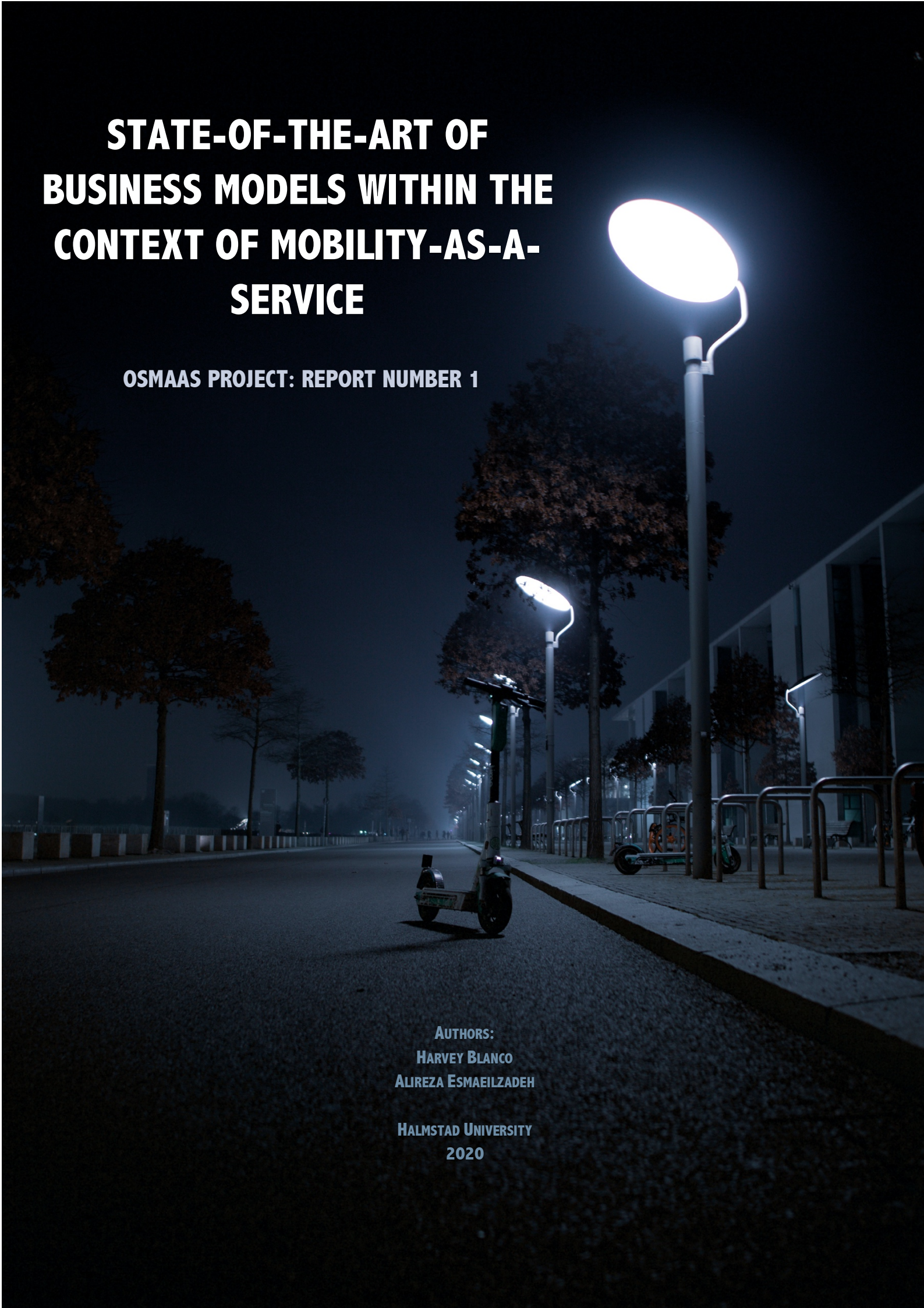
STATE-OF-THE-ART OF BUSINESS MODELS WITHIN THE CONTEXT OF MOBILITY-AS-A-SERVICE

OSMAAS PROJECT: REPORT NUMBER 1



Authors:
Harvey Blanco
Alireza Esmaeilzadeh

Halmstad University

2020

1 ABSTRACT

Mobility as a service (MaaS) integrates different forms of transportation services into a single on-demand mobility service. Demands such as personalized transport services and the search to reduce car-ownership, as well as substantial advances in Information Technologies and Communications (ICT), the Internet of Things (IoT), and other technological developments have created a market space and momentum for MaaS. Although MaaS is still in its first stages of development, in different places of the world, MaaS initiatives have been attempted allowing researchers to analyze the complexity of MaaS under various scenarios. In this report, the authors describe the state-of-the-art of business models within the context of MaaS. The methodological approach integrated the review of consultancy reports and academic papers. The authors provide a schematic representation of how business models vary depending on the actors' relationship. This process demonstrates that there is not such as MaaS business model but a series of interlinked business models enabling the implementation of MaaS.

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METHOD

This section describes the process applied to identify relevant studies within the literature of Business Models in the context of MaaS, appraise the quality of the reports and papers, and summarize their results (Jesson, Matheson and Lacey, 2011). Consultancy reports and academic papers were reviewed to develop this report. Reports were analyzed to comprehend managerial perspectives on MaaS, as well as to identify what consultants consider essential when discussing business models within the context of MaaS. On the other hand, papers were reviewed to comprehend academic perspectives on MaaS and to identify academic discussions about how different aspects could affect business modeling and the implementation of MaaS.

Table 1 summarizes the inclusion and exclusion criteria used to set the boundaries of the managerial reports search.

Table 1 Report inclusion and exclusion search criteria

Criteria		Motivation
Search Engine	Google	A vast collection of publications
Consultancy company	Known and reputation	Importance of the consultancy company
Type of document	Report	Managerial/market-research source
Keywords combination	"Business Model" AND "MaaS"; "Business Model" AND "Mobility as a Service"	Aimed topic
Time frame	2010 to 2020	Updated literature
Language	English	A substantial number of papers in English

Table 2 summarizes the inclusion and exclusion criteria used to set the boundaries of the papers search.

Our search process yielded 25 reports and 202 papers. Thereafter, Zotero software was used as a tool for reference management, as well as an instrument to identify duplicated papers and refine our papers databank. A total of 140 papers resulted after duplication filtration was applied. 25 reports and 140 papers subsequently were analyzed. Then, in Miro, reports and papers were mapped. Themes were formed when reading the literature (i.e., roles, enablers and barriers, and business models). Table 3 shows the summary of the report/papers search process.

Table 2 Papers inclusion and exclusion search criteria

Criteria		Motivation
Database	Scopus, and ACM Digital Library	A vast collection of publications within the fields of management and technology
Journal	Impactor factor	The journal must have impact factor
Type of document	Paper	Prior-research source
Paper	Peer-reviewed	Transparent discussion of research
Keywords combination	"Business Model" AND "MaaS"; "Business Model" AND "Mobility as a Service"; "Business Model" AND "Mobility Services"; "Business Model" AND "Integrated Mobility";	Aimed topic
Keywords limited search to	Title and abstract	Field identification
Time frame	2010 to 2020	To identify updated literature on the field of research
Number of citations	Top 10 when searching	To identify the most important discussions regarding our research field
Relevance of the paper	Top 10 when searching	To make sure the search is consistent with our research field
Language	English	A substantial number of papers in English

Table 3 Summary of the report/papers search process

Search engine/Database	Yielded
Google	25
Scopus	200
ACM Digital Library	2
Total reports/papers yielded	227
Papers duplicated	62
Total reports mapped	25
Total papers mapped	140
Total reports/papers analyzed	165

In the following chapters, we introduce the concept of MaaS, provide a representation of our understanding of business models within the context of MaaS, discuss the outcome of our analysis, and point out further research.

3 INTRODUCTION

MaaS is subject to different research paths. Arias-Molinares and Carlos García-Palomares (2020) classified research paths around MaaS as following: (i) the architecture of the concept and classification of MaaS; (ii) the organizational structures and business models to implement MaaS; (iii) demand and travel preferences from recent MaaS pilots in urban and rural areas; and (iv) governance issues for MaaS to be feasible, identifying barriers, enabling factors, regulation challenges and stakeholder viewpoints. In this report, however, we focus on identifying the current business models for MaaS discussed within the literature. Before opening the discussion regarding business models, we provide an overview of adjacent topics including, the concept of MaaS, MaaS objectives, MaaS typology, roles within MaaS, and enablers and barriers which provide to the reader, the minimum understanding needed to discuss the topic in research.

3.1 THE CONCEPT OF MAAS

Although the term 'Mobility-as-a-Service' (MaaS) was coined in 2014, the idea of Combined Mobility (CM) had already been introduced as the non-competitive combination of public transport with other shared-use modes. However, it failed to provide any practical solution for combining transportation modes to complement public transport. Therefore, using the term CM as a synonym for MaaS has been controversial. Besides, 'Integrated Mobility Services' (IMS) is often used as a synonym for MaaS in some references (Sochor et al., 2018).

Mobility-as-a-service can be thought of as a new transport solution, as a phenomenon, or as a concept (Jittrapirom et al., 2017). The bottom line is that MaaS has emerged as an innovative transport solution, anticipated to pose radical changes in the current transport system by addressing the growing needs of mobility more sustainably. Mobility services are expected to become more comfortable, more flexible, more reliable, and price-worthier both for travelers and goods shipping. Therefore, it is not a surprise to see the increasing attention of academia, industry, and the public sector on this topic (Cottrill, 2020). Although its implementation seems to be far too optimistic at this moment, in the long-term, there is a realistic chance to achieve such a MaaS if it is well conceptualized (Giesecke, Surakka and Hakonen, 2016).

So far, there is a little agreement on a definition of MaaS and its core characteristics in the conceptual level (Jittrapirom et al., 2017). MaaS is a radical innovation in the early stage of development (Fluid phase) that is known by experimentation with a variety of competing

product/service designs. Though providing a single definition at this point seems to be premature. However, table 4, provided by Sochor et al. (2018), shows the relevant definitions and descriptions together with keywords and concepts related to MaaS.

