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Embracing new disruptions: Business model innovation in the transition to Mobility as a Service (MaaS)

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ABSTRACT

A decade ago, Mobility as a Service (MaaS) has emerged as a revolutionary concept destined to change the traditional transport paradigm. Indeed, MaaS envisions an integrated and on-demand transportation ecosystem where users have access to a variety of mobility options via a unified digital platform that centralizes information, ticketing, and payment systems for different service providers. Recognizing its disruptive potential, in this paper we examine the effects of MaaS introduction in the market, with a particular focus on businesses within the industry. Specifically, we aim at investigating the dynamic nature of business model innovation within the MaaS business ecosystem, thus capturing the changes, adaptations, and innovations that organizations have undergone, providing valuable insights into the new value creation, capture and delivery mechanisms that have emerged. To achieve these goals, we have employed an inductive, multiple case study approach, focusing on a total of six renowned organizations representing two key actor categories within MaaS ecosystems: service providers and technology providers. Our findings reveal that, despite their heterogeneity, both service and technology providers have adopted similar strategies in their transition to MaaS. Utilizing the value creation, capture, and delivery framework, we developed distinct models for each of these categories. We have identified common firm-specific mechanisms which have been categorized into broader macro-level mechanisms of value creation, capture, and delivery, drawing from existing literature. The findings of this study contribute to the ongoing academic literature related to MaaS and to business model innovation. Furthermore, they offer valuable practical insights for managers and policymakers, providing a guidance for strategic decision-making aimed at fostering the development and sustainability of innovative MaaS systems.

1. Introduction

In the recent years, the mobility industry has been experiencing a fast-pacing transformation driven by technological advancements, changing consumer preferences, and the growing focus on sustainability (ITF, 2021). The increasing urbanization and citizen demand for mobility are pushing policy makers, municipalities, and transport authorities to re-think cities and the extant infrastructures in response to the new challenges that have arisen (Jones, 2014). In this context, the terms Smart City and Smart Mobility have gained momentum for modern urban development and transportation planning. Indeed, by leveraging Information and Communication Technologies (ICT), Artificial Intelligence (AI), data-driven insights, and collaborative governance, city planners seek to develop smart solutions to enhance efficiency and efficacy of service provision to users, integrate and optimize infrastructures, as well as improve resource allocation and the overall quality of life for citizens (Butler et al., 2021; Albino et al., 2015; Sharifi, 2019; Harrison et al., 2010; Nam and Pardo, 2011; Klein and Kaefer, 2008; Yigitcanlar et al., 2019). Within this framework, Mobility as a Service (MaaS) has recently emerged as a revolutionary concept. Aligning closely with the principles of the access, crowd, and sharing economy (Lee et al., 2018; Geissinger et al., 2020; Tseng and Chan, 2021), it envisions an integrated and on-demand transportation ecosystem where users have access to a variety of mobility options, ranging from public transit to shared mobility services, car rents and taxi, all managed through a unique digital platform (Kamargianni and Matyas, 2017; Kamargianni et al., 2018; Sochor et al., 2018; Heikkilä, 2014; Hensher et al., 2020; Giesecke et al., 2016). MaaS aims to enhance

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the overall travel experience of users and to emulate the flexibility provided by owning a personal car (Lyons et al., 2019; Kamargianni and Matyas, 2017; Hietanen, 2014; MaaS Alliance, 2017), as well to reduce congestion and optimize connection networks in cities by boosting the efficiency of extant infrastructures, improving accessibility for rural areas and for frail and disadvantaged people, and promoting sustainable, inter-modal or just multi-modal transport solutions (Eckhardt et al., 2020; MaaS Alliance, 2018; Kamargianni and Matyas, 2017; Hensher et al., 2020; Utriainen and Pöllänen, 2018; Ambrosino et al., 2016; König et al., 2016). In the literature, MaaS has been considered a disruptive "phenomenon" that transcends traditional transportation modes (Sochor et al., 2018; Merkert and Wong, 2020; Wilson and Mason, 2019; Giesecke et al., 2016). Indeed, from a user perspective, it simplifies the decision-making process and enhances the travel experience by integrating real-time information on transit schedules, traffic conditions, and vehicles positions with a unique booking and payment system for different transport providers. As a result, it provides a simple, flexible, and cost-effective service that disrupts the traditional fragmented paradigm (Lyons et al., 2019; Jittrapirom et al., 2017; Heikkilä, 2014; Pangbourne et al., 2020; Utriainen and Pöllänen, 2018). Instead, from a supplier perspective, the adoption of MaaS necessitates a shift towards a customer-centric approach. Specifically, the focus is on providing personalized, on-demand transport solutions that cater to the unique needs and preferences of individual users (Jittrapirom et al., 2017; Hensher et al., 2020). Furthermore, its success relies on the collaboration among different stakeholders, the integration between previously separated entities. Thereby, new and innovative business models are created, transforming the traditional landscape of the transportation industry (Kamargianni and Matyas, 2017; Polydoropoulou et al., 2020; Wong et al., 2018; Hensher, 2017; Mukhtar--Landgren et al., 2016; König et al., 2016; Aapaoja et al., 2017a). Although almost ten years have passed since its introduction, there remains a scarcity of concrete ideas on how to effectively offer a MaaS service: while MaaS applications have been downloaded by millions of users, providers continue to face challenges in achieving profitability and breaking even (Krauss et al., 2022; van den Heuvel et al., 2020). Newcomers and incumbent players in the transport sector, as well as governments around the world, have a growing interest in its development and implementation, but most of the times a MaaS service doesn't get through the prototype stages (Hensher et al., 2020; Karlsson et al., 2020). Hence, studying business models for MaaS is not only crucial but also highly beneficial for the successful realization of MaaS schemes (Polydoropoulou et al., 2020). Thus, the body of literature on MaaS business models is currently widening (see, for example, König et al., 2016; Holmberg et al., 2016; Sarasini et al., 2017; Ebrahimi et al., 2018; Polydoropoulou et al., 2020; Krauss et al., 2022), and previous studies predominantly focused on providing a static representation of the business model of MaaS providers, often utilizing frameworks like the Business Model Canvas (Osterwalder and Pigneur, 2010). These studies have typically explored how the governance structure (private, public, or public-private partnership) influences the design and operation of the MaaS business model (Aapaoja et al., 2017a; Narupiti, 2019; Smith et al., 2018; Wong et al., 2020; Zhang and Zhang, 2021). Instead, the present study aims at investigating the dynamic nature of business model innovation (hereafter BMI) within the context of MaaS. In particular, by studying existing firms operating in the MaaS ecosystem, we aim at picturing and describing the impacts of MaaS introduction on businesses in order to capture the changes, adaptations, and innovations that occurred and gain insights on the new value creation, capture and delivery mechanisms that emerged. Hence, the following research questions will be addressed.

- How have firms in the ecosystem changed their business models in response to the emergence of MaaS?
- What strategies and approaches can firms adopt to implement the MaaS concept and create, capture, and delivery new value?

To do so, we adopt an inductive, multiple case study approach (Yin, 1994; Eisenhardt, 1989; Eisenhardt and Graebner, 2007). After defining the business ecosystem for MaaS, a longitudinal analysis has been conducted, focusing on a total of six specific organizations belonging to two types of actors: service providers and technology providers. These actors represent the core components of the MaaS ecosystem, as they enable the implementation of the service (Kamargianni and Matyas, 2017). As for the service providers, Uber Technologies Inc (mainly a ride-hailing company), Berliner Verkehrsbetriebe (also known as BVG, a public transport provider) and Neutron Holdings Inc (also known as Lime, a micro-mobility solutions provider) were selected and analysed, while for the technology providers the choice fell on Mercedes-Benz Group AG (a car manufacturer), Masabi Ltd (a digital payments and fare collection solutions provider), and Siemens AG (focusing on its mobility division). Our research process involved collecting and organizing data from these case studies, leveraging the value creation, capture, and delivery framework (Bocken et al., 2015; Lepak et al., 2007). This framework allows for an analysis of the BMI from the pre-MaaS to the post-MaaS eras. Indeed, the BMI concept is often defined as the process of creating, capturing, and delivering value in new ways that differ from existing practices; it involves the re-configuration of existing business model or the design of new ones (Acciarini et al., 2023; Amit and Zott, 2012; Foss and Saebi, 2017; Teece, 2010). Therefore, by utilizing the introduction of MaaS as a cut-off point, we examine the main changes that have occurred in the value mechanisms employed by both service and technology providers. Our findings reveal that, despite their heterogeneity, companies belonging to these two categories have embraced analogous strategies for value creation, capture, and delivery within their respective domains during their transition to MaaS. Thus, we have formulated two different models by identifying common firm-specific mechanisms and subsequently categorizing them into broader macro-level mechanisms of value creation, capture, and delivery, as identified in existing literature.

The findings of this research bring contributions to the ongoing academic literature related to MaaS and to BMI. First, we extend the theoretical knowledge on MaaS business models by highlighting the different strategies that existing firms may adopt to naturally incorporate MaaS into their value propositions. Second, our examination reveals the MaaS influence and its impact on businesses within the mobility landscape. This theme has been widely discussed in the literature (see, for instance, Srivastava and Wong, 2023; Hensher, 2017; Mulley and Nelson, 2020), but our aim is to focus on business strategies, operational dynamics, and value creation and value appropriation mechanisms. This knowledge area needs a deeper exploration, as it may advances our understanding of BMI in dynamic environments like the mobility sector and provide useful managerial insights. By describing the evolution of the business models of service and technology providers we thereby shed new light on the BMI strategies adopted by firms in response to new phenomena (e.g. Sarasini and Linder, 2018; Cohen and Kietzmann, 2014; Turoń and Kubik, 2021).

