digital Access</td>
<td>Ease of access to a multitude of transport options via a single digital interface.</td>
</tr>
<tr>
<td></td>
<td>Transport users of lower digital literacy or no previous exposure to mobile technology could be left out when shifting to a MaaS-centric paradigm.</td>
</tr>
<tr>
<td>Modal Shift</td>
<td>Potential to reduce dependency on private cars due to the convenience of fully integrated mobility offering.</td>
</tr>
<tr>
<td></td>
<td>Transport users are still likely to remain attached to their cars for reasons other than convenience.</td>
</tr>
<tr>
<td></td>
<td>Public transport users may shift to car-based shared use mobility options.</td>
</tr>
<tr>
<td>Market Shares</td>
<td>The attractiveness of MaaS to private car users leads to increased market shares, higher revenues, and profits for transport service providers.</td>
</tr>
<tr>
<td></td>
<td>Pressure off government subsidies and increased cost-effectiveness of public spending.</td>
</tr>
<tr>
<td></td>
<td>If no desired modal shift occurs and/or car-based shared use mobility is emphasised via MaaS platforms, the public transport market share is likely to be cannibalised.</td>
</tr>
<tr>
<td>Environment</td>
<td>Reduction of congestion levels due to shift away from private cars and onto public transport and multimodal travel.</td>
</tr>
<tr>
<td></td>
<td>Lower emissions and pollution.</td>
</tr>
<tr>
<td></td>
<td>If public transport users shift to car-based shared use mobility, then the likely outcomes of MaaS are adverse for the environment.</td>
</tr>
<tr>
<td>Health and Wellbeing</td>
<td>Awareness and encouragement of walking and cycling.</td>
</tr>
<tr>
<td></td>
<td>Replacing active modes that promote health and wellbeing with car-based shared mobility could happen.</td>
</tr>
<tr>
<td>Financial Support</td>
<td>Low to no investment needed to initiate MaaS.</td>
</tr>
<tr>
<td></td>
<td>For MaaS that genuinely meets societal goals continuous financial support in the form of subsidies for prioritising more sustainable transport modes is necessary.</td>
</tr>
</tbody>
</table>
5. Conclusions

Proponents may argue that MaaS will become the new transport paradigm since it addresses many of society’s grand challenges in transport, promising improvements in terms of environmental sustainability, reduced congestion, and better accessibility (Smith et al., 2018b) but in reality, this has yet to be evidenced, beyond doubt. The present work suggests that MaaS despite its rapid transformation to a ‘trendy’ niche for transport researchers and a forward-thinking intervention for practitioners and regulators has not yet been universally defined, explicitly specified, entirely shaped or sufficiently tested.

MaaS to this day remains a novel concept with scarce real-life implementation; the few applications installed are pilots, mostly MaaS-lite schemes (Nikitas et al., 2020). Therefore, all the potential positive effects of MaaS are mostly hypothetical (Karlsson et al., 2020). Unless it is demonstrated that MaaS is an effective mobility tool, which is impossible before the actual implementation of it in a wider scale, stakeholders will remain reluctant to join MaaS schemes (Smith et al., 2020). Potential and actuality of MaaS impacts are not identical.

With this paper however we did try to identify and discuss 11 thematic areas, as these emerge from a rapidly emerging but still mostly hypothetical or pilot-related literature, that may underpin MaaS’ future capacity to be a transport game-changer namely: market visibility, data gathering, vehicle utilisation, accessibility, transport affordability, digital access, modal shift, market shares, environment, health and wellbeing, financial support.

We suggest that a lot of MaaS’ accomplishments may not depend on the interinstitutional collaborations and the technology quality that will be used per se but could be based on how future users decide to embrace it and how operators choose to operate. Will MaaS be an uberised profit-centric scheme or one primarily founded on public transport that disentivises car-centric services, when not necessary for sustainability reasons, even if this means being less attractive to users (Alyavina et al., 2020)?

Recent research suggests that many people share a positive attitude about the role MaaS could play in helping behaviour change and decreasing private vehicle dependence, but specific modes still remain unattractive to certain individuals and targeted interventions should be adopted to facilitate adoption (Matyas, 2020). Also, significant variation between user groups in the respondents’ willingness to pay exists due to MaaS being still largely unknown as a concept and the challenge that the mobility package which fulfils individual needs differs from person to person (Liljamo et al., 2020).

A verdict on whether MaaS is a tool capable of establishing a genuinely sustainable transport provision that will solve more problems than the ones that it could be creating cannot be reached yet. Change is rarely easy and straightforward so primary data research on understanding user attitudes, requirements, priorities, and behaviours and how these could
be influenced is critical for future MaaS development, especially if this is to genuinely serve sustainability goals.

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