Table 4 Overview of definitions and descriptions (Sochor et al., 2018)

Reference (Term)	Definition/description	Keywords/concepts
(A.D. Little, 2018, p. 59 (MaaS)	"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."	Service; Multimodality; User-centric; Integration; Platform; Planning; Payment; Packages; One-stop-shop; Public and private; Personalisation; Flexible; Efficient; Non-ownership
Atkins, 2015, p. 19 (MaaS)	"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."	Service; Multimodality; Integration; On-demand; Personalisation; Flexible; Easy
(Ghanbari et al., 2015) (MaaS)	"MaaS, a multi-actor environment that provides seamless door-to-door services for end users by combining several modes of transportation."	Service; Multimodality; Ecosystem; Seamless; Door-to-door
(Heikkilä, 2014), p. 8 (MaaS)	MaaS is "a system, in which a comprehensive range of mobility services are provided by customers to mobility operators."	Customers; Operators; Comprehensive
(Hietanen, 2014), pp. 1–2 (MaaS)	"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."	Customer's needs; One interface; Service provider; Bundling
(ITS Australia, 2018), p. 20 (MaaS)	"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."	Multimodality; Integration; Platform; Planning; Booking; Payment; Personalisation
(K2 Swedish Knowledge Centre for Public Transport, 2017) (Integrated Mobility Services)	"Integrated Mobility Services mean that in one and the same service, one knits together many ways to move in the city (e.g. car-sharing, 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)	One service; Multimodality; One interface; Payment; Information; Choice; Reduced private car ownership; Urban

Table 4 Continue

Reference (Term)	Definition/description	Keywords/concepts
(Kamargianni et al., 2015), pp. 11–12 (MaaS)	"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."	Service; Consumers' needs; Operator; One platform; Single payment; Non-ownership
(Karmargianni & Matyas, 2017), p. 3 (MaaS)	"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."	User-centric; Aggregation; Single platform; Provider; Sole operator; Intelligent
(König, Eckhardt, Aapaoja, Sochor, & Karlsson, 2016) (MaaS)	"Multimodal and sustainable mobility services addressing customers' transport needs by integrating planning and payment on a one-stop-shop principle."	Service; Multimodal; Customer needs; Integration; Planning; Payment; One-stop-shop; Sustainability
(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." "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."	Single service; Multimodal; User-centric; Customer needs; Integration; People and goods; Bundle; On-demand; Personalisation; Flexible; Easy
(MaaS Global, 2018) (MaaS)	"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."	Single service; Multimodality; Remove hassle
(MuConsult, 2017), p. 4 (MaaS)	"MaaS is defined 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." (translated from Dutch)	Service; Multimodality; Integration; Platform; Demand-driven; Personalisation
(Mukthar-Landgren et al., 2016), p. 8 (Integrated Mobility Services)	"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."	Flexible Service; Multimodal; Integrated; Common interface; One-stop access; Information; Payment; Subscriptions; Other services; People & Goods; Public and private; Seamless

Table 4 Continue

Reference (Term)	Definition/description	Keywords/concepts
(Samtrafiken, 2017), pp. 4, 18 (Combined mobility and/or MaaS)	(p. 18) A way of thinking where "mobility is something that can be purchased as a service and does not require owning a private car." (translated from Swedish) (p. 4) 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." (translated from Swedish)	Service; Multimodality; Planning; Subscription; People & Goods; Way of thinking; Sustainability; Reduce private car dependency
(Transport Systems Catapult, 2016), (MaaS)	(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?'."	Service; Customer needs; Business model; Digital interface
(UITP, 2011), p. 1 (Combined mobility)	Combined mobility is "car-sharing, 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 car-pooling, i.e. shared use.)	Multimodality; Comprehensive; Shared use

Regardless of the definitions, MaaS is about (i) offering a service based on users' needs; (ii) offering multi-modal mobility rather than transport; and (iii) offering integrated transport services, information, payment, and ticketing (Sochor et al., 2018). According to Goodall et al. (2017), MaaS combines different modes of transport to offer a tailored mobility package, including other complementary services, such as reservation, trip planning, and payment, through a single platform to substitute car ownership. MaaS, at its core, relies on a digital platform that integrates booking, end-to-end trip planning, electronic ticketing, and payment services across all transportation modes, including public and private service providers. However, the development of MaaS in cities relies on two preconditions: They must contain a robust public transport system as well as a growing and diverse shared mobility offer (Li and Voege, 2017; Arias-Molinares and Carlos García-Palomares, 2020). Jittrapirom et al. (2017) summarized the core characteristics of MaaS, which are shown in table 5.

Table 5 Description of MaaS's core characteristics based on a literature review (Jittrapirom et al.*, 2017).*

Core Characteristic	Description
Integration of transport modes	A goal of MaaS schemes is to encourage the use of public transport services, by bringing together multi-modal transportation and allowing the users to choose and facilitating them in their intermodal trips. Following transport modes may be included: public transport, taxi, car-sharing, ride-sharing, bike-sharing, car-rental, on-demand bus services. Envisioning a service beyond the urban boundaries, it will embrace also long-distance buses and trains, flights, and ferries.
Tariff option	MaaS platform offers users two types of tariffs in accessing its mobility services: "mobility package" and "pay-as-you-go". The package offers bundles of various transport modes and includes a certain amount of km/minutes/points that can be utilized in exchange for a monthly payment. The pay-as-you-go charges users according to the effective use of the service.
One platform	MaaS relies on a digital platform (mobile app or web page) through which the end-users can access to all the necessary services for their trips: trip planning, booking, ticketing, payment, and real-time information. Users might also access to other useful services, such as weather forecasting, synchronization with personal activity calendar, travel history report, invoicing, and feedback.
Multiple actors	MaaS ecosystem is built on interactions between different groups of actors through a digital platform: demanders of mobility (e.g. private customer or business customer), a supplier of transport services (e.g. public or private) and platform owners (e.g. third party, PT provider, authority). Other actors can also cooperate to enable the functioning of the service and improve its efficiency: local authorities, payment clearing, telecommunication and data management companies.
Use of technologies	Different technologies are combined to enable MaaS: devices, such as mobile computers and smartphones; a reliable mobile internet network (WiFi, 3G, 4G, LTE); GPS; e-ticketing and e-payment system; database management system and integrated infrastructure of technologies (i.e. IoT).
Demand orientation	MaaS is a user-centric paradigm. It seeks to offer a transport solution that is best from customer's perspective to be made via multimodal trip planning feature and inclusion of demand-responsive services, such as taxi.
Registration requirement	The end-user is required to join the platform to access available services. An account can be valid for a single individual or, in certain cases, an entire household. The subscription not only facilitates the use of the services but also enables the service personalization.
Personalization	Personalization ensures end users' requirements and expectations are met more effectively and efficiently by considering the uniqueness of each customer. The system provides the end-user with specific recommendations and tailor-made solutions on the basis of her/his profile, expressed preferences, and past behaviors (e.g. travel history). Additionally, they may connect their social network profiles with their MaaS account.
Customization	Customization enables end users to modify the offered service option in according to their preferences. This can increase MaaS' attractiveness among travelers and its customers' satisfaction and loyalty. They may freely compose a specified chained trip or build their mobility package with a different volume of usage of certain transport modes to better achieve their preferred travel experiences.

Table 5 Continue

Core Characteristic	Description
***Decision influence**	Certain MaaS schemes have features to influence users' trip decisions, ranges from a less active approach, such as SMILE's comparison of CO_2 emission by each mode to a more active approach in UbiGo, which promotes PT mode, and an incentive-based of Whim, which rewards users for their 'green' trips. These features can be beneficial in ensuring MaaS positive contribution to sustainability. On the other hand, it also points toward a need for a monitoring system to ensure that such feature is utilized for societal benefits.
***The inclusion of other services**	SMILE included access to parking, park and ride service, e-vehicle, and regional ship demonstrates the result of including a broad range of stakeholders in MaaS. Tuup's inclusion of Piggy baggy, a crowdsourcing freight transport service and My Cicero's municipality services are also unique examples how MaaS can open the possibility for other transport related services.
***Mobility 'currency'**	Whim is the only scheme considered here that employs this feature, which can be a step toward a truly integrated multimodal transport system. It enables users to customize their monthly mobility budget to best suit their preferences and not 'locked in' by any sunk cost, such as annual PT subscription or car rental membership. On the other hand, it also increases platform provider influence toward pricing of service. A Whim point purchase through its most expensive subscription (389€ for 10,000 points) is more than 50% cheaper than a Whim point purchase through its most basic package (89€ for 1,000 points). The economy of scale of such basic commodity can have implications on equity aspects.

* MaaS attributes extracted from the review of case studies.

In this section we have reviewed the different definitions and core characteristics of MaaS. This help us to understand not only the evolution of the concept but also the general goal of MaaS. But what are the objectives of MaaS? In the next section we explore the MaaS objectives described in the literature.

3.2 MAAS OBJECTIVES

In our last section, we explored the variety of definitions of MaaS intending to comprehend the evolution of the concept. In this section, we list the objectives of MaaS to understand the purpose behind implementing MaaS.

As seen in the definitions, MaaS has the potential of being an efficient alternative to private car use, to make more efficient use of transport networks and to move to sustainable transport modes. Hence, the literature reveals six key objectives for implementing MaaS as a transportation system:

1. The reduction of privately own vehicle in urban areas (Sochor, Strömberg and Karlsson, 2015; Bothos et al., 2019; Sjöman, Ringenson and Kramers, 2020), or to offer a better service than the private car (Inland Transport Committee, 2020).
2. The reduction of environmental impacts from transportation (Sochor, Strömberg and Karlsson, 2015).

3. To provide an interface for multimodal transport use throughout the integration of diverse mobility solutions (Bothos et al., 2019).
4. Lead the transitions towards a more sustainable transportation system (Sjöman, Ringenson and Kramers, 2020).
5. Seamless and efficient flow of information, goods, and people both locally and long distances (Inland Transport Committee, 2020).
6. An open ecosystem for information and services in intelligent transportation (Inland Transport Committee, 2020).

MaaS can thus respond to different issues according to the objectives of its implementation. Although the academic literature does not establish specific target groups for MaaS, the practice does. Therefore, MaaS can also respond to different mobility demands providing other mobility solutions. According to the Inland Transport Committee (2020), MaaS is addressed to three established target groups:

1. Business to customer or B2C: to meet mobility needs, MaaS is designed for commuters and residents of regions and cities. Easy payment and booking for all integrated services and seamless mobility from point A to B while saving money or time are recommended to the user throughout a MaaS platform.
2. Business to employee or B2E: to meet mobility needs, MaaS is designed to serve employees of an enterprise. User expectations are taking into account to reduce the enterprise cost of mobility.
3. Business to business or B2B: to create a networking platform aim at fostering MaaS in general, a MaaS platform is designed to be combined with a variety of mobility operators with various MaaS providers.

MaaS objectives and target groups were explored in this section; we consider both aspects directly related to business models, which is the focus area of this report and will be further analyzed.

3.3 MAAS TYPOLOGY

When analyzing the definitions and objectives of MaaS, the various features and scopes of its implementation can be observed. This variety suggests that the implementation of MaaS can be achieved at different levels, involving a progression regarding platform integration. It also suggests that the MaaS business model will depend of its typology. MaaS typologies can vary

according to its level of integration (Sochor et al., 2018; Sakai, 2020) or according to its public-private partnership form (Lucken, Trapenberg Frick and Shaheen, 2019).

Sochor et al. (2018) developed a typological approach to MaaS to (I) simplify the discussion around the MaaS concept, (II) enable the comparison of different services, (III) understand MaaS requirements and effects in terms of four levels: society, business, user/customer and technology, and (IV) aid in the integration of societal goals. These levels of integration are:

level zero - Within this level, there is not MaaS integration. Services are provided separately by different means of transportation. A user/customer must access various websites, apps, or interfaces for planning and paying for an A to B journey that consists of multiple route segments and modes.