Our research has also straightforward practical implications. It mainly informs managers and policymakers of the evolutionary trajectory of business models within firms operating in MaaS ecosystems and highlights the value mechanisms used by them to navigate the challenges and opportunities presented by MaaS. Understanding their dynamics might guide the decision-making process and the implementation of strategic plans that foster innovation and the creation of new MaaS systems, while also ensuring their long-term success and sustainability.

The paper is structured as follows. The upcoming section provides a comprehensive overview of the theoretical background surrounding MaaS. Section 3 briefly describes the methodology adopted. Section 4 presents the results of the analysis. Section 5 concludes the paper by discussing the findings, the main implications for theory and practice, and possible avenues for further research.

2. Theoretical background

2.1. The MaaS concept

Since its introduction, MaaS has garnered significant attention from scholars, practitioners, and policy makers, due to its potential to change the way transportation is perceived and experienced, as well as in achieving sustainable and efficient goals (Hensher et al., 2020). There have been numerous attempts to define its boundaries and characteristics; however, a universally recognized definition of MaaS has yet to be established (Arias-Molinares and Garcia-Palomares, 2020; Maas, 2022). Indeed, MaaS may be considered as a new mobility paradigm based on the concepts of integration and interoperability (Giesecke et al., 2016; Sochor et al., 2018). It can be viewed as an evolutionary step from the idea of mobility management, which emerged in the early 1990s with the aim of enhancing the efficiency and accessibility of public transportation (Mulley, 2017; Lyons et al., 2019). This idea has now become possible due to several factors that characterize today's society, as the increasing urbanization, advancements in technologies and better penetration of smartphones, the proliferation of privately-owned shared mobility services (such as bike sharing, e-scooter sharing, car sharing, etc.), and a cultural shift driven by the preferences of new generations (Heikkilä, 2014; Hensher and Xi, 2022). On its basis, MaaS is strictly connected and shares several conceptual and operational similarities with new economic paradigms such as crowd and sharing economy (Lee et al., 2018; Geissinger et al., 2020; Tseng and Chan, 2021). Indeed, by emphasizing access over ownership, MaaS enables users to access transportation services on-demand, rather than owning vehicles outright. Moreover, it offers viable and sustainable alternatives which emulate the flexibility of private car use for moving from point A to point B (Kamargianni et al., 2018; Fioreze et al., 2019; Lyons et al., 2019). It involves the integration and combination of different modes, facilitating the realization of intermodal travel and enabling a free, informed, and convenient choice for consumers among the various existing mobility solutions (bus, cabs, metro, trains, sharing and on-demand services, even ferries, or a mix of these). In addition to mobility, MaaS offerings may also include mobility-related (e.g., parking, recharge stations, etc.) or other types of services (food delivery, logistics, television packages, retail discounts, and so on), forming a comprehensive and multimodal portfolio of services (Hensher et al., 2021; Hensher and Mulley, 2021; Kamargianni et al., 2016). Generally, MaaS schemes differ by the level of service integration in their value proposition; as the level of integration increases, there are different shades or "degree of MaaS-ness" (Hensher et al., 2020, 2021; Sochor et al., 2018). The MaaS experience, as in many other sharing-labelled services, is offered through apps, which provide real-time information on timetables, routes prices, vehicles location and availability, traffic conditions, and centralize the booking and payment process (one-stop-shop principle) (Hensher et al., 2020, 2021; Sochor et al., 2018; Kamargianni and Matyas, 2017). The app may also offer additional features such as info on weather updates, synchronization with the personal activity calendar, trips history and ability to re-buy tickets, display of invoices, ability to issue feedbacks, etc (Jittrapirom et al., 2017; Cruz and Sarmento, 2020; Esztergár-Kiss et al., 2020). The payment options can range from single trip purchases (pay-as-you-go) to monthly subscriptions that provide mobility bundles at potentially discounted prices (Reck et al., 2020; Ho et al., 2018, 2020). MaaS is intended to be a user-centric service: it focuses on users and their real needs; it seeks to provide a unique (or personalized) travel experience that is integrated, easily accessible, door-to-door, seamless, convenient, and of high-quality standards (Hensher et al., 2021; Jittrapirom et al., 2017; MaaS Alliance, 2019). Moreover, MaaS promotes a collaborative approach that fosters the creation of a single, cooperative, and interconnected transportation market. In this model, all participating parties continuously interact and share data, hence creating a dynamic ecosystem where resources are efficiently utilized (Hietanen, 2014; Polydoropoulou et al., 2020; Kandanaarachchi et al., 2022; Meurs et al., 2018). The smooth operation of MaaS is thus enabled by leveraging collective resources and expertise of all the stakeholders within the ecosystem (Kamargianni and Matyas, 2017; Karlsson et al., 2020; Zhang and Zhang, 2021).

2.2. MaaS expansion and open challenges

Currently, MaaS is undergoing a rapid expansion within the mobility sector, with its valuation surpassing $120 billion in 2021 and projected to grow with a CAGR of 16.8% until 2030 (P&S Intelligence, 2022). This surge is characterized by the emergence of numerous start-ups, prompting the development of innovative platforms that offer consumers a diverse array of mobility options (Hensher et al., 2021). Additionally, incumbent firms are adapting their strategies to incorporate this new offering into their portfolios, while governments worldwide are proactively supporting its development and implementation through a proliferation of government-led MaaS trials (Hensher et al., 2020; König et al., 2016; Polydoropoulou et al., 2020). Multiple factors are driving this phenomenon. On one hand, companies are willing to seize the economic opportunity represented by MaaS, to diversify their revenues and expand in new markets. On the other hand, policy makers are attracted by the potential benefits promised by this innovative service. Indeed, when correctly designed, MaaS can potentially shift consumer preferences toward more sustainable modes of transportation (Ho et al., 2018; Lyons et al., 2019). A drastic decline in private car use would result in reduced emissions and congestion, as well as the need for less parking space. In turn, such facilities could be redeveloped into green spaces, thus contributing to better city liveability and environmental sustainability (Kamargianni et al., 2018; Pangbourne et al., 2020; Audouin and Finger, 2018; Aapaoja et al., 2017b). MaaS systems can improve urban connectivity by providing first and last mile solutions and ensure greater accessibility to transportation services for rural areas and fragile people (Eckhardt et al., 2020; MaaS Alliance, 2017; Sarasini et al., 2017). Finally, MaaS has the potential to enhance efficiency by optimizing the utilization of existing infrastructures, filling gaps in the transportation network, offering alternative options and necessary redundancy during peak hours, and facilitating comprehensive planning of the entire transportation system (Kamargianni and Matyas, 2017; Wong et al., 2020; Butler et al., 2021). However, all these positive externalities are still uncertain, as there is still no evidence based on the MaaS trials conducted around the world (Hensher et al., 2020; Pangbourne et al., 2020; Arias-Molinares and Garcia-Palomares, 2020). This is because many MaaS initiatives remain stuck in the prototype stages, unable to progress to full-scale implementation (Hensher et al., 2020; Karlsson et al., 2020). Moreover, even when these initiatives manage to reach the commercialization stage, providers often encounter significant challenges in achieving financial sustainability and breaking even (Krauss et al., 2022; van den Heuvel et al., 2020; Harrison et al., 2010). In sum, MaaS faces various practical difficulties that hinder its widespread adoption. Firstly, integrating diverse transportation modes and service providers poses technical challenges, as it requires seamless data sharing, interoperability, and compatibility among different systems, as well as organizational challenges, as it necessitates the coordination and collaboration of the actors involved, which may have conflicting goals (Kamargianni and Matyas, 2017; Giesecke et al., 2016; Butler et al., 2021; Li and Voege, 2017; Zhang and Zhang, 2021). Secondly, regulatory frameworks and policies may not be adequately adapted to accommodate the unique characteristics of MaaS, creating legal and governance barriers (Karlsson et al., 2016; Mukhtar-Landgren et al., 2016). Additionally, MaaS requires a shift in user behaviour and a willingness to embrace alternative modes of transportation: resistance to change can significantly impact the penetration of MaaS and hinder the ability of firms to achieve profitability (Mukhtar-Landgren et al., 2016; Butler et al., 2021; Karlsson et al., 2020; Mulley, 2017). Table 1 provides a comprehensive synthesis of the factors that influence MaaS adoption, considering aspects related to the industry side, the demand side, and

Table 1
Aspects influencing MaaS adoption (Sources: Authors' own rielaboration from Mukhtar-Landgren et al., 2016; Karlsson et al., 2020; Butler et al., 2021; Zhao et al., 2020; Matyas, 2020; Mulley and Kronsell, 2018; Zhang and Zhang, 2021).

GENERAL TRENDS		
• *Growing Urbanization* •*Globalization* •*Sharing economy* •*Servitisation*	•*Social Changes triggered by Millennials* •*Technological advancements* •*Increased awareness of environmental, economic, social sustainability*	
INDUSTRY SIDE *Uncertainties about:*	*DEMAND SIDE* *Willingness-to-pay for MaaS services. It is influenced by:*	*GOVERNMENT* *Legislative measures about:*
- *the economic viability of the business*	-*Awareness of the added value provided by the service*	- *Taxes, subsidies and allocation of financial resources for mobility*
- *who should assume leadership*	-*Awareness of one's spending on mobility*	- *More flexible procurement and contracts on public transportation modes*
- *the distribution of profits*	-*Financial availability of individuals*	- *Standardization of data*
- *the prices to adopt*	-*Perception of a personalized service (match between need and service offered)*	- *Protection of user privacy*
-*the services to include* -*the management of the brand*		
Ability to create a shared vision and a roadmap for service implementation	*Awareness of the existence of alternative modes of transportation and their costs*	*"Push measures": economic disincentives, taxing cars, increasing fuel and highway fares, reducing the number of parking lots, banning car traffic in city centers*
Ability to measure performance and outcomes achieved	*Social and cultural context*	*"Pull measures": subsidize investment in electric vehicles and reduce the cost of public transportation; economic incentives for companies that want to undertake a MaaS project*
Resistance to change or Presence of an entrepreneurial mindset open to innovations	*Emotional relationship of users with their private car*	*Proactive measures to foster cooperation between companies in the industry and regulate competition*
Ability to provide an intuitive, easy-to-use app and ensure extensive service coverage	*Travel habits*	*Ability to develop a shared vision and roadmap to drive change*
Ability to ensure users' privacy adequately	*Difficulties in using smartphones and new technologies (elderly)*	*Strong political will to make the transition, to rethink and redefine the concept of "public transportation"*
Ability to establish collaboration and data/ resource sharing		*Economic incentives, grants and funding for new MaaS initiatives.*

the government (or policy side).

