Unpacking the complexities of MaaS business models – A relational approach

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ABSTRACT

Mobility as a Service (MaaS) integrates different transportation services into a single on-demand mobility service to promote sustainable mobility. A challenge is how to innovate new business models for MaaS as it demands an understanding of how various actors position themselves within a MaaS ecosystem and how value creation changes in such ecosystems. While different streams of research on MaaS business model innovation have applied an ecosystem approach, the approach has been limited to a focal actor or the relationships between a few actors. This paper reviews academic literature and consultancy reports on business models for MaaS and presents an integrated framework that describes actors’ roles and relationships in MaaS ecosystems as well as types of business models. In doing so, the paper contributes to an understanding of the interlinked character of value creation and value capture – two central parts of any business model – in MaaS. Based on the findings, the paper argues that taking an ecosystem approach to the analysis of MaaS business models can be a way to fully capture the complexity of value creation and value capture in MaaS business models.

1. Introduction

Mobility is transforming from a focus on a physical asset – the vehicle – to a focus on a service that incorporates many transportation modes, such as cars, buses, flights, ferries, and rail presented as a single, on-demand service (Ambrosino et al., 2016). As Jittrapirom et al. (2017) explain this is a new way to envision mobility called Mobility as a Service (MaaS). MaaS has the potential to help users recognize and choose daily mobility options without thinking about how they connect, and thus increase transportation efficiency (Strömberg et al., 2016). MaaS poses radical changes to meet the growing need for personalized, on-demand, user-cantered mobility services, and has the potential to uncover opportunities for more sustainable mobility (Jittrapirom et al., 2017; Polydoropoulou et al., 2020). To achieve this, a MaaS must involve a wide range of private and public actors such as authorities, public and private transport operators, data

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providers, IT companies, ticketing and payment service providers, telecommunications, 
financing companies, insurance institutions, passenger associations, etc. (Macedo et al., 
2022). However, despite the vast interest in understanding and implementing MaaS 
(Cottrill, 2020), how it will unfold depends on a series of technological, social and 
regulatory trends, and so far, its large-scale implementation has been slow (Giesecke 
et al., 2016; Karlsson et al., 2020; Polydoropoulou et al., 2020). The change from a goods-
centric to a service-centric logic (Vargo & Lusch, 2018) in mobility has generated new 
demands for service innovation methods and tools (Lusch & Nambisan, 2015). Not least, 
the service innovation revolution has consequences for how to innovate new business 
models (BMs) that are aligned with a service-centric paradigm in the context of MaaS. 
From a BM perspective, MaaS can enable value creation, and capture for many actors 
since integrating different forms of transport services into a sole, on-demand mobility 
service will stimulate many-for-many businesses based on combinations of service 
offerings (Hietanen, 2014). It will also require product companies to shift focus to 
services, leading to new value propositions to customers, new value creation activities, 
new partnerships, and new revenue models. In other words, novel mobility service 
offerings will disrupt the existing BMs (Athanasopoulou et al., 2019). This new mobility 
services marketplace where multiple interlinked suppliers and actors collaborate to offer 
customers multimodal one-stop services puts severe pressure on actors to build up new 
competences for how to combine products with services, refining and personalizing the 
service offers as well as understanding the service ecosystem (Goncalves & Bergquist, 
2022; Monios & Bergqvist, 2020; Willing et al., 2017; Wong et al., 2018). This also implies 
that MaaS goes beyond a single-firm BM to BMs co-created in a network of actors where 
the development process is continuous and iterative by nature (Williamson & De Meyer, 
2012; Wong et al., 2018). For example, one actor can offer a map service, which enables 
better route planning to consider time to destination, availability of charging stations and 
optimal charging time. The map service can become part of services for parking avail-
ability and location as well as assistance availability in case of accident or emergency stop. 
To provide accurate calculations, the map service will be dependent on actors with 
information about infrastructures and other resources, traveller’s behaviour and needs, 
and consumption behaviour such as payment platforms and insurance services. All these 
components need other actors’ resources to work as a MaaS solution.