Level one - In this level, there exists a loose integration of information into the one MaaS interface. This level of integration facilitates the user/costumer's decision when selecting the route and the mode of transportation for a journey at a specific time of the day.

Level two - This level builds upon the information provided by platform aggregators by allowing users/customers to find, book, and pay for their journey without having to negotiate a way for the MaaS platform. An example of this level of integration is Moovit[1], a case in Germany. Throughout the Moovit app, the users/costumers can pay for their train ride and then cover the last mile of their A to B journey with car-sharing or bike-sharing modes.

Level three - This level builds upon level two of integration. Here, a layer of service is added throughout bundling. As in level two, users/costumers can still pay per single journey, but they also have the option to purchase a subscription to a variety of packages of mobility services. These mobility services are thus offered at a differential price level, depending on what is included in the package. According to the Inland Transport Committee (2020), a case offering this level of integration is Whim[2] in Helsinki. Whim offers two subscription packages, (I) monthly unlimited transit usage and discounted taxi rides, car rentals, and bike-sharing journeys can be bought for a price of €49, and (II) unlimited use of all modes for €499 per month.

[1] https://moovitapp.com/index/en/public_transit-BerlinBrandenburg-1663
[2] https://whimapp.com

Inland Transport Committee (2020) also found that the up-front payment models offered at this level of integration simplify the decision making process of users/costumers when using shared mobility. The key facts here are the easy purchase of mobility services through an app, and the visibility of the real cost of transportation since users/costumers can compare the price of different mobility means when planning a journey from point A to B.

Level four - In this level, the MaaS role goes beyond linking supply and demand. MaaS is responsible for correcting transport issues, improve the trade of transport services and reach the economic, societal, and environmental-related goals regarding the city or region of its operations.

When looking into the role of MaaS in the provision of public transport, Lucken et al. (2019) developed a public-private partnership typology with four service models.

First-mile/last-mile model: In this model, the public transport subsidizes MaaS trips to or from stops or stations.

Low-density model: This partnership targets low-density areas that cannot support the fixed-route bus service. Here, the public transport subsidizes MaaS trips everywhere within a designated zone.

Off-peak model: The public transport partner discounts MaaS trips during off-peak hours.

Paratransit model: MaaS is used to supplement or replace public transport for people with disabilities.

As seen above, one of the motives for which Sochor et al. (2018) studied the topology of MaaS was to understand the requirements and effects of MaaS when designing business models. We took into consideration his observation and decided to include in this report a general overview of MaaS typology with the purpose of introducing to the reader the importance of this topic when developing business models. In the next section, we introduce the roles performed by the different actors in MaaS.

4 MaaS Roles

Here we discuss the essential roles that actors must take to realize MaaS. These roles can either be absorbed by existing players or by new actors. Moreover, one actor might act in several roles, or several actors might work in parallel to fulfill a particular role (Smith, Sochor and Karlsson, 2018). Each role involves a certain level of cost and risk, which, in turn, creates distinctive operational and revenue challenges (Inland Transport Committee, 2020). In order to study the business models within MaaS, we first need to clarify which role is offering and which one is receiving the value proposition. In this section, we discuss the nature of the potential roles within MaaS.

4.1 MaaS Integrator

Kamargianni and Matyas (2017) proposed that a new role has to emerge in the transport market for MaaS to be successfully implemented. MaaS integrator combines the offerings of different transport service providers within a single platform. According to Smith et al. (2018, p. 593), "*MaaS integrators mediate the offerings from several transport service providers (and potentially other suppliers) to MaaS operators through activities such as technical integration, contract management, and financial clearing*."

The Integrator provides data and intermediates between the end-user and the transport operator. It coordinates the data exchange between the different operators using application programming interface gateways (API) and provides analytics on usage, planning, demand, and reporting (Goodall et al., 2017). The MaaS concept includes a wide range of transport services, from intermodal planning, booking, payment, transport modes, and packages. However, the extent to which an integrator covers these functionalities depends on the level of integration, and it is still controversial among scholars (Smith, Sochor and Karlsson, 2018). A good MaaS platform should cover a range of transportation modes and real-time traffic updates. Table 6 shows a list of these integrators and the range of services they cover.

Table 6 Reviewed MaaS integrators

MaaS schemes	Coverage Area	Modes											Notes
		Urban public transport	Bike-sharing	e-Scooters	Car-sharing	Car rental	Taxi	Rail	Parking	Flights	Coach	Refueling and charging	
UbiGo	Stockholm	*			*	*	*	*					• Level 5 payment options.
Whim	Helsinki, Antwerp, Birmingham	*	*	*		*	*	*					• Level 5 payment options. (three payment options: pay-as-you-go; monthly subscription; and annual subscription with on-demand services) • "Broker" governance model[1]
Aarhus (Fluidtime)	Aarhus	*	*	*									• Fluidtime provides smart mobility technologies for companies, cities, and regions. Aarhus is one of their projects.
Moovit	3200 cities across 106 countries	*	*	*	*	*	*	*					• Ecosystem agnostic[2] application • Subscription model[3]
STIB+Cambio	Brussels	*	*		*		*	*	*				• A partnership between STIB (public transport and rail operator) and Cambio (plus other ride-sharing, bike-sharing, and park & ride services). • "Alliance" model[4].
Moovel	Germany				*	*	*	*					• A partnership between Daimler AG and the BMW Group • Level 2 payment option
Qixxit	Germany							*		*	*		• Pay-as-you-go schemes or redirecting to separate bookings • "Broker" governance model
Switchh	Hamburg		*		*								• Pay-as-you-go schemes or redirecting to separate bookings • "Broker" governance model
Mobility Mix	Netherlands	*	*	*	*	*	*	*	*			*	
NS-business card	Netherlands	*	*		*	*	*	*	*				
Radiuz Total Mobility	Netherlands	*	*		*	*	*	*				*	
Tuup	Finland (Turku Region)	*	*		*	*	*		*				
TransitApp	US, Canada, Europe, Australia	*	*		*		*						• Purely a trip planning app

[1] Broker model is discussed in chapter 6
[2] Agnostic, in an information technology (IT) context, refers to something that is generalized so that it is interoperable among various systems.
[3] Subscription model is discussed in chapter 6
[4] Alliance model is discussed in chapter 6

4.2 MaaS Operator

MaaS requires the provision of various mobility operators working together with public transport to provide end-users with the most suitable trip without owning the mean of transport (Inland Transport Committee, 2020). MaaS operators package and deliver mobility offerings to end-users. As Smith et al. (2018, p. 593) put in, "*MaaS operators deliver MaaS to end-users by enabling them to seamlessly plan, pay for and execute use of public transport and other transport services, through a single interface.*"

Undoubtedly, public transportation is the largest operator of mobility services. However, gaps in public transport and the growing demands of new services have driven many transportation agencies to offer innovative modes of travel such as e-scooters, parking, on-demand bus rides, car-pooling, and bike-sharing. This, in turn, led to a jungle of different apps with separate payment mechanisms, interfaces, and customer relationships (Goodall et al., 2017). Table 7 illustrates a list of examples of some operators reviewed in this study.

4.3 MaaS User

According to Jittrapirom et al. (2017), MaaS is a user-centric paradigm. It aims to offer a mobility service that is personalized, flexible, and on-demand. In other words, MaaS is supposed to provide the end-users with tailor-made solutions and recommendations based on their profile, preferences, and past behavior. Sochor et al. (2015) described experiences from a field operational test of UbiGo, in which essential matches between users, operators, and society expectation, including the concept of a transportation smorgasbord, increased pre-trip planning, and reduced private car ownership have been identified. However, to date, our knowledge about the general attitude and needs of society towards MaaS is minimal (Hoerler et al., 2020).

MaaS can potentially affect users towards more sustainable mobility behaviors. Various mobility alternatives, together with the right incentives, relieve the stressed mobility network. Although, as the multimodal mobility grows, the complexity of managing the mobility offers rises dramatically. Users are forced to deal with a considerable amount of alternatives, which makes it more complicated for them to choose between modes (Schwinger and Krempels, 2019). Nevertheless, studies show that the shift has already started in car-ownership due to the appearance of offerings such as car-sharing, bike-sharing, and ride-sharing schemes (Ho et al., 2018).

4.4 FACILITATORS

Besides the integrators and operators, the value chain of MaaS consist of other actors that provide necessary products and services for MaaS to operate. Although they might or might not be involved in the day to day operations, the facilitators have a significant impact on the MaaS (Smith, Sochor and Karlsson, 2018). Facilitators might belong (but not limited to) to the following categories (adopted from Transport Trends and Economics 2018–2019 Mobility as a Service, 2020):

- Data and API providers;
- IT companies and software developers;
- Ticketing and payment service providers;
- Telecommunication companies;
- Insurance companies;
- Vehicle manufacturers, and
- Financing companies and investors.

Table 7 Reviewed MaaS Operators

Mobility Operator	Modes	Coverage Area	Notes
GoMore	Car-rental	Sweden	• Both keyless and with key • Booking and deposit • Account-based
Zify	Car-pool	France, Germany, India	• Broker Model
DriveNow	Car sharing, Car Rental	Germany	• Cooperation between BMW and MINI • It is merged with BMW's ShareNow venture. • Free-floating car sharing
Car2go	Carsharing	Stockholm (discontinued[1]) continues in other 14 cities in Europe, North America, and China.	• The former car-share program of Daimler that has merged with BMW's ShareNow venture. • Free-floating car sharing
Sharenow	Carsharing	Austria, Denmark, France, Germany, Hungary, Italy, Netherlands, Spain	• Pay-as-you-go • Insurance covered
ZipCar	Carsharing	United States, Canada, United Kingdom, Taiwan, Turkey	• Partnered with Volkswagen in 2018 to introduce 325 electric vehicles into its fleet • Keyless • Station-based
Heathrow	Carsharing	London	• An exclusive car share scheme for airport workers administered by Liftshare
Weeshare	Carsharing	Global	• Owned by Volkswagen • A general sharing system with a booking system, the output and cost system, the positioning system, a communication system
Lyft[2]	Transit, Bikes & Scooters, Carsharing, Carpool, Car-rental	United States, Canada	• Broker Model
Turo	Carsharing	United States	• Pay-as-you-go • Insurance covered • A marketplace for owners with underutilized cars
Getaround	Carsharing	300 cities around the world	• Pay-as-you-go • Insurance covered • A marketplace for owners with underutilized cars
Hertz	Car-rental	Asia, Australia, and New Zealand, Europe, United States, The Caribbean, Latin America	• Vehicles are operated, maintained and owned by the respective companies, while renters can access vehicles by the minute, hour, or day
Avis	Car-rental	165 countries	• Vehicles are operated, maintained and owned by the respective companies, while renters can access vehicles by the minute, hour, or day
Flexdrive	Car-rental	Greater Toronto Area	• Car subscription
Donkey Republic	Bike-rental	Malmö	• Dock-based
Citi Bike	Bike-rental	New York City	• Dock-based
Bridj	On-demand-bus	Australia	• Demand Responsive Transport
Beeline	On-demand-bus	Singapore (discontinued)	• Demand Responsive Transport
nuTonomy	Self-driving taxi	Las Vegas	• A commercial, autonomous ride-hailing service • Point-to-point mobility

[1] Did not reach the necessary number of members or car-usage
[2] Lyft's new business model covers a variety of modes though we can probably consider it as a MaaS integrator

5 ENABLERS AND BARRIERS

5.1 REGULATION AND POLICY

In nature, regulations are restrictive measures, while policies are rules aiming to achieve objectives and goals. Regulations are portrayed by a public authority that pursues activities to pave the way for MaaS. The range of regulation includes facilitating business opportunities, technology development, and trials. Public MaaS policies seek to influence the progress and the trajectory of MaaS developments involving guiding principles for mobility business models such as inclusivity, democracy, diversity, openness (Smith and Hensher, 2020), supply and demand (Meng, Somenahalli and Berry, 2020), trust (Cottrill, 2020) and competition (Wilson and Mason, 2020). Like this, regulation and policy can act as both enablers and barriers when implementing MaaS. In this section, we describe the role of regulation and policy and how they affect the business modeling progress of MaaS.