2.3. MaaS business models

Given the complexity of implementing MaaS and the absence of a universally effective business strategy to ensure its success and sustainability, the importance of developing robust business models has become a focal point for both academics and practitioners (Polydoropoulou et al., 2020; Krauss et al., 2022). This interest is reflected by a notable increase in scholarly articles and industry analyses aimed at exploring this topic. However, many previous contributions have primarily focused on providing a static representation of the "prototype" business model for the MaaS provider, describing how it should function based on the principles of the MaaS concept, often using the Business Model Canvas framework (Osterwalder and Pigneur, 2010). Moreover, they acknowledge the influence of the governance model and the entity assuming the role of the MaaS provider in the value creation, delivery, and capture processes (Sochor et al., 2018; see, for example, Smith et al., 2018; Narupiti, 2019; Wong et al., 2020; Zhang and Zhang, 2021). Holmberg et al. (2016) presented UbiGo's Business Model Canvas and described the potential role of public transport in a MaaS scheme. Within the "MAASiFiE" and "Rural-MaaS" projects, König et al. (2016), Aapaoja et al. (2017a) and Eckhardt et al. (2017) developed four models of MaaS provision, as reseller, integrator, public and public-private partnership (PPP). Their differences are based on which actors hold control over the integration of mobility services, and each specific model may be appropriate depending on whether they are developed in urban, suburban, national, or international areas. However, these four models are barely characterized in the aforementioned papers. In addition, König et al. (2016) proposed a very generic Business Model Canvas for MaaS. Instead, Polydoropoulou et al. (2020) developed a business model prototype with the Business Model Canvas' framework and investigated how this prototype can be characterized to successfully adapt in different operational contexts. Krauss et al. (2022) combined the morphological analysis (Zwicky, 1967) with Osterwalder and Pigneur' (2010) Business Model Canvas with the aim of structuring and characterizing a MaaS business model from the point of view of the service provider. The result is a framework that pinpoints all the considerable elements of a MaaS Business Model. Finally, Srivastava and Wong (2023), after performing a macro analysis of the current MaaS market in China, developed three new business models specifically tailored for automobile manufacturers which aim to address the opportunities and threats arising from the rapid development of MaaS. All these works tend to overlook the dynamicity of MaaS and its impact on established transportation businesses. In contrast, recognizing its transformative power, this paper delves into understanding the effects of MaaS on existing companies within the transportation sector. Our objective is to explore the innovation mechanisms and strategies employed by these enterprises to effectively seize the opportunities presented by MaaS and successfully integrate such a system in their business models. In other words, rather than focusing on business model prototypes for MaaS, this paper offers a distinct viewpoint by examining the strategies and mechanisms through which companies in the transportation sector integrate MaaS. Thereby, by focusing on these strategic approaches to MaaS adoption, our study contributes to a broader understanding of how MaaS impacts the mobility sector.

3. Methods

In the present study, we adopt an inductive, multiple case study approach (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 1994) to explore and understand the dynamics of business model innovation in the context of MaaS. The selection of this research approach is driven by several key motivations and considerations. Firstly, as underlined in the previous section, there is a relative lack of investigation in the field of BMI for MaaS and more theory-building is necessary in this emerging domain (Eisenhardt, 1989). Secondly, MaaS represents a complex and transforming concept, involving several stakeholders and intricate interdependencies (Kamargianni and Matyas, 2017; Hensher et al., 2020; Liimatainen and Mladenović, 2018). Hence, studying multiple rather than single cases can be more indicated, as it enables the exploration of diverse perspectives and variations, allowing us to compare and contrast different and independent examples in the MaaS industry, identifying common patterns and unique features that contribute to a more comprehensive understanding of the phenomenon (Eisenhardt and Graebner, 2007). Furthermore, the utilization of multiple cases in our research design enhances the generalizability and robustness of our findings, offering stronger evidence compared to single case studies (Davis et al., 2007). Overall, this methodology offers an opportunity to capture the multifaceted nature of the industry, generate insights, and

contribute to both theoretical knowledge and practical implications. In the following sections, we provide an elaborate account of the research setting and the enacted methodological process.

3.1. Research setting

We have chosen to study MaaS through the theoretical lens of Business Model Innovation (Amit and Zott, 2020; Foss and Saebi, 2017; Girotra and Netessine, 2014) for several compelling reasons. Firstly, as noted in the previous sections, MaaS is a relatively new concept that is continuously evolving (Sochor et al., 2018) and shaping its presence in the marketplace (Hensher et al., 2020; Harrison et al., 2010; van den Heuvel et al., 2020). The dynamicity of MaaS calls for in-depth research to explore and understand the diverse business models that emerge to translate this concept into a viable and profitable business (Krauss et al., 2022). The scalability and sustainability of MaaS implementations are critical factors in realizing its full potential (Mulley, 2017). Thereby, understanding the business models that enable scalability is vital for ensuring the growth of MaaS and the realization of all its externalities (Polydoropoulou et al., 2020; Krauss et al., 2022). Secondly, MaaS is a new and disruptive concept that is currently transforming the way firms operate within the mobility sector and how they deliver value to the customers (Jittrapirom et al., 2017; Giesecke et al., 2016). Its impact extends beyond the MaaS providers themselves and permeates throughout the entire ecosystem of companies involved in this domain (García et al., 2020; Kamargianni and Matyas, 2017). As MaaS changes the traditional and fragmented transport paradigm, it prompts transportation providers, technology companies, and various service providers to reassess their roles and redefine how they create and capture value by embracing a more collaborative approach (Hensher, 2017; Wong et al., 2020; Pangbourne et al., 2020; Hensher et al., 2020). Therefore, the examination of the effects on the business models of firms in the MaaS business ecosystem is undoubtedly interesting and holds substantial implications for both theory and practice. Finally, MaaS is experiencing a rapid and steady growth in the transportation market. Since its introduction, a plethora of trials and startups have emerged to explore and practically develop MaaS (Hensher et al., 2020; König et al., 2016; Polydoropoulou et al., 2020). Governments worldwide have taken proactive measures to foster its adoption, providing support for trials and recognizing its potential in addressing sustainability challenges within cities (Hensher et al., 2020; Pangbourne et al., 2020; Butler et al., 2021). Concurrently, new companies, such as MaaS Global, Citymapper, and Moovit, have recognized the profitability prospects associated with MaaS and have consequently developed innovative platforms to offer consumers a growing array of mobility options (Hensher et al., 2021). Furthermore, many incumbents in the mobility sector have actively sought to capitalize on the opportunities that this concept represents by evolving their operations and business strategies and developing their own MaaS service; this can be observed in well-known examples in the field, such as Uber and Lyft (P&S Intelligence, 2022). Overall, the MaaS market has been valued over $120 billion in 2021, and it is projected to grow with a CAGR of 16.8% until 2030 (P&S Intelligence, 2022). We can therefore expect that MaaS will become an integral part of everyday life, serving as a central component in the realm of transportation solutions. Within this dynamic landscape, our research findings may hold significant relevance for future studies that focus on analysing and understanding MaaS.

3.2. Research sample

The research sample consists of six prominent organizations operating within the MaaS business ecosystem, all of which have adapted their business models in response to MaaS introduction. The selection of these organizations follows a theoretical sampling approach, aiming to identify cases that can either replicate or extend the emerging theory (Eisenhardt, 1989). The primary objective is to develop theory rather than solely test it. In order to illustrate the sampling process, it is essential to establish a preliminary definition of the MaaS business ecosystem. A comprehensive description has already been provided by Kamargianni and Matyas (2017), and we present a simplified representation in Fig. 1.