Digitalization is crucial for connecting actors so that they can generate and capture 
value in new ways (Gawer & Cusumano, 2014; Koskela-Huotari et al., 2016; Tiwana, 
2015). This is an important reason why previous BMs for mobility are not entirely 
applicable in a MaaS context, which is organized as an ecosystem, based on smart 
integration of information resources connected to various mobility modes, supporting 
systems, and infrastructures (Llopis-Albert et al., 2021) of which the digital platform is 
one actor. The composition of each MaaS ecosystem and the related BMs may be totally 
different due to the varying configurations (Polydoropoulou et al., 2020). As Guyader 
et al. (2021) and Šulskytė (2021) emphasize, the complexity of a new, digitally enhanced 
mobility ecosystem would most likely trigger a change and renegotiation of well-
established roles in the exiting ecosystem and would require design of new BMs.

Indeed, literature on innovation has emphasized the role of ecosystems (Adner, 2006). 
Ecosystems enable companies to develop businesses that they could not pursue on their 
own because of a lack of resources. The advance of MaaS BMs is vital for the prosperity of
emerging MaaS ecosystems (Karlsson et al., 2020; Zhang & Zhang, 2021). Thus, the importance of ecosystems is recognized in research about MaaS (Reyes García et al., 2020), and BMs in MaaS have been discussed from an ecosystem perspective but in a quite one-dimensional way: it assumes a focal actor (typically the MaaS provider) with a core business that can be extended and is dependent on other actors (Kamargianni & Matyas, 2017; Šulskytė, 2021). However, as the literature review presented in this paper will show, the MaaS provider’s BM will not necessarily define all the relationships and that there is more to the picture. Our results support Guyader et al.’s (2021) conclusion that different logics and roles within the ecosystem can co-exist, evolve and vary over time.

To summarize, while there is growing research on the role of ecosystems, actor dependencies and boundary resources in digital platform evolution and service innovation (Llopis-Albert et al., 2021), research on BM innovation for MaaS is not sufficiently explored (Corazza & Carassiti, 2021; Hult et al., 2021; Wong & Hensher, 2021) and has been analytically limited to either a focal actor in an ecosystem (Turoň, 2022), or the relationship between a few actors (Šulskytė, 2021). This has fragmented our understanding of how value creation and value capture in MaaS ecosystems are interconnected based on different roles actors might take in the ecosystem (Hensher et al., 2021).

This paper is founded on a literature review which showed that a valuable step in increasing our understanding of BM innovation in MaaS ecosystems can be achieved by analysing received literature from an ecosystem perspective to better understand how BMs are affected by ecosystem multi-actor relations. Therefore, based on an analysis of how value in service systems is co-created in ecosystems, the overall aim of this paper is to contribute to a better understanding of how a MaaS BM perspective can inform service innovation. We use as a starting point the definition of BM as the ‘design or architecture of the value creation, delivery, and capture mechanisms’ (Teece, 2010, 172) and specifically discuss the value creation and value capture aspects of it. The result is presented in the form of a framework that conceptualizes types of prototypical roles and relations identified in MaaS ecosystem.

The paper is organized as follows. First, we describe the method used when identifying relevant literature for analysis. We then present the identified relationships, based on roles actors take in MaaS ecosystems, and the BMs that emanate from these relations. The paper ends with a discussion and conclusions based on the findings of how an ecosystem approach to BM innovation can enhance the understanding of value creation and value capture in MaaS ecosystems, relevance for research and practice, and suggestions for future research.

2. Method

2.1 Data collection

The data collection for this study was based on a broad data sourcing strategy. To get a comprehensive picture of existing MaaS actors and BMs, a combination of searches in journal articles, reports, and other sources was needed since certain MaaS actors and their BMs have been favoured by research, while others understudied. In line with Collin et al. (1996), and Jesson et al. (2011) the search was divided into two parts: first, we
searched research databases for scientific papers; second, we used a more inclusive search strategy including other channels to also identify relevant white papers, consultancy reports, popular press, and case studies.