Within the literature, MaaS proponents seem to agree that regulation and policy have a key enabling role to play when scaling up MaaS (Mulley and Kronsell, 2018; Bothos et al., 2019; Sakai, 2019; Cottrill, 2020; Meng, Somenahalli and Berry, 2020; Smith and Hensher, 2020). Examples of MaaS policy include the new transportation code in Finland, which demands all mobility operators to release single journey tickets for third-party or MaaS provider to resell. In Sweden, policy work has been done in an attempt to launch a national mass integrator. Denmark has released a decision to integrate private mobility services to the national travel planner and to release public transport data and tickets for integrators resale. In Germany, the authorities operated the MaaS servicer (Smith and Hensher, 2020). In Australia, the policy has facilitated the usage of Uber as an extension of public transport to cover the last mile face of the public transport journey (Wilson and Mason, 2020).

On the other hand, Wilson and Mason (2020) have also argued that if public authorities do not thrive for facilitating regulation and policy instruments for the implementation of MaaS, regulation, and policy themselves might become factors affecting the prospects of it. Thus, due to the novelty of the MaaS concept, it is difficult to assess the extent to which the current activities carried out by regulators are sufficient for catalyzing the full-scale implementation of MaaS. When analyzing the literature, it seems that the job done by academics regarding regulation and policy on MaaS is no extensive enough to support the development of policy objectives for MaaS. In our research (our sample), Smith and Hensher (2020) appears to be the

only document aiming to support action and steer the development of MaaS towards addressing policy objectives by proposing a framework for MaaS policy analysis.

The literature also points out the existing tension between regulation and policy formulation and operator(s) market standpoints. Mulley and Kronsell (2018) suggest that policy happens to be more focused on market outcomes, per se, let the market find the product and then public authorities step in to formulate regulations, while operators focus on the market experience. Operators likewise see regulations as a barrier for innovation, particularly regulations that attempt to control market failure.

In summary, the actions of regulation and policy can act as both enablers and barriers when creating new business opportunities and implementing MaaS. Regulation might block or enable innovative mobility private initiatives, while policy can slow down or accelerate the process of MaaS implementation. The examples provided above demonstrated the role or regulation and policy when enabling MaaS implementation. In general, from our research, we could observe that the literature does not provide instruments to help regulators and policymakers to establish the right regulations and policies to increase new mobility business opportunities and the implementation of MaaS.

5.2 TECHNOLOGY

After regulation, the literature acknowledges the importance of technological-related developments for implementing MaaS. From our perspective, technological innovations also may act as both enablers and barriers when creating new business opportunities and implementing MaaS, as well as increasing or decreasing the speed of its diffusion and adoption. Advances in technologies in the front-end and user-interaction are in the global literature conversation for MaaS. In particular, related topics such as:

- Data – discussions around modeling, big data, privacy, and sharing (Veeneman et al., 2018; He and Chow, 2020).
- Autonomous driving – conversations on how autonomous vehicles impact travel cost and time (Medina-Tapia and Robusté, 2019), impact on current mobility scenarios (Jager, Agua and Lienkamp, 2018), on smart-cities (Nikitas et al., 2020), on consumer, business, and society (Pakusch et al., 2016; McLoughlin, Prendergast and Donnellan, 2018; Medina-Tapia and Robusté, 2018; Antonialli et al., 2019; Ramseyer et al., 2019),

on energy consumption and infrastructure (Noussan and Tagliapietra, 2020; Vosooghi et al., 2020).

- Vehicle electrification and distributed energy systems – the literature builds upon digitalization (Miyata, 2018; Anthony Jnr et al., 2020; Fuentes et al., 2020), user experience, charging efficiency and power grid (Cao and Wang, 2017), vehicle to grid actors, business and technologies (Armengaud et al., 2019; Sovacool et al., 2020; Vosooghi et al., 2020).
- Intelligent systems – the literature discusses how advancements on-demand responsive transport influence MaaS (Callegati et al., 2017; Inturri et al., 2019).
- Connectivity and Internet of Things – technologies and communications solutions for mobility services (Pakusch et al., 2016; Miyata, 2018; Nikitas et al., 2020), means for building user trust (Melis et al., 2016; Rech, Pistauer and Steger, 2019), parking and highways scenarios (Minea and Gheorghiu, 2017; Azevedo, D'Orey and Ferreira, 2020), and markets (Callegati et al., 2017).
- And blockchain – mainly in the stream of blockchain-based mobility service (Bothos et al., 2019; Nguyen, Partala and Pirttikangas, 2019).

Considering the pace of development of technologies and their applicability to mobility services, vehicle manufacturing, and vehicle connectivity, we believe that technological innovations will progressively enable new innovative business models within the context of MaaS and will be a forefront area of further research.

5.3 INFRASTRUCTURE

The infrastructure provider (traditionally the government) focusses on the creation of value for users (citizens); hence delivering designed, planned, and managed infrastructure is a requirement to meet their mobilization necessities. Activities such as asset management and traffic management are also offered by the infrastructure provider (Inland Transport Committee, 2020).

The literature unveils two infrastructure research fronts in the context of MaaS. (I) infrastructure for seamless interlinks between transport modes, and (II) land usage.

MaaS development depends on the thoughtful integration of physical infrastructure to enable transfer between transportation services, such as bus and train/subway interchanges, or bike and car-sharing spaces at stations (Goodall et al., 2017). The impact of infrastructure on MaaS,

therefore, is based on solutions to enable the usage of mobility services. In this case, transport infrastructure providers are not only responsible for building roads, managing assets, and traffic but also for designing seamless interchange loops to allow shared transport users to move from one mobility mode to another all-at-once. MaaS requires effective and efficient connectivity between different transportation modes, which then requires effective and efficient connectivity between the various types of infrastructure where bounded mobility services are provided. Thus, the reliability of the overall transport network, including the right infrastructure for seamless mobility of a city where MaaS operates, is needed (Inland Transport Committee, 2020).

When discussing land usage, MaaS potentially has an impact in both urban and rural areas. The interfaces between MaaS and land use are divided into two: macroscale and operative level. The macroscale is related to national-level planning in terms of policy and national planning for infrastructure; megatrends like aging, urbanization, and growing population are directly related to the macroscale interface. On the other hand, operative levels cover practical actions in land use processes and development of MaaS, for instance, planning and construction (Rantasila, 2016).

6 BUSINESS MODELS AND MAAS

The appearance of smart devices and bigdata enabled instantaneous sharing of users' information to mobility providers. MaaS actors are now able to track the users' behavior, preferences, and location to create and offer a combination of different services within different sets of packages. This transformation led to the emergence of new business models for different actors involved in this new mobility space (Merkert and Wong, 2020). *Regarding the fact that the MaaS ecosystem consists of different roles, the nature of business models varies depending on the type of proposed value, the role of value creator, and the role of value receiver*. In this study, we classified the potential group of business models based on the role of value creator and value receiver. This, in order to provide a structure for our exploration towards the-state-of-art in MaaS business models. Figure 1 shows a schematic illustration of the proposed structure. According to Teece (2010, p. 172), a business model describes the "*design or architecture of the value creation, delivery, and capture mechanisms*." Therefore, in each group of business models, we discuss both value creation and value capture aspects to draw a holistic, comparable view of the the-state-of-art in MaaS business models.

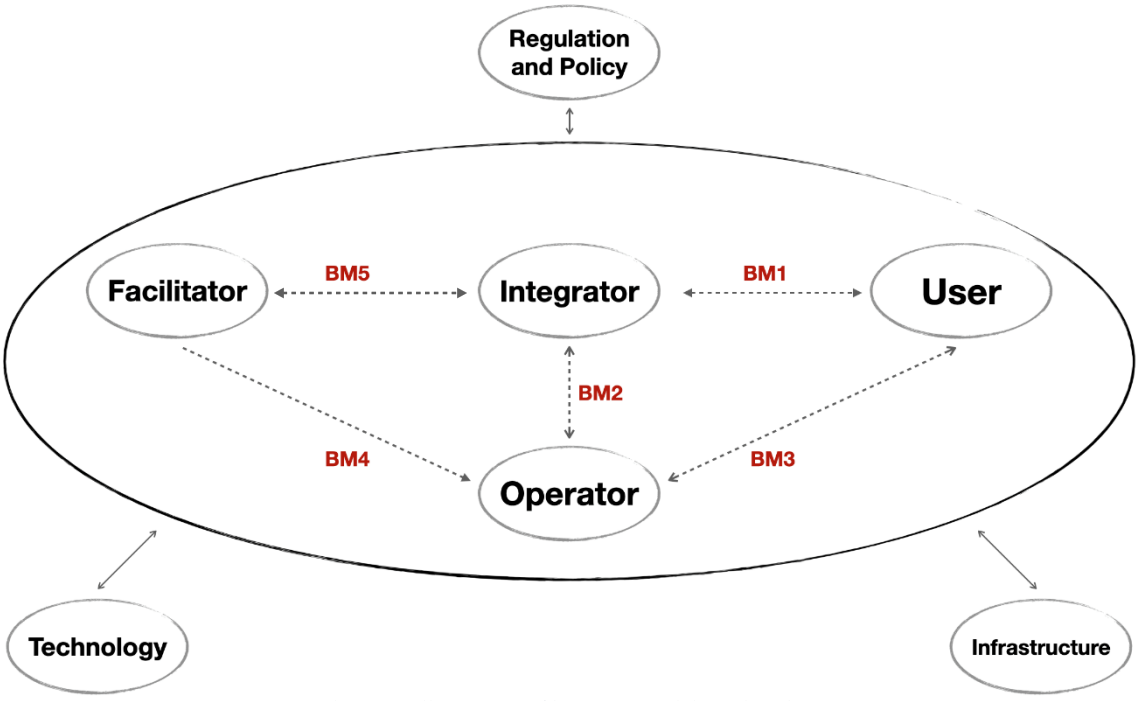

Figure 1 A schematic illustration of business models within the MaaS context

Previously, we discussed four different roles within the MaaS context. In this section, we describe the relationship between the roles in terms of business models or, in other words, the way they do the business together. Accordingly, we classified the business models into five groups (BM1-BM2-BM3-BM4-BM5). Moreover, Regulation and policy, Technology, and

Infrastructure can potentially act as enablers or barriers for MaaS business opportunities and implementation, as explained in chapter 5. It is worth mentioning that the focus of this report is not to hypothesize how Regulation and policy, Technology, and Infrastructure might enable or hinder business models.