The MaaS provider operates within a collaborative network of key stakeholders spanning multiple sectors and playing a crucial role in shaping the service provision, as well as the dynamics of value creation and value appropriation (Kamargianni and Matyas, 2017). The ecosystem comprises four key entities, as service providers, technology providers, financial partners, and customers. To evaluate the effects of MaaS, we choose to analyse companies belonging to the categories of service and technology providers. Service providers constitute the core of MaaS, as they encompass a range of transportation, mobility, and mobility-related service operators. Instead, technology firms provide the backbone (software solutions, digital infrastructures, data management systems) that enables real-time information exchange, booking and payment processing, data analytics, and user-friendly interfaces (HaCon Company, 2022; Maas, 2022). Customers were excluded, as our primary emphasis is on the industry side. Furthermore, we have also opted to exclude financial partners (such as investors, funding organizations and insurance companies) from our research, acknowledging their distinct dynamics that differ from those of service providers and technology companies. In order to ensure both literal and theoretical replication, we employed four criteria to guide the sampling process for the multi-case study. The first criterion that guided our selection of companies was their status of established player in the industry. This decision was motivated by our aim to comprehensively study the evolution of their business models in response to MaaS adoption. By focusing on well-established firms, we can gain valuable insights into how their business models have evolved over time, benefiting from their operational stability and experience. This approach allows us to capture the complexities and nuances associated with MaaS implementation and its impact on mature organizations, providing a robust foundation for our research. The second criterion identified was the company size, reputation, and ideally, their status as publicly traded organizations. This criterion was driven by the need for access to a wealth of information, particularly from both primary and secondary sources. By choosing well-known and larger companies, we could ensure a greater availability of information regarding the evolution of their business models over time. This facilitated tracking and analysing the changes and adaptations made by these companies in response to MaaS adoption. The third criterion was the heterogeneity of companies in terms of their core services within their respective categories. For instance, within the category of service providers, we selected a micro mobility, a public transport, and a ride-hailing company, while within the technology providers category, we chose a car manufacturer, a provider of ticketing and payment solutions, and a provider of software solutions and digital services. Heterogeneity allows for a broader exploration of the phenomenon under investigation. Different cases with diverse characteristics and contexts provide a more comprehensive understanding of the subject matter, capturing a range of perspectives, challenges, and outcomes (Eisenhardt, 1989). Moreover, heterogeneity promotes theoretical replication and extension and enhances the validity of the research findings (Eisenhardt and Graebner, 2007; Yin, 1994). Finally, the last criterion was to include in the research companies that successfully adopted MaaS, regardless of their geographical location. Indeed, by focusing on companies that have demonstrated the ability to effectively integrate MaaS into their operations and achieve sustainable outcomes, we can gather meaningful data and draw robust conclusions about the implications and potential benefits of MaaS adoption. After establishing the selection criteria, an initial search was conducted across various literature, industry reports, and news sources to identify notable companies operating within the MaaS ecosystem. This preliminary research yielded a list of potential candidates. Subsequently, each company on the list was evaluated based on the selection criteria, taking into account

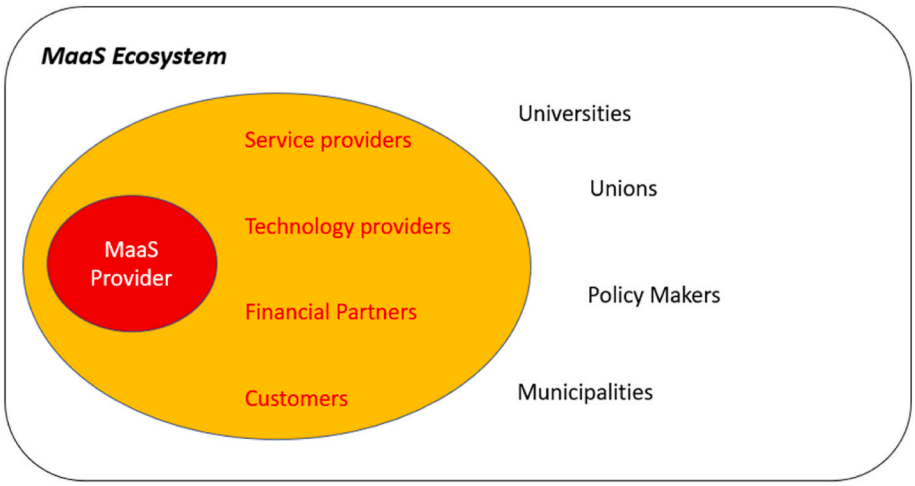

Fig. 1. A simplified representation of the MaaS Business Ecosystem according to Kamargianni and Matyas (2017); García et al., 2020

their suitability for the research objectives. For the service providers category, we identified Uber, a prominent ride-hailing service with a global presence; BVG, a well-established public transport company in Berlin; and Lime,[1] a leading provider of bike and e-scooter sharing services. In the technology providers category, we included Mercedes-Benz Group AG, a renowned car manufacturer; Masabi, a provider of ticketing and payment solutions; and Siemens AG, a multinational company specializing in electrification, automation, and digitalization. In response to the introduction of MaaS, all these companies have innovated their business models. Some have transitioned to become MaaS providers or have joined existing MaaS systems, while others have evolved into MaaS-as-a-Service providers to expand their offerings. In Table 2, we present a brief overview of each selected case study.

3.3. Data collection

The data collection process for this analysis consisted mainly in three sequential steps. First, we gathered data related to the case studies from various online sources, and then carefully summarized key information, pertinently to our research questions. Second, we focused on the validation of the knowledge we gathered in the previous step by asking for interviews or the completion of an online survey to the managerial personnel of the selected companies. Third, we engaged discussions with industry experts, employing them as key informants to enrich our understanding of the research theme and to gather additional insights on the organizations under analysis. We iterated through the first three steps as needed, incorporating feedback into our research. We analysed multiple sources of information to allow triangulation for more accurate findings (Eisenhardt, 1989). Therefore, our data sources encompassed two main categories, namely archival records and documentary information, as well as individual interviews and survey.

3.3.1. Archival records and documentary information

The preponderant source of information was retrieved from secondary sources. In particular, we began by consulting industry reports, research articles, and newspaper articles in order to gain an initial understanding of the organizations under analysis and to retrieve primary insights. Subsequently, we carefully examined their annual reports, websites, and press releases to obtain specific and up-to-date details. Given the characteristics of the transportation market and the ongoing evolution of MaaS (ITF, 2021; Hensher et al., 2020), we focused on the most recent data available. While some of the selected companies have a long history and have undergone various business model transformations over time, the study placed particular emphasis on investigating their current strategies and approaches in relation to the emergence of MaaS.

3.3.2. Individual interviews and survey

Information from primary sources served to validate our findings retrieved online. Specifically, we asked various managerial personnel from the selected organizations to conduct an interview, offering the option of either face-to-face meetings or asynchronous interviews via email exchanges. The interview structure encompassed three key sections of questions. Informants were prompted to reflect on (i) their company's business model before the emergence of MaaS, (ii) their current one, and (iii) what are the most significant changes that occurred in the transition between the pre-MaaS and post-MaaS era. We used BMI theory as a foundational framework to formulate the questions (Amit and Zott, 2020; Foss and Saebi, 2017). Additionally, to provide them greater flexibility, we designed an online survey, the structure of which is detailed in Table 3. Therefore, informants could choose to participate either with an interview or by completing the online survey. The main difference is that the survey was designed with a predefined structure comprising multiple-choice questions, which facilitated responses based on the insights gathered from our prior research of secondary sources. Finally, face-to-face meetings or asynchronous interviews via email exchanges were conducted with industry experts to further validate our findings. We conducted interviews with at least one member from each company, in addition to consulting with nine industry experts. This resulted in a total of fifteen interviews.

3.4. Data analysis

Following the recommended approach by Strauss and Corbin (1990), the data analysis process involved iterative steps. Once the case selection was over, we applied the value creation, capture, and delivery framework (Bocken et al., 2015; Lepak et al., 2007) to each company based on the initially gathered information from secondary sources. Drawing from literature highlighting that BMI involves changes in the architecture of value creation, capture, and delivery of a firm (Teece, 2010; Amit and Zott, 2012; Foss and Saebi, 2017; Acciarini et al., 2023), we identified this framework as the most appropriate for our analysis. We applied it both before and after the adoption of MaaS for each case. To enhance the organization and interpretation of data, we compiled the

[1] It is important to note that, while Uber does not directly own Lime, they are indeed financially intertwined. However, Lime maintained its operations independent. This strategic partnership reflects a common tendency among service providers that will be further discussed in the next sections.

Table 2
Overview of the six selected cases.

Company name	Type	Year of found.	HQ Location	Core Business	Size
Uber Technologies Inc.	Service provider	2009	San Francisco, California, USA	Ride-hailing	Available in 10.5K cities Revenue: $31.88 billion (2022) Market cap: appr. $85 billion Employees: 10K+
Berliner Verkehrsbetriebe (BVG)	Service provider	1928	Berlin, Germany	Public Transport	Revenue: €1.34 billion (2022) Employees: 10K+
Neutron Holdings, Inc. (Lime)	Service provider	2017	San Francisco, California, USA	Bike-sharing and e-scooter sharing	Available in more than 2K cities Revenue: $10 - $100 million Employees: 1.001–5.000
Mercedes-Benz Group AG	Technology provider	1926	Stuttgard, Germany	Car manufacturer	Revenue: €150 billion (2022) Market cap: appr. €87.5 billion Employees: 10K+
Masabi Ltd	Technology provider	2001	London, UK	Ticketing and payment solutions	Revenue: €37.8 million (2022) Employees: 201-500
Siemens AG	Technology provider	1847	Munich, Germany	Digital solutions, automation, energy	Revenue: €62 billion (2022) Market cap: appr. €125 billion Employees: 10K+

information into tables that provided a comprehensive overview of the business model innovation mechanisms employed by each company and the resulting transformations in their business models. Furthermore, primary data sources were utilized to enrich the information previously retrieved. In order to derive theoretical insights from the qualitative nature of the data (Glaser and Strauss, 1967), an intra-case and cross-case analysis was conducted (Eisenhardt, 1989; Yin, 1994). This analysis aimed to identify potential patterns of BMI within each category (service and technology providers) and to discern differences between the two categories. As previously mentioned, to ensure the integrity of the data and enhance the reliability of our findings, we employed a triangulation approach by utilizing multiple sources of information. Additionally, we conducted independent reviews and analyses of the collected information, engaging in collaborative discussions and meetings to exchange and challenge ideas. In cases where disagreements arose, we gathered additional sources of information and conducted comparative analyses. These measures were taken to establish a robust foundation for our results, grounded both empirically and theoretically.