The first search round aimed to identify relevant peer-reviewed scientific articles and conference papers discussing BMs within the context of MaaS. The databases Scopus and ACM Digital Library were selected. We included papers published from January 2010 up to January 2022. We used the keyword combinations 'Business Model' OR 'Business Models' AND 'MaaS' OR 'Mobility as a Service'. The search resulted in 247 scientific articles. Duplicates were removed, leaving 202 papers. This was followed by an examination of the title, abstract and keywords, removing papers that were clearly irrelevant or only mentioning BM aspects of mobility services but not providing examples and/or analysing the BMs so that roles and relations could be extracted, leaving 45 articles.

The second search round identified relevant consultancy reports (white papers, case studies with empirical examples) to add cases and actors based on managerial perspectives on MaaS. In congruence with the first search round, we aimed to identify publications that discussed BMs within the context of MaaS. The Google search engine was used and included the same combination of keywords as the first round. Google search is the leading search engine in terms of user base and has a ranking algorithm based on a combination of backlink count, the website’s age, impact of content type and user experience, number of visits and traffic, metadata and keyword indexing, and domain authority (Joshi & Patel, 2018). We used the advanced features and set language to ‘English’, regions to ‘all regions’, updated to ‘anytime’, and file type to ‘PDF files (.pdf)’. Portable Document Format (PDF) was chosen because it, unlike web pages or blogs that are under constant change, connotes a stable format with a certain authority. PDF is easy to distribute and has become a de-facto standard for formal communication (Castiglione et al., 2010). The search resulted in 25 documents for data extraction, leaving in total 45 scientific articles and 25 consultancy reports finally included in this review (Table 1).

### 2.2 Data analysis

The consultancy reports and scientific articles were analysed using thematic analysis (Guest et al., 2012). Themes were identified when reading the literature (i.e. roles, enablers and barriers, BMs). The analysis mapped roles in the MaaS ecosystem and identified the relations and corresponding BMs, and how they varied depending on the type of proposed value, the role of the value creator, and the role of the value receiver. Finally, in line with Teece’s (2010) BM definition, within each BM group, value creation and value capture aspects were further analysed from a relational perspective, to clarify the complexity of the relations. Finally, the output of the findings was composed into a framework (Figure 1).

| Table 1. Summary of the report/papers search process. |
|---------------------------------------------|-----------------|
| Search engine/Database                      | Yielded         |
| Google – consultancy reports                | 25              |
| Scopus & ACM Digital Library – scientific papers | 202             |
| Total consultancy reports mapped           | 25              |
| Total scientific articles                   | 45              |
3. Findings

The review showed that some core characteristics are that 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). For example, Jittrapirom et al. (2017) summarize the core characteristics of MaaS as follows (i) integration of transport modes, (ii) tariff option, (iii) one platform, (iv) multiple actors, (v) use of technologies, (vi) demand orientation, (vii) registration requirement, (viii) personalization, and (ix) customization. Furthermore, MaaS can be implemented with different levels of integration. Sochor et al. (2018) identified four levels of integration where at the highest level the effects of MaaS go beyond linking supply and demand, reaching economic, societal, and environmental-related goals. The varying levels of integration also implies that MaaS BMs will vary depending on the integration of all features of MaaS. In the sections below, based on our overview, we first map out and explain the different roles that actors take in a MaaS ecosystem and then classify the relationships between roles in terms of value creation and value capture (BM1-BM2-BM3-BM4-BM5).

3.1 Roles in the MaaS context

Our review identified four major roles in the MaaS context – integrators, operators, users, and facilitators.

*Maas integrators* combine the offerings of different transport service providers within a single platform. According to Smith et al. (2018, 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’. Kamargianni and Matyas (2017) see this role as crucial for the successful MaaS implementation. 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).

MaaS operators package and deliver mobility offerings to end-users. As Smith et al. (2018, 593) put it, ‘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’. Various mobility operators are working together with public transport to provide end-users with the most suitable trip without owning the means of transport ("UNECE" 2020). 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, and on-demand bus rides.

MaaS users represent another key role. MaaS is a user-centric paradigm (Jittrapirom et al., 2017) which provides end-users with tailor-made solutions and recommendations based on their profile, preferences, and past behaviour. MaaS users should be seen as service providers in the sense that they can provide profiles, establish use patterns, preferences and the like to other actors. As multimodal mobility grows, the complexity of managing the mobility offers rises dramatically. Consequently, users are forced to deal with a considerable number of alternatives, which makes it more complicated for them to choose between modes (Schwinger & Krempels, 2019).