Further, we describe different groups of business models based on the proposed model.

6.1 BUSINESS MODELS: INTEGRATOR-USER

In sections 4.1and 4.3, we describe the role of MaaS integrators and users, respectively. In this section, we discuss the business models used by integrators when targeting individual users of mobility services, how they create value, and capture it.

Figure 2 Integrator-User business models

In our research, when analyzing the relationship between integrators and users, the literature showed us that there is not one or a list of established business models for offering MaaS to users. However, we could observe how integrators create value for users as well as their means to capture it. In the tables below, we breakdown how integrators create value for users (Table 8) and list the means for capturing it (Table 9).

Table 8 Integrator to user value creation

Value creation		
Flexibility and inclusivity (convenience)	○ More travel choice tailored to the individual needs of the user ○ Convenience through easy access to and payment for mobility ○ Flexibility regarding route choice, time and whether to share or not the ride ○ Attractive for dense urban areas with the multiplicity of mobility options	(Giesecke, Surakka and Hakonen, 2016; Jittrapirom *et al.*, 2017; Falconer, Zhou and Felder, 2018; Schwinger and Krempels, 2019; Arias-Molinares and Carlos García-Palomares, 2020).
Affordability (cost)	Users no longer have to own a car or pay for parking or other incidental costs like insurance and fuel	
Connectivity (time)	All in one platform, elimination of queuing, seamless interlinks, avoidance on urban congestion	

When analyzing value capture, we observed that the means for value capture vary according to the typology of MaaS. In section 3.3, we have discussed the different typologies of MaaS and how they vary according to the level of integration. Here, we provide a list of means for value capturing and how these vary in relation to the typology of MaaS.

Table 9 Integrator to user value capture

Value capture			
Typology		Means for capturing value	
Level of integration	Information	○ Schedules vending ○ Routing vending	(Sochor *et al.*, 2018)
	Direct payment	○ Booking ○ Direct payment	
	Pay-as-you-go	○ Invoicing	
	Account-based	○ Monthly invoicing	
	Subscription-based	○ Mobility packages ○ Subscription	
Public-private partnership	Low-density model	○ The public transport subsidizes MaaS trips everywhere within a designated zone	(Lucken, Trapenberg Frick and Shaheen, 2019)
	Off-peak model	○ The public transport partner discounts MaaS trips during off-peak hours	
	Paratransit model	○ No found within the literature	

Both papers and reports provided us discussions regarding how integrators create value for and capture value from users. Nevertheless, no evidence was found regarding how users can create and capture value when they become businesses. At some point, users would be able to sell data and offer their vehicles to integrators, meaning users will also be businesses. The questions that are to be answered then are what business models would users implement, what value would they provide to integrators, and how would they capture it?

6.2 BUSINESS MODELS: INTEGRATOR-OPERATOR

As can be seen in figure 3, integrators not only need to create value for users but also to operators. Polydoropoulou et al. (2020), in his research, examined the importance of a large variety of stakeholders when implementing MaaS. He concluded that operators are most likely to be the most critical group of MaaS actors, particularly the public transport operator. This view can also be observed in MaaS pilots such as Sydney and Amsterdam, where the operators' role was to enhance the public transport service (supporting public transport in firs-mile/last-mile trips) rather than replace it. In this section, we present how integrators create value for and capture value from operators. See table 10 and 11 respectively.

Figure 3 Integrator-operator business model

Table 10 Integrator to operator value creation

Value creation		
Innovation and differentiation	○ Offers a greater opportunity for innovation in mobility provision (different combinations of transportation mean) ○ Drives innovations in the travel market such as new partnerships models, booking systems, payment and information tools, data sharing agreements, etc.	(Falconer, Zhou and Felder, 2018)
Revenue generation	○ Decentralizes revenue for services and improves means to target particular customer/journey market segments ○ A fair share of the revenue	
Market share	○ Provides new means of entry into the transportation service market	
Improve efficiency	○ When public transport is not available, improves off-peak transport options ○ Replaces conventional routes with low patronage that operate in significant subsidy ○ Adds reliability to the transport network particularly in extreme weather conditions	
Increase coverage	○ Enhances conventional transit network, especially first and last-mile connections	

We observed that the vast majority of studies within the literature on MaaS focused on how integrators create and capture value from users. Although, Polydoropoulou et al. (2020) revealed the importance of operators when implementing MaaS, Falconer, Zhou and Felder (2018) from ARUP consultancy is the only document from literature database of this report that discusses the value that integrators could offer to operators once a MaaS is implemented. Nevertheless, Falconer, Zhou and Felder (2018) overlooked aspects such as the fact that integrators could provide to operators:

- *A digital platform*, meaning operators do not need to spend their capital on research and development building a digital infrastructure to reach users,
- *Power of negotiation*, once a MaaS is implemented, the power of negotiation it will benefit transport operators when discussing regulation and policy with governmental institutions.
- *The economy of scale* will allow operators to reach up to customers quickly and efficiently in a structured manner while saving the cost of continually upgrading the platform.
- *And holistic information about customers*, meaning operators would not only have available data from customers when they make use of their services but also when MaaS users make use of other services. For instance, a car-hailing operator would have access to data from scooters or car-sharing users, increasing their ability to analyze transportation users' behavior from a holistic perspective.

Table 11 Integrator to operator value capture

Value capture		
Broker/aggregator model	Based on commission per transaction	(Wong, Hensher and Mulley, 2018; Cooper *et al.*, 2019; Wong and Hensher, 2020)
Partnering/alliance model	Partnerships/alliances between operators and Integrators	(McKinsey Center for Future Mobility, 2019)
Road pricing/ Free market model	Based on fees for infrastructure usage and market competition	(Beheshtian *et al.*, 2020; Sparrow and Howard, 2020; Wong, Hensher and Mulley, 2020)

Despite the limited understanding of the supply-side around new business models for delivering MaaS, the literature presents three models.

The first model is the broker model; the broker could be a public entity, private enterprise, or coordinated (public-private) (Sakai, 2020). Brokers bring together suppliers of transportation services, as well as platform providers, financial enterprises, data providers, insurance companies, regulatory organizations, universities/research institutions, and other mobility specialized businesses (Wong, Hensher and Mulley, 2018; Wong and Hensher, 2020). The broker packages these raw services as bundles to transportation users who purchase these services all in one, under a subscription-based, account-based, pay-as-you-go, or direct payment model. Regarding the integrator's revenue models, the broker model requires a big scale to be profitable. Therefore, following this revenue models, the integrators and operators must operate in a big city or several cities (*The Future of Mobility 3.0*, 2018).

The second business model is based on partnerships. The Center for Future Mobility (2019) points out three partnerships types between the integrator and operator to improve mobility in a city (see below). It is worth to mention that the partnership model assumes that the integrator is a public agency and takes as the primary transportation mode, public transport. Evidence for partnerships has not been registered within the literature. However, the following alliances are described.

I. Dynamic trip-planning and ticketing services: partnering with consumer experience services such as transit information services and virtual ticketing and payment services allow integrators to offer a combination of public and private transport modes, and thereby facilitate multimodal journeys as well as increasing public transit.
II. On-demand minibuses: this partnership will help integrators to maintain or extend coverage in under-served areas while lowering their cost of service.
III. First/last-mile ride-sharing: integrators can improve users' access to public transport by subsidizing shared rides.

The third model described in the literature is the free market model; this model is based on the hypothesis of having fully operating electric and autonomous vehicles. According to Sparrow and Howard (2020), autonomous vehicles would offer a new opportunity to price access to the roads under the free market. The model follows the idea of allocating timeslots or tolling to roads (Beheshtian et al., 2020), paying for privileged access to infrastructures such as freeways and highways. Mobility operators or private car users are to pay by trip if roads are used (Wong, Hensher and Mulley, 2020). The closest example of this model is the air travel model in which airlines pay fees to airports to use their infrastructure. Fees are higher during peak hours while the price is reduced off-peak.

This model is also based on competence since it is assumed that the best operators will offer the best service to users in terms of experience and time. The expected outcome is the increase in people walking or cycling, or at least sharing a ride in trains, buses, and cars, while wealthy people make use of individual rides. Nevertheless, Sparrow and Howard (2020) evaluate social concerns about this model. They discuss aspects such as the privatization of public space (roads), mobility justice, the social impact of making mobility for the wealthy, and the social cost of markets in mobility; these aspects are not part of our research.

In our research, we found examples of the broker model and partnership model. Pilots and first stage MaaS initiatives such as Qixxit and Moovel in Germany, Mobility Mixx, NS – Business Card and Radiuz Total Mobility in Holland, Transit App in the US, Canada, Europe and Australia, Tuup and Whim in Finland are examples of integrators using the broker model at different levels of MaaS integration. Integrators such as Switchh in Germany and Ubigo in Sweden have implemented the partnership model. Nonetheless, evidence regarding the road pricing/free-market model within the MaaS context was not found.

In this section, we also analyze how operators create and capture value for/from integrators (see table 12). Evidence regarding this direction of the business relationship was not found within the literature. However, we understand that operators also offer value to integrators as well as have the means to capture it from them.

Table 12 Operator to integrator value creation

	Value creation
Mobility services	○ The spectrum of modes of mobility services (scooter, bike, car, van, microbus, bus, tram, train, etc.) ○ Data (operational data) ○ Customer relationship (cobranding, visibility for MaaS)

Operators offer to integrators all the vehicles needed to offer a MaaS service. Also, operators are the actors getting in touch with the MaaS user, delivering the mobility service experience to them. They are also the first stream of data for integrators. Nevertheless, the value offered by the integrator to the operators has not been adequately discussed.

6.3 BUSINESS MODELS: OPERATOR-USER

This section describes how current shared-mobility operators create and capture value. We could observe that to date, operators and integrators (see section 6.1) are not only offering about the same value to its users, but they also capture value in similar ways. Table 13 shows the value that operators offer to their customers.