4. Findings

MaaS is more than just a new mobility trend. Indeed, it can be seen as a new and disruptive concept that is transforming the mobility landscape (Hensher et al., 2020; Sochor et al., 2018). MaaS represents a paradigm shift in how individuals perceive and access transportation options, as well as in how mobility is provided to users (Jittrapirom et al., 2017; Lyons et al., 2019; Polydoropoulou et al., 2020). Giving more emphasis to the supply side, the primary aim of this research is to assess how the introduction of MaaS has influenced the organizations operating within the MaaS ecosystem. In particular, our focus is to analyse the subsequent evolution of their business models and shed new light on the mechanisms and strategies adopted by firms. Fig. 2 illustrates a timeline showcasing the primary initiatives undertaken by the companies under analysis. Our findings reveal that, despite their heterogeneity, companies in the service provider and technology provider categories have embraced analogous strategies for value creation, capture, and delivery within their respective domains during their transition to MaaS. Thus, we created different models for the two categories by discerning common firm-specific mechanisms and subsequently grouping them into broader macro-level mechanisms of value creation, capture, and delivery as identified in existing literature. Results are shown in Table 4 and Table 5. The following sections describe our contribution in detail.

4.1. Service providers

4.1.1. Value creation

As previously mentioned, service providers in our study constitute a diverse spectrum of entities engaged in delivering transportation, mobility, and related services. Thereby, during the pre-MaaS era, their priority revolved around providing specific transportation services – their core business – to users. For instance, Uber focus on its ride-hailing service, Lime on micro mobility, while BVG offers essential public transport services. Additionally, to distinguish themselves in the competitive landscape, service providers implemented product differentiation strategies. This strategic approach encompassed, in the first place, the introduction of a wide range of transportation options tailored to the specific needs of users. For example, Uber not only provided various car choices for riders but also expanded its service portfolio by integrating mobility-related services such as food delivery and logistics.[2] Similarly, BVG offered an array of transportation modes including trains, metro, trams, buses, and ferries,[3] while Lime concentrated on e-scooter and e-bike sharing.[4] This strategy of incorporating different alternatives aimed at enhancing the attractiveness of their overall value proposition and the customer satisfaction. Secondly, their main objective laid in enhancing flexibility, convenience, and accessibility for users.,[5,6] Certainly, both Uber and Lime have developed a service model that allows users to book a private taxi or access bikes and e-scooters

[2] Uber Technologies Inc., 2019. "Uber Announces Results for Fourth Quarter and Full Year 2019". Available at: https://investor.uber.com/news-events/news/press-release-details/2020/Uber-Announces-Results-for-Fourth-Quarter-and-Full-Year-2019/(Accessed 28 May 2023)See also Uber: "Our offerings". At: https://www.uber.com/it/en/about/uber-offerings/?uclick_id=2e5c484d-0670-4789-8cb1-556495b95e71 (Accessed 28 May 2023).

[3] BVG, 2020. "Annual Report 2020". Available at: https://unternehmen.bvg.de/media-downloads/(Accessed 10 June 2023)See also BVG: "Our company". Available at: https://unternehmen.bvg.de/profile/(Accessed 9 June 2023).

[4] Neutron Holdings Inc.: About page. Available at: https://www.li.me/about (Accessed 4 June 2023).

[5] Uber Technologies Inc., 2020. "2020 Investor Presentation". Uploaded in February 6, 2020. Available at: https://s23.q4cdn.com/407969754/files/doc_financials/2019/q4/InvestorPresentation_2020_Feb13.pdf (Accessed 29 May 2023).

[6] Neutron Holdings Inc., "Our core principles". Available at: https://www.li.me/(Accessed 4 June 2023).

Table 3
Survey structure.

Section	Motivation	References
Introduction	This section serves as an introduction, where participants are provided with a clear context for the research that is being carried out. Key terms and concepts are here defined. The section begins by requesting basic details, such as the name of the respondent's organization. Additionally, it seeks to determine whether the respondent's organization predominantly functions as a service provider or a technology provider	Braun et al. (2021)
Pre-MaaS business model	The second section of the survey aims at gathering information regarding the business models that organizations employed before the emergence of MaaS in the market. We delve into the strategies and value mechanisms that these organizations utilized in the pre-MaaS era. We asked for their value proposition, customer segments, key partnerships and resources. Furthermore, we asked what were in their opinion the main value creation, capture and delivery mechanism they employed. The questions in this section were mainly designed as multiple-choice, providing respondents with structured options.	Osterwalder and Pigneur (2010); Amit and Zott (2001); Lepak et al. (2007)
Post-MaaS business model	The third section delves in the current state of respondents' organizations business models and explores the changes that occurred after the introduction of MaaS. We asked specifically what the main shifts in their value mechanisms are and on what aspects or business areas MaaS had the most significant impact.	Osterwalder and Pigneur (2010);
BMI Process	The final section delves into the "how" behind these changes and explores the motivations. Respondents were asked about the key strategies they employed to introduce MaaS solutions, which partners they engaged, and the critical steps taken during this process.	Amit and Zott (2020); Foss and Saebi (2017); Teece (2010)

effortlessly, regardless of their location.,[7,8] Moreover, this process is facilitated through intuitive and user-friendly mobile applications. These applications not only streamline the booking and payment processes but also provide real-time updates on vehicle availability, estimated arrival times, and route navigation. On the other hand, BVG, as a public transport provider, focuses on delivering extensive coverage and well-defined timetables, ensuring that a significant portion of the urban area is effectively connected.[9] Another common concern for service providers is the commitment to offering a secure and reliable experience during transport. Notably, Uber and Lime faced certain challenges in this aspect. In the case of Uber, concerns over passenger safety and incidents involving drivers prompted the company to implement stringent background checks and safety protocols, such as in-app emergency buttons and real-time location sharing, in order to create more confidence among their users.[10] Similarly, Lime has reinforced safety guidelines, provided supplied helmets, and promoted awareness campaigns to ensure the well-being of both riders and pedestrians.[11] Instead, BVG installed CCTV cameras across its network of buses, trams, and subway stations to enhance the overall security of its transit network. Furthermore, it has introduced a real-time monitoring system that allows for the swift response to any incidents or disruptions.[12] Finally, sustainability and environmental initiatives not only align with their strategic goals but also serve as a distinct element of product differentiation in their value proposition. This approach has been adopted to distinguish themselves in the competitive market by appealing to environmentally conscious consumers. Uber, for instance, launched its "Uber Green" option, enabling riders to opt for hybrid or electric vehicles, reducing carbon emissions from their trips.[13] This initiative is part of Uber's broader commitment to becoming a zero-emission platform by 2040.[14] Lime's emphasis on micro mobility naturally fosters sustainability by promoting cleaner and more eco-friendly transportation options. Moreover, Lime's commitment to accessibility and community welfare is demonstrated through initiatives like Lime Access and Lime Able.[15] In a similar vein, BVG has incorporated electric buses into its fleet and implemented route optimization strategies to enhance energy efficiency.[16] Another pivotal mechanism of value creation employed by this category of firms involves continuous innovation and enhancement of their services. Uber, Lime, and BVG have all strategically pursued advancements through investments in new technologies.,[17,18,19] For instance, Uber heavily invested in financial services and refining its already sophisticated algorithms to minimize waiting times and optimize routing.[20] Lime invested in IoT technology to track, manage, and optimize the utilization of its vehicles, which are central to its dockless mobility service, while BVG invested in digitalizing its ticketing system and providing real-time information on schedules and delays. Another dimension of their innovation strategy involves investments in new infrastructures and fleets.,[21,22] This approach resonates with their commitment to improving the overall mobility experience within urban environments. Sometimes, these investments are intertwined with the

[7] Uber, website Homepage. Available at: https://www.uber.com/it/en/ (Accessed 28 May 2023).
[8] Neutron Holdings Inc., "Why Lime". Available at: https://www.li.me/why (Accessed 4 June 2023).
[9] BVG, 2020. "Annual Report 2020". Also, BVG, 2021. "Annual Report 2021"-Available at: https://unternehmen.bvg.de/media-downloads/(Accessed 10 June 2023).
[10] Uber Technologies Inc., "Our Commitment to safety" – Available at: https://www.uber.com/us/en/safety/(Accessed 30 May 2023).
[11] Neutron Holdings Inc., "Rider Community" – Available at: https://www.li.me/blog/category/rider-community (Accessed 4 June 2023).
[12] BVG, 2020. "Safety in numbers" – Available at: https://unternehmen.bvg.de/wp-content/uploads/2023/08/BVG_Sicherheit-in-Zahlen-2022.pdf.
[13] Uber Technologies Inc., "Uber Green" – Available at: https://www.uber.com/it/it/ride/ubergreen/(Accessed 30 May 2023).
[14] Uber Technologies Inc., "Your city, our commitment" – Available at: https://www.uber.com/us/en/about/sustainability/?uclick_id=23f8fd9e-24d4-4318-9a97-32095c7ff45e.
[15] Neutron Holdings Inc., "Community – Lime Access" – Available at: https://www.li.me/why/community/lime-access See also "How Lime leveraged sustainability to achieve profitability" – Available at: https://www.li.me/blog/how-lime-leveraged-sustainability-to-achieve-profitability (Accessed 5 June 2023).
[16] BVG, 2020. "Annual Report 2020" - Available at: https://unternehmen.bvg.de/media-downloads/(Accessed 10 June 2023).
[17] Neutron Holdings Inc., "Why Lime – Innovation" Available at: https://www.li.me/why/innovation (Accessed 5 June 2023).
[18] Uber Technologies Inc., 2020. "2020 Investor Presentation".
[19] BVG, 2020. "Annual Report 2020".
[20] Uber Technologies Inc., 2020. "2020 Investor Presentation".
[21] Uber Technologies Inc., 2020. "2020 Investor Presentation".
[22] BVG, 2020. "Annual Report 2020".