MaaS facilitators provide necessary products and services for MaaS to operate (Smith et al., 2018). Although they might or might not be involved in the day-to-day operations, the facilitators have a significant impact on the MaaS infrastructure. 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 are examples of actors that often take a facilitator role.

The MaaS roles described above allow actors to create and offer combinations of services within sets and packages in the MaaS ecosystem. In the following sections, the identified BMs are paired with role-combinations and described from a value creation and value capture relationship.

3.2 BM1: integrator – user relationship

When it comes to the relationship between integrators and users, the literature showed that there is not one or a list of established BMs for offering MaaS to users. In the tables below, it is shown how integrators create value for users (Table 2) and the means for capturing it (Table 3). Overall, users get smooth, and price-worthy personalized mobility solutions offering a balance between convenience, cost and time (Arias-Molinares and Carlos García-Palomares, 2020; Giesecke, Falconer et al., 2018; Giesecke, Surakka and Hakonen 2016; Schwinger & Krempels, 2019). Additionally, as Ditmore and Miller (2021) state integrators can mitigate health-related impacts of commuting and travel such as stress.
The means for value capture vary according to the typology of MaaS, based on the level of integration (Sochor et al., 2018) as well as the public-private partnership (Lucken et al., 2019). Table 3 shows a list of means for value capturing and how these vary concerning the typology of MaaS.

Even if the reviewed papers discussed how integrators create value for and capture value from users, less evidence was found regarding how users create and capture value in this relation. Matowicki et al. (2022) outline both attitudinal and context-specific factors affecting value generation among users and the likeliness to choose MaaS solutions. Šulskytė (2021) discusses that users also provide valuable resources such as data and vehicles, which are offered to integrators. Thus, the BMs become influenced by the degree users trust the MaaS solution, and the willingness to share travel data, profiles, and preferences with the integrator which determines the extent users can provide and

**Table 2. 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 the ride or not |
| 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 of urban congestion |

**Table 3. Integrator to user value capture.**

|                     | Means of capturing value | Value capture                                                                 |
|---------------------|--------------------------|-------------------------------------------------------------------------------|
| Typology             |                          | Schedules vending, Routing vending                                             |
| Level of integration | Information              | Booking, Direct payment                                                        |
|                     | Direct payment           | Invoicing                                                                     |
|                     | Pay-as-you-go            | Monthly invoicing                                                             |
|                     | Account-based            | Mobility packages, Subscription                                                |
|                     | Subscription-based       |                                                                             |
| Public-private partnership | Low-density model | 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        | Not found within the literature                                                |

**Table 4. Integrator to operator value creation.**

|                  | Value creation                                                                 |
|------------------|-------------------------------------------------------------------------------|
| Innovation and differentiation | Offers a more significant opportunity for innovation in mobility provision (different combinations of transportation means) |
|                  | Drives innovations in the travel market include new partnership models, booking systems, payment and information tools, data sharing agreements, etc. |
| 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, it 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 |
capture value from integrators (Alonso-González et al. 2020). Furthermore, the aggregation of personal data is seen as the key empowering factor for value creation for integrators and digital platforms (Hoffmann et al., 2021).

### 3.3 BM2: integrator – operator relationship

The literature shows that integrators not only create value for users but also for operators. Polydoropoulou et al. (2020) concludes that operators are likely to be the most critical MaaS actors, particularly public transport operators. Empirically, this is illustrated by MaaS pilot projects such as in Sydney and Amsterdam, where the operators’ role was to enhance the public transport service (supporting public transport in first-mile/last-mile trips) rather than replacing it. From a BM perspective, the operator is as likely to be private as well as public, however this has implications for BMs. Tables 4 and 5 show the value creation and value capture.