Figure 4 Operator-user business model

Table 13 Operator to user value creation

Value creation	
Flexibility and inclusivity (convenience)	○ Easy access to and payment for mobility ○ Flexibility regarding route choice, time and whether to share or not the ride ○ Attractive for dense urban areas with a multiplicity of mobility options
Affordability (cost)	Users no longer have to own a car or pay for parking or other incidental costs like insurance and fuel

We found that in contrast with integrators, operators do not offer to its customers: individual tailored-made travel choices, all in one platform booking and payment, and seamless interlinks for mobility. Since the literature (papers and reports) does not study specifically an operator, the gathered information regarding current shared-mobility operators was made by carefully reading their websites. In table 14, we list the operators' websites analyzed for this research:

Table 14 list of the operators' websites analyzed for this research

Operator(s)	Reference
Uber	(*Earn Money by Driving or Get a Ride Now | Uber Denmark*, 2020)
GoMore	(*Peer-to-peer car rental*, 2020)
Zify	(*Zify Carpool*, 2020)
DriveNow	(*DriveNow Car Sharing in Europe | BMW & MINI*, 2020)
ZipCar	(*Car Sharing: An Alternative to Car Rental with Zipcar*, 2020)
Turo	(*Turo | The world's largest car-sharing marketplace*, 2020)
WeShare	(*WeShare – 100% Electric Car Sharing*, 2020)
Lyft	(Inc Lyft, 2020)
GetAround	(Drivy, 2020)
Hertz	(*Car Sharing Connect by Hertz*, 2020)
AVIS	(*Rent a car Fast Online - Rent a car at a good price*, 2020)
FlexDrive	(*Flexdrive*, 2020)
Fair	(*Fair: The Used Car Leasing Platform*, 2020)
Clutch	(*Clutch Technologies*, 2020)
Care by Volvo	(*Care by Volvo*, 2020)

When analyzing how operators capture value, we found that they have been implementing the same means for capturing value as integrators (see table 15).

Table 15 Operator to user value capture

Value capture	
Information	○ Schedules offering ○ Routing offering
Direct payment	○ Booking ○ Direct payment
Pay-as-you-go	○ Invoicing
Account-based	○ Monthly invoicing
Subscription-based	○ Mobility packages ○ Subscription

We came to comprehend that the operator(s) means for capturing value could also depend on their level of integration. Lyft is an example of it. Lyft has gradually integrated into its car-

sharing offering different mobility services such as bikes, scooters, and luxury cars. Lyft, as an integrator, is offering to its customers: mobility packages, subscription plans, monthly invoices, invoicing, and direct payment. Therefore, Lyft could thus be an example of how operators could become integrators by absorbing competition, partnering, and venturing.

Operators' offering is highly associated with the location and geography. Just a few operators are active in more than a country and almost none of them covers both the rural and urban areas within their territory. It seems important to study the reasons of this phenomena and the reasons behind it to implement an integrated and comprehensive MaaS in the future.

6.4 Business models: Facilitator-Operator and Facilitator-Integrator

In section 4.4, we introduced the facilitator as a role that provides products and services to the other actors to facilitate value creation. In this section, we take a closer look at the facilitators' business models when offering their value proposition to the operators and integrators. Although, due to the variety of activities and services, it is hard to generalize the conclusions.

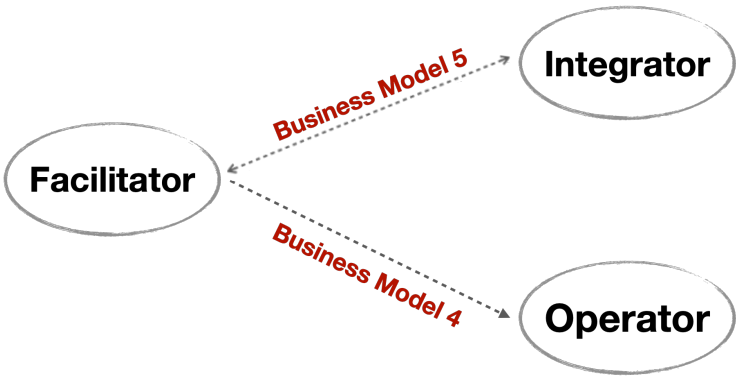

Figure 5 Facilitator-integrator and operator business model

Further, we discuss some of these facilitators and the state-of-art regarding their business with integrators and operators. The reason we discussed both groups of business models together is; first, there is not enough evidence showing the differences between the services and products offered to the integrators and operators. Secondly, the area of services is too vast to analyze all of them in this report. However, regarding the potential impact of the facilitators' business models to the MaaS business model, we suggest it as future research.

6.4.1 Automotive Industry

New trends such as connected cars, sharing cars, automated driving, electrification, and mobility as a service have enabled large-scale innovations in the automobile industry (Miyata,

2018). The automotive industry is currently subject to three main changes: automated driving, electrification of vehicle propulsion, and a shift towards mobility as a service. Among them, the later one challenges the private ownership of a car while others provide opportunities for the industry growth (Azevedo, D'Orey and Ferreira, 2020). According to Accenture's estimation, by 2030, revenues from manufacturing and selling vehicles are likely to remain at the same level as it is today. However, revenues from MaaS are projected to escalate dramatically. Therefore, OEMs must face three critical challenges to survive the emerging 'passenger economy'. First, they need to address the users' growing expectations resulted from the emergence of new shared economy ventures. Second, they need to ensure their profitability in these new services. So far, most of the experiments in car-sharing and ride-hailing are not profitable. Third, they need to integrate their traditional business models with the new shared mobility offerings. For this, they need to find a balance between software, hardware, and the ecosystem. Addressing these challenges requires partnership between OEMs and other actors. Some signs of partnership are already evident between big car manufacturers like Daimler, Volkswagen and BMW with telecommunication companies in order to develop the required infrastructure.

To survive and win the new market, OEMs need to adopt new business models that create new capabilities. Further, we discuss some of these possible business models that are potentially profitable for OEMs (Schmidt, Reers and Gerhardy, 2018).

- Luxury Vehicle manufacturer OEM: Focusing on a niche market of the customers who still want to own a car. This business model is likely to build upon a premium or even a luxury brand with the highest quality. In this model, the OEM plays a traditional role.
- B2B Asset Provider OEM: In this business model, OEMs focus on manufacturing, selling, and supporting vehicles and delivering them to fleet providers. In this model, the OEMs will focus more on its flexible production capabilities and less on brand marketing activities. Here, the OEM act as a facilitator for operators.
- Vehicle & Fleet Operator OEM: in this business model, OEMs own and operate the fleet to realize the optimal lifecycle of the vehicles from manufacturing to waste management. The vehicles are designed for more efficiency and reducing the cost of MaaS. Here, the OEM act as an operator.
- Car Mobility Service Provider OEM: in this model, the OEM provides valuable customer data insights by adding classic car-sharing services. With this data and strong

partnerships, OEMs can provide personalized services. However, building a strong brand to stay competitive is a challenge. Here, the OEM act as an integrator.

- Full Mobility Provider: in this case, the OEM acts as a comprehensive integrator by combining multiple transportation modes. OEMs that follow this model become the heart of the ecosystem with a strong partnership with public and private actors. They would broaden the scope of data and strengthen their user interface, and eventually, they become the dominant Integrator in the market. However, the fierce competition between the OEMs might pose a significant challenge for any of them to take over the whole market.

OEMs, as strong actors in the MaaS ecosystem, can play a variety of roles from facilitators, operators, or integrators of MaaS. Meanwhile, their business models play a crucial role in the implementation of MaaS and their future success.

6.4.2 INSURANCE SERVICE PROVIDERS

Mobility companies are now able to analyze the big data and anticipate customer needs and behaviors to address them with a more sophisticated, targeted, and efficiently priced insurance coverage. However, they must face some significant challenges like insurance structure and pricing before offering their services. Besides, the legal identity of the drivers (whether they are considered as an independent contractor or employee) is a challenge towards offering good insurance services. Since the emergence of new mobility offerings such as ride-sharing, relative insurance services have evolved dramatically. New insurance services now offer different limits and coverage, relative to the point in the journey. For example, the drivers' personal insurance is now sensitive to the events of the service.

In the future, when more insurers come to the market, the MaaS platforms may offer more insurance alternatives. Moreover, due to the competition, more innovative insurance solutions might emerge that offer more flexible pricing and coverage options. Regarding the importance of the insurance structure and pricing, it is likely to become a competitive advantage of any MaaS solution. As the technology advances, usage-based and real-time insurance become a dominant standard of mobility solutions; therefore, insurers must strive to understand the new technologies to define the risk profile on the platform and manage them accordingly (Wyman, 2020).

To conclude, insurance providers play a crucial role in the MaaS ecosystem. Their business models have already started altering from a static, fixed service to a real-time and usage-based model. However, more insurers must fuel the competition with their innovative solutions.

6.4.3 DATA AND API (APPLICATION PROGRAMMING INTERFACE) PROVIDERS;

MaaS intensely relies on access and exchange of reliable and quality data. MaaS integrators forecast travel demand and provide travel demand management services as well as traffic and time data to operators. This integrated data enables MaaS operators to provide more precise services; therefore, travelers will receive a higher level of service (Polydoropoulou et al., 2020). To plan a dynamic journey, commercial or open-source external routing APIs are critically important. Google directions, Bing Routes, Here Routing, Graphhopper, Open Trip Planner (OTP), and Open Source Routing Machine (OSRM) are some examples of such APIs that are being used in different cases based on their specific functionalities and performance (Georgakis et al., 2019). Google Maps offers an API that allows the businesses to make requests and embed the received information in their offers to the end-users. For example, Uber's app enormously relies on Google maps. In just three years, Uber has paid Google around $58 M for mapping (Lyons, 2020). Because Uber and Google started competing in different areas, such as self-driving technology (Novet, 2019), Ubers' dependency on Google's APIs is not risk-free especially, where no other alternative is reliable enough to replace Google's.

Here, we provided a short overview of three major groups of facilitators and their business models. However, there are more groups, such as IT companies, software companies, telecommunication companies, and financial companies that are out of the scope of this research and need further analysis. In short, facilitators have a critical role in the MaaS ecosystem, and their business models should be taken into consideration when designing an integrated business model for MaaS. It is worth mentioning that most of the facilitators such as OEMs, Telecommunication companies, and IT companies, operate and compete in global markets. Therefore, the role of integrator to connect the facilitators' global market to operators' local market is crucial. In this study, we just took a short glance on some of the facilitators and the relevant discussions about their business models. However, a more precise investigation on how they create value for and capture value from the integrator and the operators is a matter of study. At some point, the integrator might also provide value for the facilitators in terms of data, new markets, etc. which needs further investigations.

6.5 VALUE CHAIN IN MAAS

The tradeoff between different MaaS roles through their business models creates the MaaS value chain. So far, the MaaS ecosystem lacks a fully implemented integrator role, and the operators are in the center of value creation. In this case, the mobility platforms are fragmented building blocks with no or limited communication with each other. Figure 6 is an illustration of the value chain without the integrator role in which the Operators receive the value in the form of products or services from facilitators, add their own offerings, and transfer the value to the end-users through their business models.