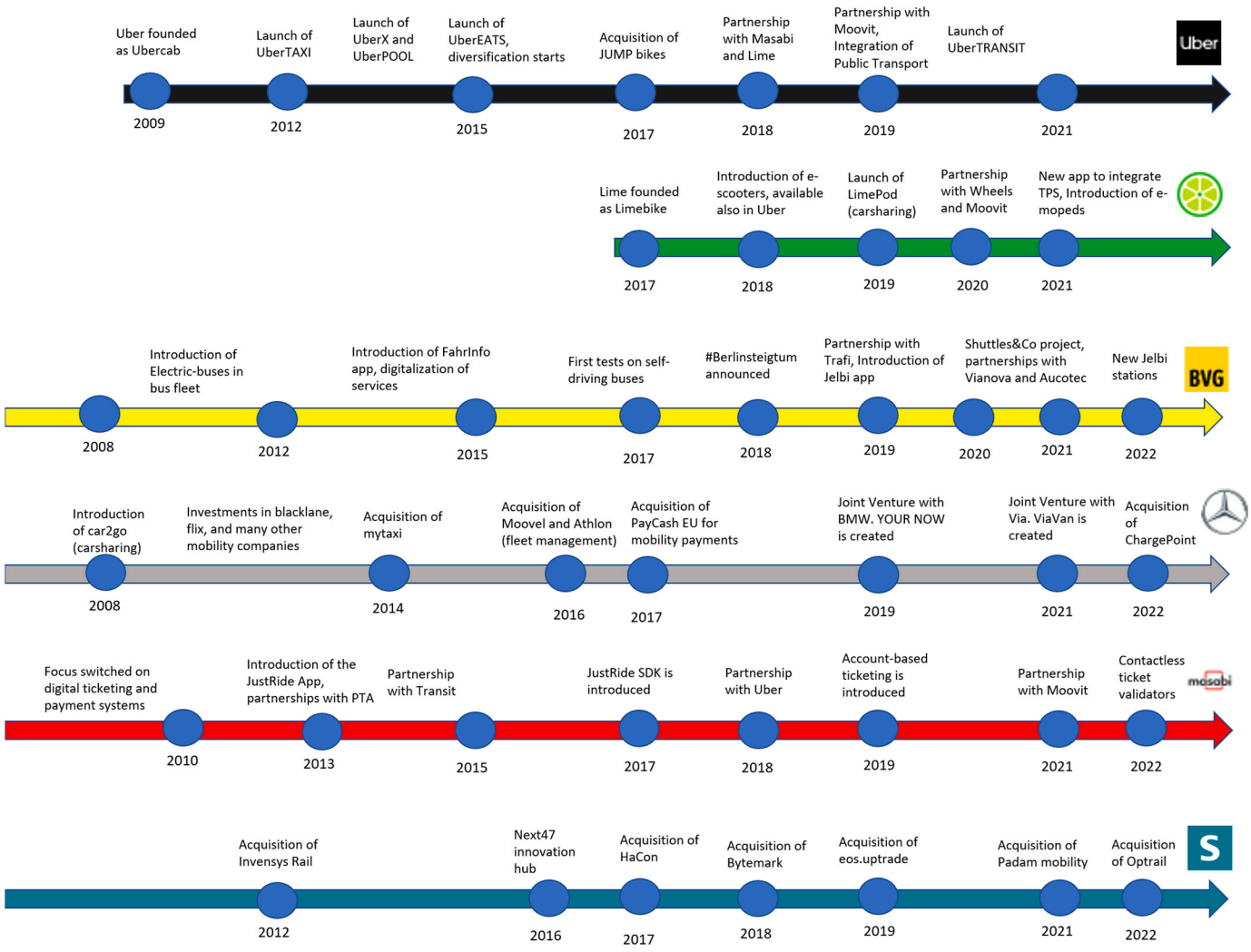

Fig. 2. Key initiatives towards MaaS by uber, lime, bvg, mercedes-benz, masabi, siemens mobility.

imperative to expand into different cities and explore novel market segments. In particular, both Uber and Lime have established their services across various cities and regions worldwide, amplifying their brand presence and diversifying their revenues.[23]

Building upon the aforementioned points, MaaS adds novelty to the value proposition of service providers. It represents more than a mere extension of existing offerings; rather, it brings about a fundamental transformation in the way services are bundled, presented, and delivered. The companies under examination are now strategically positioned to offer users a holistic and integrated solution that encompasses multiple modes of transportation, curating a comprehensive multimodal portfolio. This positioning has been achieved through various means, including partnerships with other service providers or technology providers and through direct investments or acquisitions. For instance, Uber has expanded its MaaS capabilities by partnering with Moovit, a start-up leader in multimodal trip planning, which allowed Uber to integrate real-time public transit data from over 7000 agencies directly within the Uber app. Moreover, Uber has acquired Routematch and invested in micro-mobility companies like JUMP Bikes to offer a diversified range of transportation options.[24] Uber and Lime partnered to offer Lime Scooters through the Uber's app.[25] BVG partnered with Trafi,[26] a start-up specialized in white-label solutions that enable cities and transport companies to develop their own customized MaaS systems. These strategies focused on leveraging and sometimes developing key resources and competences internally to support their new business. Partnership management, contract negotiation, project management, and technology-related skills were considered crucial in the transition. With a new and enhanced platform, service providers offer a unique ticket and payment system for all the mobility options available. Moreover, real-time information dissemination empowers users with timely updates on routes, schedules, and potential disruptions, fostering an enhanced sense of control and reducing the uncertainties associated with travel. They heavily leverage on data analytics to optimize the process and enhance their efficiency. Uber has built the Gairos platform, which optimizes data ingestion and querying to support dynamic pricing and trip

[23] See Neutron Holdings Inc., "Location" – Available at: https://www.li.me/locations (Accessed 5 June 2023).And Uber Technologies Inc., "Cities" – Available at: https://www.uber.com/global/en/cities/?uclick_id=2e5c484d-0670-4789-8cb1-556495b95e71 (Accessed 30 May 2023).

[24] Lyko, M2050, "Is Uber a MaaS app?" – Available at: https://m2050.media/en/uber-on-its-way-to-becoming-a-maas-player/.

[25] See Neutron Holdings Inc., Help center – Available at: https://help.li.me/hc/en-us/articles/1260805266589-How-does-renting-a-scooter-through-Uber-work.

[26] BVG, 2021. "Annual Report 2021". See also BVG website: "Jelbi" – Available at https://www.jelbi.de/en.

Table 4
Value creation, capture, and delivery framework applied to Service Providers.

	PRE-MAAS MECHANISMS		POST-MAAS MECHANISMS	
	Macro-Level	Micro-Level	Macro-Level	Micro-Level
Value Creation	[Transport] Product and Service provision	• Core transportation service offering (Sharing mobility, ride-hailing, PT)	New Products and Services	• Integrated mobility solutions (creation of a multimodal portfolio) • Ticket interoperability, real-time information, and unique payment system for multiple services • Real-time traffic monitoring and Route Optimization • Inclusion of other mobility-related products and services
	Product Differentiation	• Wide range of product alternatives based on customer needs • Integration of mobility-related services in the product portfolio • More flexibility, convenience, and accessibility for mobility needs • Sustainable initiatives and incentives • Quality and security focus	R&D	• Investments in new technologies (AI, Machine Learning, AV, EV, app algorithms, Smart Mobility solutions)
	Innovation and improvements	• Investments in new technologies (digitalization of services, EV, AV) • Investments in new infrastructures and fleets (Improvements in the connection network in cities)	Efficiency	• Data analytics and insights • Process Optimization
	Market Development – Expansion in new segments	• Expansion in new cities		
Value Capture	Traditional Revenue Streams	• Commissions and Fees/Fares • Subscriptions • Advertising (in-app/posters) • Sponsorships • Pricing Strategies • Data monetization • Government subsidies • Vouchers/Discounts1	New Revenue Streams	• New pricing strategy • New subscription offers and memberships revenue • Revenue sharing with partners
			Networking and Partnerships	• Strategic Alliances • Increased visibility and reduced costs of customer acquisition • Co-Promotion and Marketing
			Lock-In	• Loyalty Programs • Brand reputation
Value Delivery	Digital Platforms and Technology	• App/Platform • Website • Customer support and assistance5.	Improvements to Digital and phisical infrastructures	• New and improved Apps • Side platforms • API and integrated platform with partners • Data sharing
	Phisical Infrastructure and assets	• Stations and routes • Vehicles6		• New stations and routes

forecasting. Lime handles vast data streams using AWS and Amazon Kinesis, to monitor millions of trips and ensure that its vehicles are charged and available, enhancing the user experience. These mechanisms play a pivotal role in tailoring services to meet changing demands, while also allowing them to allocate resources strategically and streamline their operations.,[27][28] In the quest for continuous innovation and staying at the forefront of the mobility landscape, service providers are increasingly investing in R&D. Uber allocates annually approximately 10% of its revenue in R&D, entailing the exploration of cutting-edge technologies as AI, machine learning and autonomous vehicles (AV) to enhance the efficiency, safety, and sustainability of their services. BVG has also started pilot projects deploying driverless vehicles with on-board attendants and other AI-based systems for connected mobility.[29]

4.1.2. *Value capture*

In terms of value capture, pre-MaaS service providers relied on traditional revenue streams commonly associated with the transportation sector. Mobility platforms like Uber and Lime typically charge commissions and fees on transactions made through their apps, based on the effective usage of their service.[30] BVG, instead, collects ride fares at capped prices, supplemented by government subsidies, to maintain its financial sustainability while ensuring accessibility for a diverse population.[31] Most of the times, subscription models are used to provide a predictable revenue stream and promote user loyalty by offering benefits such as reduced prices, priority service, or access to exclusive features. This category of firms also offers vouchers and discounts as a means to attract new customers, retain existing ones, and encourage increased usage of their services. In addition, platforms like Uber adopt particular dynamic and personalized pricing strategies to adapt their prices based on real-time demand and supply conditions, in order to optimize revenue generation.[32] Finally, other value capture mechanisms adopted are data monetization, advertising and sponsorships.