Polydoropoulou et al. (2020) is one of the few that reveal the importance of operators when implementing MaaS. Falconer et al. (2018) from ARUP consultancy also discuss the value that integrators could offer operators once a MaaS is implemented. The four most important aspects are:

- A digital platform, meaning operators do not need to invest in R&D to develop and build a digital infrastructure to reach users.
- Under negotiations transport operators would have a say in discussions of regulation and policy with governmental institutions.
- Economy of scale will allow operators to reach customers quickly and efficiently while saving the cost of continually upgrading the platform.
- Holistic information about customers, meaning operators will have data about customers when they make use of their services and when MaaS users make use of other benefits. For instance, a car-hailing operator can have access to data from scooters or car-sharing users, increasing their ability to analyse transportation users’ behaviour from a holistic perspective.

Despite the limited understanding of the supply-side around MaaS BMs, the literature identifies three models.

**The broker model:** the broker could be a public entity, private enterprise, or coordinated (public-private; Cooper et al., 2019; Sakai, 2020). Brokers bring together suppliers of transportation services and platform providers, financial enterprises, data providers, insurance companies, regulatory organizations, universities/research institutions, and other mobility specialized businesses (Wong et al., 2018, 2020). The broker packages these essential 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 (big city or several cities) to be profitable (Audenhove et al., 2018).

| Table 5. Integrator to operator value capture. |
|-----------------------------------------------|
| Value capture                                 |
| Broker/aggregator model                        | Based on commission per transaction |
| Partnering/alliance model                     | Partnerships/alliances between operators and Integrators |
| Road pricing/ Free market model               | Based on fees for infrastructure usage and market competition |
The partnership model: The partnership model assumes that the Integrator is a public agency and takes as the primary transportation mode, public transport. McKinsey Center for Future Mobility (2019) points out three partnership types between the Integrator and Operator to improve mobility in a city.

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, thereby facilitating multi-modal journeys, and increasing public transit.

On-demand minibuses: this partnership will help integrators maintain or extend coverage in underserved areas while lowering their service cost.

First/last-mile ridesharing: integrators can improve users’ access to public transport by subsidizing shared rides.

The free market model, where fully operating electric and autonomous vehicles are available. According to Beheshtian et al. (2020) the model follows the idea of allocating timeslots or tolling to roads, paying for privileged access to infrastructures such as freeways and highways. Mobility operators or private car users pay by trip if roads are used (Wong et al., 2020). Another aspect of the model is service quality since it is assumed that the best operators will offer users the best service in terms of experience and time. Sparrow and Howard (2020) have raised social concerns about this model that it will lead to privatization of public space (roads) and thus the unequal distribution of mobility resources.

Operators offer to integrators transport technologies to provide a MaaS service. Operators are also the main contact with MaaS users, delivering the mobility service experience and are thus the first stream of data gathering for integrators. Šulskytė (2021), Wong and Hensher (2021), and Zhang and Zhang (2021) show that operators provide access to funding, capabilities, data (e.g. occupancy levels; real-time travel information) or other intellectual knowhow as well as tangible assets (i.e. vehicles, depots) and in that way create value for the integrator. Furthermore, as Van den Berg et al. (2022) note, there are different configurations and degrees to which the operators would keep the control over the pricing of the mobility solutions offered by the integrators. Nevertheless, more research is needed to explore the value offered by the Integrator to the Operators.

3.4 BM3: operator – user relationship

The literature showed that operators and integrators are not only offering similar value to their users, but they also capture value in similar ways. Table 7 shows the value that operators provide to their customers while Table 6 is showing the value that operators provide to the integrators of value.

The Operator(s) means of capturing value (Table 8) could depend on their level of integration. Lyft ride sharing is an example of this. Lyft has gradually integrated different mobility services into its car-sharing offers, such as bikes, scooters, and luxury cars.

Lyft, as an integrator, is offering its customers mobility packages, subscription plans, monthly invoices, invoicing, and direct payment. Operators’ offering is also positively associated with the location and geography. They are active in more than one country, and cover both the rural and urban areas within their territory.
3.5 BM4 and BM5: facilitator-operator and facilitator-integrator relationships