With the appearance of an integrator within the ecosystem, the value chain changes dramatically. The integrator is a smart stitching of several building blocks while orchestrating the whole system. Figure 7 shows the new value chain after the entrance of the Integrator as the center of MaaS. In this case, the Integrator receives the services and products from facilitators, share them with the operators and finally delivers the value to the end users, through its platform. This shift might disrupt (or at least weaken) the whole previous value chain. For example, the operators might lose their brand visibility which promotes resistance to the change in value chain. On the other hand, the new value chain regulates and connects the supply side and the demand side through a single hub. In the extreme level, the Integrator might become a monopoly (in relation with the users), a monopsony (in relation with the operators), and a mass buyer (from the facilitators). We hypnotize that if the integrator's value proposition to other roles is convincing, it can overcome the resistance against the change in value chain. However, designing a value proposition that ensures operators', users' and facilitators' benefits, while remaining profitable and sustainable, is a dilemma yet to be solved.

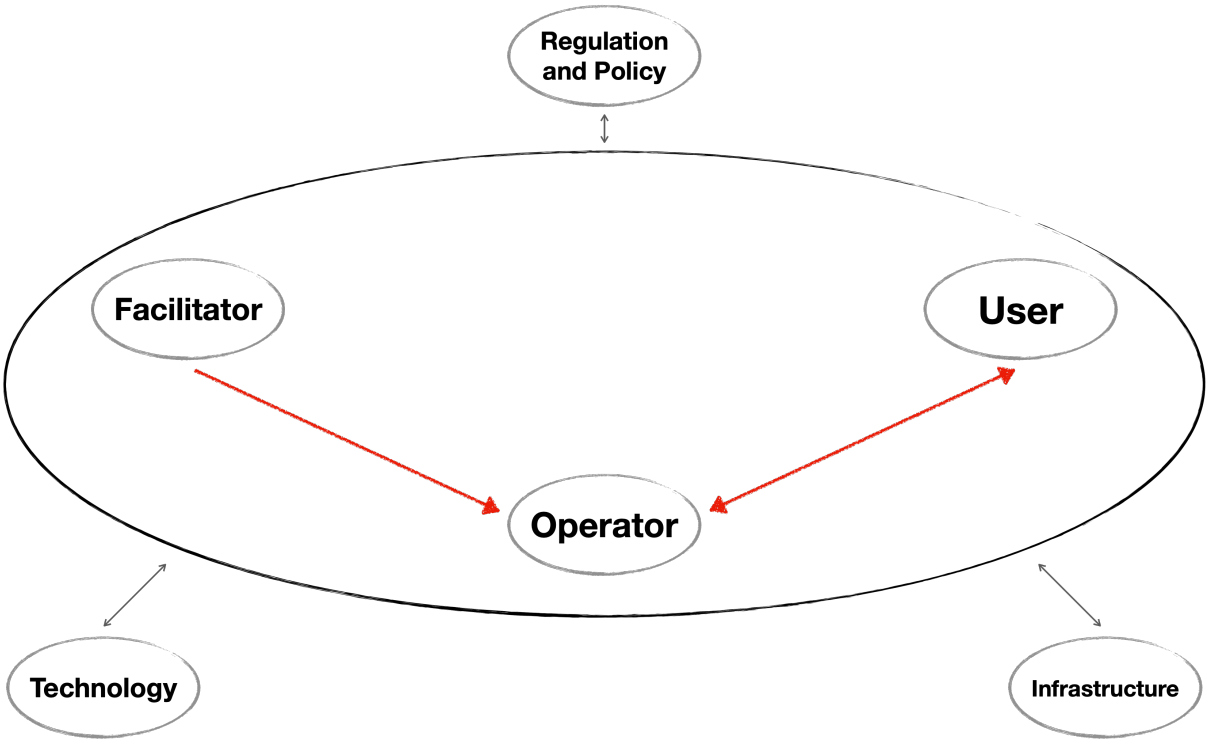

Figure 6 A schematic illustration of the value chain without integrator

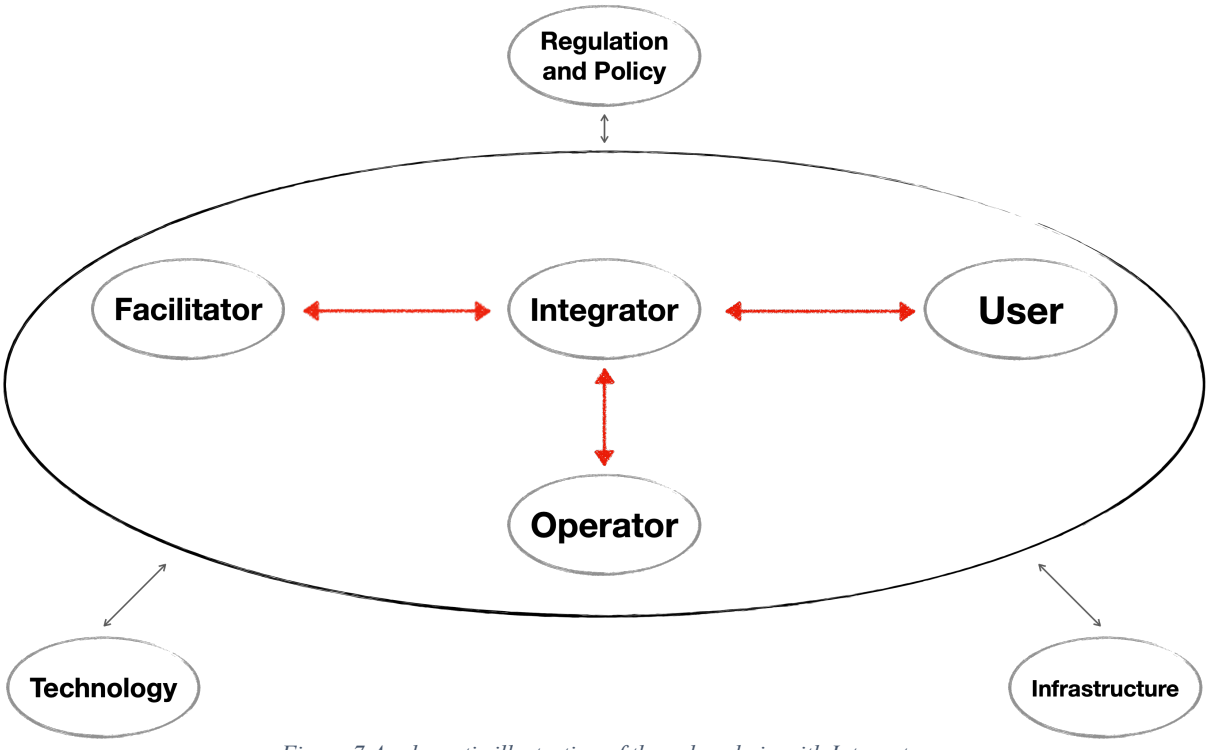

Figure 7 A schematic illustration of the value chain with Integrator

MaaS is not just an app. Successful integration in mobility services requires investments in physical services and infrastructure (The Future of Mobility 3.0, 2018). Besides, the integrator must ensure the social and environmental benefits for the society as well as profitability for the system as a whole. Currently, the MaaS value chain lacks such a comprehensive solution due to the limitation explained below (*The Future of Mobility 3.0*, 2018):

- Time to Market: MaaS has not yet delivered on its promises. The pace of deployment is slower than the expectations;
- User adoption: the MaaS offerings have not been attractive enough to cause the modal shift;
- Public transport operators' resistance: partnership models are not yet clear which pose a major obstacle to deployment of MaaS;
- B2C MaaS initiatives have not yet reached economy of scale viability;
- Integrators' promises of reducing service costs have not been materialized yet.

In summary, the shift in value chain might promote operators' resistance while a well-designed, comprehensive and integrated value proposition can create new business opportunities for the existing and new actors, which, in long term, leads to profitability. It is worth mentioning that, the role of government as infrastructure provider, knowledge provider, and regulator is crucial and requires further researches.

7 CONCLUSION

Mobility-as-a-service has already started transforming the face of the mobility industry. Car ownership is becoming less critical while “sharing economy” and “as-a-service” movements are taking over the mobility market. However, there is still a lack of successful implementation of an integrated and comprehensive MaaS. Technology, regulation and policy, infrastructure, and business models must come together to form such a MaaS ecosystem. Although a lot of studies have been done regarding the MaaS business models, the discussions cover different areas while a comprehensive structure is missing.

When considering business models within the context of MaaS, the literature generally focuses on the relation between integrator and the users. Discussions regarding user behavior, and how integrators create, and capture value are dominant in the field. The relationship between integrator and operator is also covered; integrator value creation and capture are described, nevertheless there is still a lack of content when analyzing the willingness of operators to engage in MaaS, as well as research analyzing if the current value offered by MaaS is substantial for such engagement. We also observed that there is gap in the literature regarding the relation between integrator and the facilitators. Examples are described; however, it is uncertain how the integrator creates and capture value for/from facilitators and vice-versa.

In this report, we argued that there is not a single MaaS business model. Instead, there is an ecosystem of interrelated business models between different mobility actors that are a key prerequisite for MaaS to work. To understand this ecosystem of interrelated business models, we analyzed MaaS roles from which four influential groups emerged, including: MaaS integrator, MaaS operator, MaaS facilitator, and the end-users. Their interrelated business models have been explored separately. Three significant enablers and barriers of MaaS and their effect on business models have also been discussed (infrastructure, technology, and regulation and policy). The MaaS value chain and the importance of public transport were also highlighted as important aspects to be taken into consideration when analyzing business models within MaaS. Exploring the different business models that could be related to MaaS and what factors might enable or create a barrier for them to work, can help researches and industry to create the synergy and to reduce the uncertainty within this field. Further, we discuss future possible research questions that we found relevant to the topic.

7.1 FUTURE RESEARCH

As a next step in deepening the understanding of business models within the MaaS context, further analysis is desirable regarding,

- How users can create a capture value when they become businesses. At some point, users would be able to sell data, electricity and offer their vehicles to integrators, meaning users will also be businesses. The questions that are to be answered then are what business models would users implement, what value would they provide to integrators, and how would they capture it?
- The value offered by the integrator to the operators has not been adequately discussed. how integrators create and capture value if they could offer to operators a full operative digital platform? meaning operators do not need to spend their capital on research and development building a digital infrastructure to reach users; how integrators could capture value from power of negotiation once MaaS is implemented? And how integrators could maximize value capture from economy of scale? And from information? meaning operators would not only have available data from customers when they make use of their services but also when MaaS users make use of other services. For instance, a car-hailing operator would have access to data from scooters or car-sharing users, increasing their ability to analyze transportation users' behavior from a holistic perspective.
- Operators offer to integrators all the vehicles needed to offer a MaaS service. Also, operators are the actors getting in touch with the MaaS user, delivering the mobility service experience to them. They are also the first stream of data for integrators. But how operators capture value from integrators? Still a matter of study. Operators' offering is highly associated with the location and geography. Just a few operators are active in more than a country and almost none of them covers both the rural and urban areas within their territory. It seems important to study the reasons of this phenomena and the reasons behind it to implement an integrated and comprehensive MaaS in the future.
- Integrators at some point in the future would also be able to integrate all facilitators into one platform to increase their value creation towards operators and users. What value would integrators offer to facilitators (i.e vehicle manufacturers, insurance companies, internet and telecommunication companies etc) still is a matter of further research.