[27] BVG, 2022. "Annual Report 2022". Available at: https://unternehmen.bvg.de/media-downloads/(Accessed 11 June 2023).
[28] Uber Technologies Inc., 2022. "Annual Report 2022". Available at: https://s23.q4cdn.com/407969754/files/doc_financials/2023/ar/2022-annual-report.pdf (Accessed 1 June 2023).
[29] Uber Technologies Inc., 2022. "Annual Report 2022". BVG, 2022. "Annual Report 2022". See also: BVG, "Smart Cities" – Available at: https://unternehmen.bvg.de/smartcity/(Accessed 12 June 2023).
[30] Neutron Holdings Inc., "User Agreements" – Available at: https://www.li.me/user-agreement (Accessed 7 June 2023). Also Uber Technologies Inc., 2019. "Uber Announces Results for Fourth Quarter and Full Year 2019".
[31] BVG, 2020. "Annual Report 2020".
[32] Uber Technologies Inc., "Dynamic pricing" – Available at: https://www.uber.com/en-GB/blog/uber-dynamic-pricing/(Accessed 2 June 2023).

Table 5
Value creation, capture, and delivery framework applied to Technology Providers.

	PRE-MAAS MECHANISMS		POST-MAAS MECHANISMS	
	Macro-Level	Micro-Level	Macro-Level	Micro-Level
Value Creation	[IT and Transport-related] Products and Services provision	• Software and digital solutions • Vehicle manufacturing and trasnport infrastructure solutions • Consulting and digital transformation services • Customized and tailored products and customer services	New Products and Services	• New Digital Solutions for quick innovation, cost reduction, increase in operational efficiency, easy integration with third-party apps and services • Development of Mobility Management solutions (fleet management systems, White label MaaS apps, parking and lot management, recharging systems) • Mobility data analytics and insights (Mobility data platforms) Mobility consulting and advisory services
	Complementarities	• After sales services (Maintenance, technical support, training, updates) • Financial and mobility services • Sustainability and ESG initiatives		
	R&D	• Investments in EV and AV • Investments in new technologies (smart mobility, digitalization, AI)		
	Market Development – Expansion in new segments	• Investments in new Production Plants (emerging economies) • Expansion of customer base•		
Value Capture	Product and service sales and revenues	• Direct sales and service implementation fees • Financial services revenues • Intellectual property and licensing revenues	New Revenue Streams	• Suscriptions to digital and connected services • New softwares licensing and implementation fees • Data monetization • Partnership agreements and revenue sharing • Premium prices for extra features and upgrades
	Lock-In	• Brand Reputation • Cross-selling and up-selling	Tangible and Intangible resources acquisition	• Joint Ventures • Merges/Acquisitions
	Networking and Partnerships	• Collaborative R&D • Suppliers and distribution Partnerships • Advertising and Sponsorship•		
Value Delivery	Digital Platforms and Technology	• Mobile Apps • Website • Customer service	Improvements to Digital and phisical infrastructures	• Integrated mobility platforms (white label) • APIs and data integration tools • Improved digital and mobile apps
	Phisical Infrastructure and assets	• Sales and Dealership network		• Updates and innovations
	Knowledge Transfer	• Training and knowledge transfer • System integration and Project Management		• Cloud-based support services

The advent of MaaS opened up new revenue streams for service providers. This transformation is underscored by the integration of new pricing strategies, the introduction of innovative subscription offers, and the implementation of loyalty programs, all of which contribute to lock-in users and promote retention. For instance, Uber launched Uber Rewards to offer benefits across different tiers, including discounts on rides, priority support, and flexible cancellation policies. Moreover, Uber One has been introduced to provide discounts and exclusive experiences across both rides and delivery.[33] Instead, Lime launched Limepass, which provides unlimited free scouter unlocks for a week, and LimePrime, a monthly subscription program offering unlimited free unlocks and discounts on rides.[34] Partnership and network strategies have emerged as key mechanisms for value appropriation, involving revenue sharing models, co-promotion, and increased brand recognition to all the participants.[35] For instance, Uber has extended its delivery network by setting strategic partnerships with existing restaurants and retail locations. By taking a fee for every order, Uber helps local businesses gain recognition among its vast user-base. Additionally, Uber has partnered with public transport and micro-mobility providers to enhance its mobility offer and diversify its revenues. Finally, Uber's adopted co-promotion strategies with companies from various sectors (e.g. Spotify) to extend its market reach and brand presence. With Jelbi, BVG opened to new shared revenue streams with the transportation services included in its offering. Businesses that link to the MaaS provider, as Lime did, have experienced a greater visibility of their brand and the access to other's customer bases.

4.1.3. Value delivery

In terms of value delivery, service providers in the pre-MaaS era relied on both digital platforms and physical assets to grant transportation to users and enhance their overall experience. Leveraging intuitive mobile applications, they allowed users to make bookings, request rides, access vehicles, plan routes, get assistance in every moment. Furthermore, comprehensive fleets of vehicles and maintained well-defined routes for public transport, ensured that users could access transportation options across urban landscapes.[36]

In the Post-MaaS era, new value delivery mechanisms emerged to contribute to a more seamless and integrated mobility experience for users. One of these mechanisms involves data sharing, which underscores the significance of collaboration and interconnectedness among various stakeholders in the MaaS ecosystem. This is made possible through the integration of Application Programming Interfaces (APIs) and the creation of integrated platforms.,[37][38] These enable service providers to connect their offerings with those of complementary partners, allowing users to access a multitude of services through a single interface. Furthermore, the establishment of new stations and routes serves as a tangible manifestation of service providers' commitment to expanding their reach and accessibility.

4.2. Technology providers

4.2.1. Value creation

Moving to the technology provider category, these firms contribute through the provision of software solutions, digital infrastructures, data management systems, and other technological enablers that facilitate the creation of MaaS systems. Before the introduction of MaaS, technology providers were distinctively engaged in delivering specific technological solutions that catered to various aspects of the transportation and mobility landscape. For instance, Mercedes-Benz, renowned for its expertise in luxury car manufacturing and production of vans, trucks, and buses, ventured into the realm of mobility with car sharing, like car2go, and fleet management solutions.[39] Masabi, on the other hand, carved its niche in the realm of e-ticketing and related validation systems. It directed its efforts towards developing comprehensive back-end solutions that ensured secure payments, efficient ticket management, robust customer service, detailed reporting, and real-time analytics. Through these solutions, Masabi contributed to enhancing the efficiency and convenience of public transportation systems, facilitating streamlined fare collection and management.[40] Siemens Mobility offer a wide range of solutions, from locomotive manufacturing and rail electrification systems, rail automation and digital solutions as signalling systems, traffic management systems, tolling systems, to electric vehicle charging solutions, and intelligent parking systems for mobility.[41] In the more recent years leading up to the advent of MaaS, technology providers pivoted their focus towards digital transformation solutions designed to increase the operational efficiency of their clients. Leveraging their deep-rooted knowledge in technology, they began to provide them valuable insights and strategic guidance. In addition to consulting services, a central part of their value proposition is the creation of customized and tailored products to integrate their solutions into existing frameworks while accommodating client's requirements. Indeed, Masabi and Siemens strongly collaborate with their clients to understand their needs and propose the right solution that fits the case.[42] Mercedes-Benz's commitment to customization is demonstrated through its practice of allowing customers to personalize their vehicles by selecting specific features and options based on their preferences.[43] The concept of complementary services emerges as a fundamental value creation mechanism within technology providers. Cross-selling and up-selling enabled technology providers to offer their clients enhanced functionalities or expanded capabilities that aligned with their existing needs. They usually offer their products and services in packages encompassing software, assets, infrastructures, support, after sales services such as maintenance, training, updates, and even financial services.[44] To remain at the forefront of their respective industries and maintain a competitive edge, technology providers consistently channel substantial investments into the development of

[33] Uber Technologies Inc., "Uber Introduces Uber One: A New Membership Program Bringing Together the Best of Uber" – Available at: https://investor.uber.com/news-events/news/press-release-details/2021/Uber-Introduces-Uber-One-A-New-Membership-Program-Bringing-Together-the-Best-of-Uber/default.aspx.

[34] Neutron Holdings Inc., Newsroom: https://www.li.me/en-gb/blog/lime-introduces-lime-prime-just-in-time-for-summer.

[35] Uber Technologies Inc., "Transit" – Available at: https://www.uber.com/it/it/transit/(Accessed 2 June 2023). Also Uber Technologies Inc., 2022. "Annual Report 2022".

[36] Uber, Lime, and BVG websites.

[37] Neutron Holdings Inc, API guide, Available at: https://docs.lime-crm.com/integration/rest-apis/start#:~:text=Limetype%20API.%20Used%20to%20discover%20and%20retrieve%20metadata,to%20binary%20file%20data%20stored%20in%20Lime%20CRM.

[38] Uber Technologies Inc, "Riders API References" – Available at: https://developer.uber.com/docs/riders/references/api.

[39] Mercedes-Benz Group AG, 2015. "Annual Report 2015". Available at: https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/.

[40] Masabi Ltd., "Products: Justride" Available at: https://www.masabi.com/justride-mobile-ticketing/(Accessed 20 June 2023).

[41] Siemens AG, 2019. "Annual Report 2019". Available at: https://www.siemens.com/global/en/company/investor-relations/events-publications-ad-hoc/annualreports.html.

[42] Siemens AG, 2020. "Annual Report 2020". Available at: https://www.siemens.com/global/en/company/investor-relations/events-publications-ad-hoc/annualreports.html.Also Masabi Ltd., "Customers". Available at: https://www.masabi.com/agencies-and-operators-using-justride/(Accessed 20 June 2023).