The facilitator role is a bit different in the sense that a facilitator does not primarily have a BM specifically for MaaS but can be important for MaaS to work. Facilitators can enable higher efficiency which reduces the transaction costs and enables new BMs (Hoffmann et al., 2021). The facilitator provides resources that are valuable to other stakeholders, mainly integrators and operators (and indirectly to other actors in the ecosystem). Examples are map APIs, and insurances for MaaS service offerings. A facilitator can provide an infrastructure for integrators, such as a white label platform that can be localized by the operator or the integrator to support a local MaaS infrastructure, for example, a municipality or a company that customize the platform for their value offerings. This infrastructure is vital as it provides access to other market participants and unlocks the potential of new BMs through different types of data (Hoffmann et al., 2021). Facilitators sometimes develop their role and position in the ecosystem to become integrators or operators. An example is Google’s move from being a provider of maps to offering the Android Automotive mobility platform that places Google at the heart of the car or becoming an operator with Google Waymoo self-driving ride-hailing service. Additionally, an integrator providing route planning services for electric vehicles typically combine resources from several facilitators, such as weather forecasts, map data, battery performance statistics, and charging facility locations, to provide reliable and optimal route planning.

Although the facilitator can be external to the MaaS ecosystem and not capturing value (such as for example, OpenStreetMap), they often find ways to capture value, such as Google maps API, or receive more implicit values related to branding and knowledge about how to improve their services as well as to approach new markets and customer groups, such as insurance companies facilitating ride-hailing services.

| Table 6. Operator to integrator value creation. |
|-----------------------------------------------|
| Value creation                                |
| Mobility services | The spectrum of mobility services (scooter, bike, car, van, microbus, bus, tram, train, etc.) |
|                  | Data (operational data)                        |
|                  | Customer relationship (cobranding, visibility for MaaS) |

| Table 7. Operator to user value creation. |
|------------------------------------------|
| Value creation                           |
| Flexibility and inclusivity             | Easy access to and payment for mobility       |
| (convenience)                            | Flexibility regarding route choice, time, and whether to share the ride or not |
| Affordability (cost)                     | Attractive for dense urban areas with a diversity of mobility options |
|                                          | Users no longer must own a car or pay for parking or other incidental costs like insurance and fuel |

| Table 8. 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              |
some point facilitators can become competitors by moving to a new position in the ecosystem and take the role as for instance, integrator – for example, Android Automotive – to offer more and more services and products and lock in other stakeholders.

The three major groups of facilitators and their BMs are shortly discussed below. Other groups, such as IT companies, software companies, telecommunication companies, and financial companies are not included in this review and need further analysis.

### 3.5.1 Automotive industry/OEMs
New trends such as connected cars, sharing cars, automated driving, and electrification have enabled large-scale innovations in the automotive industry (Miyata 2018). Therefore, OEMs must face several critical challenges. One of them is that OEMs need to integrate their traditional BMs with the new types of mobility offerings. For this, they need to find a balance between software, hardware, and their position in the MaaS ecosystem. This requires partnerships between OEMs and other actors. Some signs of partnership are already evident between OEMs like Daimler, Volkswagen and BMW with telecommunication companies to develop the required infrastructure. OEMs, as strong actors in the MaaS ecosystem, can play a variety of roles from facilitators, operators, or integrators of MaaS. Meanwhile, their BMs play a crucial role in the implementation of MaaS and their future success.

### 3.5.2 Insurance service providers
Insurance service providers play a crucial role in the MaaS ecosystem. Their BMs have already started altering from a static, fixed service to a real-time and usage-based model. New insurance services now offer different limits and coverage, relative to the point in the journey. For example, the drivers’ personal insurance is sensitive to the events of the service. As the MaaS insurance market matures, more innovative insurance solutions, with the potential to become standard, might emerge such as flexible pricing and technology-enhanced coverage options (usage-based and real-time). Therefore, insurers must strive to understand the new technologies to identify risk profiles on the platform and manage them accordingly (Wyman, 2020).

### 3.5.3 Data and API (application programming interface) providers
MaaS intensely relies on access and exchange of reliable and quality data. MaaS integrators can forecast travel demands and provide travel demand management services as well as traffic and time data to operators. Such integrated data enables MaaS operators to provide more precise services; therefore, travellers 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.