Such analyses are key to evaluating and understanding what value can be created and how to capture it when MaaS can be achieved.

In order to provide more insights regarding the future research on MaaS business models, we created a list of further research questions. These questions were gathered during the research process (see table 16).

Table 16 Future work proposed within the literature

Proposed future work found within the literature	Reference
"For application beyond transport, it is recommended that the underlying generic value creation mechanisms at play are further explored. The particular emphasis on MaaS and digital innovation suggests "digitally-enabled innovative business models" may be the best starting point for the analysis. Taking away the transport context, mechanisms observed included sharing of data to mutual benefit (e.g., driving habits); supporting new service delivery models that bring public benefit (e.g., dynamic car routing); and assistance in delivering public policy (e.g., demand-based pricing to reduce congestion). The mechanisms rest upon meaningful cross-sector, public–private collaboration".	(Cooper *et al.*, 2019)
"An important aspect which could be tested in greater detail is how government might act as a barrier or facilitator to the development and implementation of MaaS. The Nordic experience has shown the importance of government setting a common vision and road-map (operationalized through transport legislation), political will from the authorities, and the willingness for public and private actors to share the risk inherent in investing/supplying in a new and unproven concept (Smith et al. 2019; Karlsson et al. 2020). The role of institutional context, including the political and economic environment, needs to be researched in greater detail beyond the relatively blunt 'levels' of appeal and monetary support examined in this survey. There are also opportunities to more systematically evaluate a number of policy questions surrounding organizations' internal barriers to innovation, as well as attitudes surrounding risk, return and innovation". "One final observation which might be made on the state of MaaS research is its heavy reliance so far on stated choice studies (of which this present paper is a culprit!). Whilst a number of trials and pilots have been conducted (or remain in progress) around the world, these are mainly commercial in nature with very poor evaluation and documentation on their behavioral impacts and on successes and failures. Any insights drawn on travel or business behavior lack the scientific rigor in terms of a required baseline assessment and face typical issues like self-selection bias".	(Wong and Hensher, 2020)

Table 16 Continue

Proposed future work found within the literature	Reference
"Several questions for future research result from this analysis, such as the change in positioning of current actors, the identity of the network operator and the likelihood of competition. These topics need to be explored in more detail to understand how these actors may work together or independently in the new competitive landscape. The key future question is what the identity of the network operator is, i.e. who will dominate the system and capture the most value? And how can the other actors stay relevant and attempt to capture some of this created value for themselves?" "Another key component needing further study is the physical net- work. Public and private charging stations are already being put in place now for cars. There is the potential under model 2 to introduce battery swapping stations to avoid charging time, but more research is needed on the technical evolution of batteries and the economic trade-off between swapping costs and charging time. It is quite possible that it will be economic for some years but then perhaps obsolete in the future. There is also the question of hubs connecting the EAV highway links with the rest of the road network – the longer this model operates, the more entrenched will be the role of the hub operator. This adds another interesting dimension in that there is a level of risk given this uncertainty – how will that influence market behaviour? Would it encourage or deter new entrants entering the market? Will we see an independent charging station or hub provider rolling out a network of battery swap and trailer transhipment hubs? Will it be the envisaged network operator or a separate company or a competitor? How will this change once EAVs are allowed to operate on the entire road network and connect shippers directly?"	(Monios and Bergqvist, 2020)
"First, individuals in the digital future will need to move from an ownership model to a shared model of mobility if MaaS is to be widely successful: we do not know how to encourage this process." "Second, pilot MaaS schemes need to be undertaken to build an evidence base. This will require some decisions as to how open data can be controlled – by the market or by government?" "Third, understanding the outcome of some key relationships. For example, between the goals and the shape of MaaS as it is rolled out – much current literature points to sustainability but does not identify measurable goals such as decreasing VKT/VMT. Current practice suggests that public transport will be at the core of all MaaS bundles – but is this necessarily best? How does the transport network relate to bundle creation and how does the aggregator/integrator choose the operator(s)?" "Fourth, research on the nature of pricing strategies in the three dimensions of how much customers pay for packages, how do government and MaaS players contribute to meet the societal goals of transport policy and how do aggregators/integrators and mobility providers agree their pricing frameworks."	(Mulley and Kronsell, 2018)

Table 16 Continue

Proposed future work found within the literature	Reference
"The six governance approaches rely on a simplification of a more nuanced reality of complex interactions; other factors, such as different regime elements or simultaneous niche-innovations not emphasized here, might also be connected to emerging responses to MaaS. Importantly too, the six approaches are inspired by responses adopted within the context of specific cases and, thus, the same players might act differently in other situations. Finally, the paper focuses on public sector actors at regional and national levels, and does not analyze more deeply other relevant players, including car manufacturers and IT companies. Nonetheless, the scheme of governance approaches represents a first exploratory effort to fill a void in current literature that has few empirical studies about MaaS or its governance. These proposed approaches can be revised and enhanced, serving as a stepping-stone for future work on the same or different cases." "Importantly, this paper takes an initial step to allow coming work to address the extent to which early responses to MaaS set the stage for subsequent developments. In this sense, at least two complex questions emerge. The first question concerns the type of development trajectories these varied governance approaches may entail, i.e. the types of interaction between MaaS niches and PT regimes in the future." "A second related, and even more complex question, is whether and how the different governance approaches can influence the uptake of MaaS."	(Hirschhorn *et al.*, 2019)
"Future studies should pay attention to the differences in needs and motives for using MaaS for commuting and leisure trips. Once MaaS services become more widely available, large-scale surveys could benefit from a more established technical jargon that could mitigate biases due to misunderstandings. Furthermore, MaaS also benefits from the increasing popularity of sharing systems such as car, bike- and scooter-sharing. Having some experience with such programs has been shown to increase openness to using MaaS. As MaaS is still in its infancy, preferences might continuously change, calling for regular research into these preferences and the needs of potential users."	(Hoerler *et al.*, 2020)
While these investigations and results show significant impacts of charging infrastructure on the SAEV service performance, several other aspects are open to investigation in future work. For example, rather than having the same number of chargers or the same charging speed in all stations, future efforts should examine potential combinations of normal and rapid charging as well as a different number of outlets in the stations. The authors further plan to integrate a dispatching strategy for the allocation of accessible charging stations to each SAEV within this simulation framework. Understanding the financial tradeoff between service benefits (coming from passenger kilometer traveled by SAEV) and charging infrastructure configuration is another important prerequisite for delivering SAEV service, which the authors seek to investigate in the future work.	(Vosooghi *et al.*, 2020)
"We suggest more research to match the right services and policies to different categories of travel needs. For example, very long journeys may be partially replaced by train if new mobility services can cater for the needs at the destination, and the identified middle-sized flows may be an opportunity for public transport on demand, new ride sharing services, or home delivery for shopping. Commonly recurring car trips made during the spare time, and especially those made by people who normally commute by public transport, seem to hold opportunities for new service development. For new public transport routes and destinations, unwillingness to relearn and to plan the trips poses a challenge. Although travel planning support is a central concept in MaaS, mixing public transport and other modes will still require learning, timekeeping, and accepting transits."	(Sjöman, Ringenson and Kramers, 2020)

Table 16 Continue

Proposed future work found within the literature	Reference
For future work, further scenarios for a mobility-oriented agenda planning system could be developed to derive additional requirements of the system. With the requirements the architecture and system design can also be refined. The open social and technological challenges should also be addressed in future work.	(Schwinger and Krempels, 2019)
"There is a need for a knowledge base of flexible parking requirements to be applied for new developments. We suggest that such a base should include the evaluation of houses in different contexts using the same evaluation framework. Interesting contexts include those where the quality of public transport availability and parking prices vary, as well as locations with different levels of accessibility on foot to local amenities such as food shops, leisure and culture." "Impacts of mobility as a service and other measures applied in the two blocks of flats on the travel habits of householders may vary over time. We identified three occasions as windows of opportunity: (a) when moving to a new house and, therefore, adjusting travel habits as well as encountering different parking prices (especially for groups in life-phase shifts, see above), (b) when car-free households consider buying a car, but might consider using car (sharing) as a service instead, and (c) when a car owned by a household comes to the end of its lifetime and a considerable reinvestment in the form of a new vehicle is considered. To cover such occasions, any evaluation carried out needs to follow residents over a longer period of time, ideally over several years. This is what the authors also intend to do in a five-year project for which funding has been applied for from the Swedish Transport Administration in 2019." "We also see the choice of business model for each particular car club operating in an area as important since it has impacts on the effects that can be expected on parking demand, as well as on costs for developers and homeowners' associations. We would also like to argue that accessibility services, other than those available to the homeowners we studied, should be considered, e.g., shared or on-demand micro-mobility or job hubs at urban nodes. Services like this, publicly, co-operatively or commercially provided, could potentially become important elements of the sustainable accessibility that is created or strengthened in transport planning in connection with future city district development (with or without considerable new construction)."	(Johansson, Henriksson and Envall, 2019)
Further research will focus on: (a) comparing DRST performance with pure taxi and pure bus services; (b) testing other strategies to optimize the service (i.e. increase load factor, reduce vehicle-km), e.g. rebalancing/idle strategies; (c) testing reactive/adaptive agent behaviors for route choice strategies based on system states to make the service more demand-responsive; (d) testing pricing strategies and public subsidies to increase the service effectiveness (in terms of satisfied demand); (e) testing the performance of the system with autonomous vehicles; (f) including elasticity of demand to price; (g) including the estimation of pollutant emissions and other transport externalities; (h) improving the demand model (e.g. including socio-demographics characteristics, data from surveys); (i) test the service operation taking into account real-time traffic data; (j) validate the model with real-world data. In this respect, it is planned to use data by reproducing other case studies of an analogous DRST systems based on the same platform, e.g. the case of Dubai. The final aim is to have a reliable decision-support tool for planning, management and optimization of DRST services, which can help to reduce the burden of transport in our cities and contribute to sustainable mobility.	(Inturri *et al.*, 2019)

Table 16 Continue

Proposed future work found within the literature	Reference
"More research is needed on potential nudging mechanisms that could be employed to stimulate individuals to act according to a specific desired behaviour. For instance, reducing the use of the private car while increasing the used of shared modes of transport. An example of such a nudging mechanism could be the use of gamification techniques, wherein game-design elements are employed in non-gaming contexts. The exact effects (e.g., the reduction in parking needs) of these different nudging mechanisms on travel behaviour could then be investigated. Moreover, the combination of different rewarding schemes, such as money or in-kind gifts, with certain gamification techniques could also be interesting future research in order to observe which gamification strategies renders the best-desired effect."	(Fioreze, de Gruijter and Geurs, 2019)
"Understand the extent to which particular types of MaaS plans might be delivered under an economically deregulated market model or whether they may be controlled to some extent by government through competition for the market using competitive tendering."	(Ho *et al.*, 2018)

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