Overall, facilitators have a critical role in the MaaS ecosystem, and their BMs should be taken into consideration when designing an integrated BM 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.
4. Discussion – an ecosystem approach to MaaS business models

By approaching MaaS BM from a service-centric perspective, the results show that value creation and value capture cannot entirely be understood as the relationship between a focal actor and other supporting actors. Firstly, in line with suggestions from, for example, Ricart et al. (2020), we argue that the focal actor view should be extended to include an ecosystem approach to fully appreciate the dynamics between value creation and value capture in MaaS. Secondly, the actors’ relationships seem to be determined by the role they take in the ecosystem. That is, role does not equal actor. An actor can take different roles, combine roles, and change roles over time. The literature review identified five business models relating to four different roles in MaaS ecosystems. The main roles were integrator, operator, user, and facilitator. In extension three important factors were identified that shaped roles and their relationships: regulation and policy, infrastructure, and technology. Figure 1 gives an overview of the roles and associated BMs.

From a BM perspective each role involves a certain level of cost and risk, which, in turn, creates distinctive operational and revenue challenges (“UNECE” 2020). Despite having its own interests and BM, each actor is influenced by the BMs of the other actors, and even ‘pushed’ to innovate according to the logic of existing roles and BM (Merkert & Wong, 2020), which we here call relational BMs, characterized by relational stakeholder management with a specific focus on the ecosystem. Regulation and policy, technology, and infrastructure represent the context in which MaaS operates and the BM must be adjusted accordingly (Hasselwander et al., 2022). Similar ideas are touched upon by, for example, Ng, Ding & Yip (2013), and Ricart, Snihur, Carrasco-Farré, and Berrone (2020).

Regulation and policy have a key enabling role when scaling up MaaS (Bothos et al., 2019; Cottrill, 2020; Meng et al., 2020; Mulley & Kronsell, 2018; Sakai, 2019; Smith & Hensher, 2020). Public MaaS policies seek to influence the progress and trajectory of MaaS development involving guiding principles for mobility BMs such as inclusivity, democracy, diversity, openness (Smith & Hensher, 2020), supply and demand (Meng et al., 2020), trust (Cottrill, 2020) and competition (Wilson and Mason, 2020). Thus, while Wilson and Mason (2020) problematize the possibility of regulation and policy becoming barriers for MaaS implementation, they can be important enablers when implementing MaaS, as the examples presented have shown. Technology acts as both enabler and barrier in BM innovation. Examples are data handling, autonomous driving, vehicle electrification, distributed energy systems, intelligent systems, connectivity, IoT, blockchain.

Finally, infrastructure affects BM by creating seamless interlinks between transport modes and land usage, for example, bus and train/subway interchanges, bike and car-sharing spaces (Goodall et al., 2017). The impact of infrastructure on MaaS is integration 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 users to change modality easily (“UNECE,” 2020).
5. Conclusion

Using research literature and professional reports, this paper has argued for the importance of conceptualizing BMs in MaaS as relational multi-actor ecosystems. In contrast to a view of MaaS ecosystems as consisting of a focal actor co-creating value with complementsors, we identified four main roles that actors take: integrators have the role of mediating between service providers; operators package and deliver mobility offerings; facilitators provide infrastructures while only indirectly building a BM in the ecosystem; users are key value generating actors by choosing and combining services as well as contributing with resources such as data. Between these roles five different categories of business models were identified that build on the relations between the roles. In addition, three significant enablers and barriers of MaaS BMs were identified: infrastructure, technology, and regulation and policy.

The findings have implications for future research. The current view of MaaS largely assumes that BMs are designed to be separated and competing. In contrast the findings indicate co-evolvement using combinations of collaboration and competition where actors can have several roles and change role over time. More knowledge is therefore needed about the unique particularities of each implementation area to design appropriate BMs that can provide the necessary business availability to the involved actors (Hasler & Schallmo, 2021). These BMs need to consider MaaS missions, operations, objectives, and strategies (Polydoropoulou et al., 2020).

From a practitioner perspective, this study provides a visual, schematic illustration as a guideline for actors to navigate the MaaS ecosystem to align roles with BMs. Managers can strategize on possible roles in a MaaS ecosystem and identify barriers. From a policy perspective, public authorities can recognize how relations within MaaS ecosystems impact social, environmental, and economic goals.

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