[43] Mercedes-Benz Group AG, "Passenger cars" – Available at: https://www.mercedes-benz.it/passengercars.html?group=all&subgroup=see-all&view=BODYTYPE (Accessed 2 July 2023).

[44] Siemens AG, 2019. "Annual Report 2019". Also Mercedes-Benz Group AG, 2018. "Annual Report 2018". Available at: https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/.

emerging technologies and R&D efforts. By dedicating resources to the development of smart mobility solutions, digitalization, AI, AV, and EV technologies, these types of companies try to build up patents while also contributing to the evolution of their industries and the advancement of sustainable and efficient mobility solutions.[45] Finally, a pivotal element in the value creation strategy of technology providers is the expansion of their market reach, seeking to broaden their influence across various regions and customer segments. This expansion manifests through two primary avenues: investments in new production plants, particularly in emerging economies (in Mercedes-Benz and Siemens cases), and the enlargement of their customer base, solidifying their market presence and harnessing previously unexplored revenue streams.

With the advent of MaaS, technology providers went beyond being suppliers of software and digital infrastructure and have evolved into strategic partners that contribute to the holistic development of the urban mobility ecosystem. MaaS prompted them to reimagine their role and expand their horizons, resulting in the emergence of novel products and services. To incorporate MaaS into their services, these companies have adopted various strategic measures including establishing partnerships, conducting mergers and acquisitions, and initiating joint ventures. This approach serves as a means to access both tangible and intangible resources that are essential for the development and deployment of advanced mobility solutions. New skills and competences belonging to the technology realm were considered crucial for the transition. For instance, a big company like Siemens opted to acquire smaller IT companies as HaCon, eos.uptrade, Padam, and Bytemark to extend its influence in the mobility realm and to provide a comprehensive portfolio of services, from fare collection systems to MaaS solutions.[46] Mercedes-Benz acquired the ride-hailing company mytaxi and then ventured jointly with BMW to provide a new wide-ranging mobility service called Your-Now, giving birth to the Free Now (ride-hailing), Reach Now (MaaS), Share Now (car-sharing), Park Now (parking solutions) and Charge Now (electric vehicle charging solutions) brands.[47] Instead, Masabi partnered with Transit, Trapeze, TransLoc, and other journey planning and MaaS apps to provide a comprehensive service to its customers, ranging from digital payment systems to mobility planning and scheduling, business intelligence, workforce management, and white label MaaS solutions.[48]Overall, new mobility management solutions are now developed and sold from technology providers: fleet management systems, white-label MaaS applications, parking and lot management solutions, and recharging systems have become integral offerings. In the realm of mobility data analytics, technology providers now provide comprehensive data platforms that leverage advanced analytics to offer real-time insights into mobility patterns, user behaviour, and operational performance. For instance, Siemens developed the TPS.integrate and HAFAS platforms to integrate, exchange, and analyse an extensive amount of data from various transport providers to predict the overall mobility demand based on travellers' behaviour.[49] Masabi further enhanced their Justride platform to better manage data from the mobility services connected in a MaaS system, including a comprehensive data analytics solution to improve services and operations.[50] Leveraging new technologies, companies offer solutions that streamline processes, integrate seamlessly with third-party applications and services, and drive digital transformation for a quick innovation and reduction of costs for their clients.[51]

4.2.2. Value capture

In terms of value capture, technology providers generate revenues mainly by selling their products and services to their customers. This encompasses a range of income streams, including direct sales and service implementation fees, along with the provision of financial services, intellectual property and licensing revenues to monetize their proprietary innovations.[52] Intellectual property serves also as a Lock-In effect that protects innovative solutions and make it harder for customers to switch to other alternatives in the market. Contribute to the Lock-In also the brand reputation and the cross-selling and up-selling strategies described before. Partnerships and network collaborations are also a crucial value capture mechanism for technology providers. In particular, they often recur to Collaborative R&D ventures, which bring together the expertise, resources, and knowledge of multiple stakeholders to undertake ambitious and complex innovation projects. Moreover, technology providers often rely on a diverse set of suppliers for components, materials, and specialized technologies.[53]

The emergence of the MaaS market segment has opened new avenues for technology providers to diversify their revenue streams. As they develop new software solutions, the potential for licensing and implementation fees expands. Subscriptions to their SaaS models provide also a steady stream of revenue while fostering a deeper engagement with customers. For instance, Masabi employs a Fare Payment-as-a-Service (FPaaS) approach, offering transit agencies comprehensive solutions for mobile ticketing, contactless payments, and seamless integration with existing infrastructures, in exchange for a fee. Siemens adopted a similar approach with the acquisition of Bytemark. Additionally, the vast pool of data generated by MaaS systems presents an opportunity for data monetization, creating a source of revenue that capitalizes on valuable insights drawn from user behaviour and trends. Other revenue sources for technology providers are revenue-sharing deriving from collaboration agreements and the introduction of premium-prices for new features and upgrades of their services.[54]

4.2.3. Value delivery

In the pre-MaaS era technology providers delivered value mainly through their digital platforms, as mobile apps and websites, used as gateways for clients to explore the product offerings, access information, and initiate interactions. Some companies, above all Mercedes-Benz, established a robust network of sales outlets and dealerships to provide localized support, test drives, and vehicle servicing.[55] Technology providers build up on robust customer service departments, ready to address inquiries, resolve issues, and provide technical assistance to

[45] Siemens AG, 2019. "Annual Report 2019"; Mercedes-Benz Group AG, 2017. "Annual Report 2017". Available at: https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/; Masabi Ltd., masabi.com website homepage, at: https://www.masabi.com/(Accessed 20 June 2023).

[46] Siemens AG, Press Releases 2019, 2020, 2021. Available at: https://press.siemens.com/global/en/press-search?f%5B0%5D=business%3A5&f%5B1%5D=content_type%3Ac2_ct_press_release (Accessed 15 and 16 July 2023).

[47] Mercedes-Benz Group AG, 2017. "Annual Report 2017".

[48] Masabi Ltd., Press Releases 2015, 2017, 2019. Available at: https://www.masabi.com/press-releases/(Accessed 25 June 2023).

[49] Siemens Mobility, "Data Management and Analytics" – Available at: https://www.mobility.siemens.com/global/en/portfolio/digital-solutions-software/mobility-as-a-service/data-management-analytics.html.

[50] Masabi, "Ticketing for Public Transport" – Available at: https://www.masabi.com/.

[51] Mercedes-Benz Group AG, 2022. "Annual Report 2022". Available at: https://group.mercedes-benz.com/investors/reports-news/annual-reports/download/; Siemens AG, 2022. "Annual Report 2022".

[52] Siemens AG, 2020. "Annual Report 2020"; Mercedes-Benz Group AG, 2019. "Annual Report 2019"; Masabi Ltd., "Customers". Available at: https://www.masabi.com/agencies-and-operators-using-justride/(Accessed 20 June 2023).

[53] Siemens AG, 2018 Press releases. Available at: https://press.siemens.com/global/en/press-search?f%5B0%5D=business%3A5&f%5B1%5D=content_type%3Ac2_ct_press_release (Accessed 15 July 2023).Mercedes-Benz Group AG, 2017 Press releases. Available at: https://media.mercedes-benz.com/(Accessed 5 July 2023).

[54] Siemens AG, 2022. "Annual Report 2022"; Mercedes-Benz Group AG, 2022. "Annual Report 2022"; Masabi Ltd. "Customers".

[55] Mercedes-Benz Group AG, 2015. "Annual Report 2015".

their customers. They offered comprehensive project management services, ensuring a seamless integration process of their technology within existing frameworks.[56] Finally, recognizing that the adoption of their technologies often required specialized know-how, technology providers organized training sessions and knowledge transfer initiatives with their clients to get them accustomed to the use of their products.[57]

In the post-MaaS era new value delivery mechanisms have emerged. By leveraging the power of cloud technology, providers offer robust support systems that enhance reliability, accessibility, and scalability. These services enable efficient troubleshooting, quick updates, and seamless integration for their clients. Through regular updates and innovations, technology providers ensure that their solutions remain relevant, efficient, and capable of addressing the changing needs of their clients.[58] Finally, technology providers have also improved their applications and provide complete platforms that seamlessly integrates diverse mobility services into a unified interface.

5. Discussion and conclusions

This article aims at providing a dynamic and evolutionary perspective in the MaaS business models domain. It delves into the impact of the MaaS impact on organizations operating within the MaaS ecosystem, and how it has influenced their strategies and operations. Specifically, we investigate how service and technology providers have evolved their business models over time in response to MaaS introduction in the mobility market, by adopting the value creation, capture, and delivery framework. Our results reveal that MaaS has had a significant effect on the organizations under examination.

In particular, our research reveals that MaaS adds novelty in the way both service and technology providers create, capture, and distribute value to their customers (Amit and Zott, 2001). Service providers have primarily directed their efforts towards delivering integrated and multi-modal solutions, while prioritizing the enhancement of their operations through the use of data, user convenience, safety, and overall travel experience. These companies continue to invest in elevating service quality and sustainability as key drivers of differentiation (Ioannou and Serafeim, 2019). Additionally, they are actively expanding their services into new market segments, further solidifying their reach and aiming for more profits. As for value capture, MaaS introduced a shift in their traditional scheme for revenue generation. This transformation is evident through the integration of new pricing strategies, the introduction of innovative subscription offers, and the establishment of loyalty programs. These strategies not only lock-in users but also promote user retention (Amit and Zott, 2001). Moreover, partnership and network strategies have emerged as pivotal mechanisms for value appropriation, encompassing revenue-sharing models, co-promotion, and increased brand recognition among all participants. Finally, MaaS has brought changes also in the way new value is delivered to users. A prominent mechanism that has emerged is data sharing, highlighting the importance of collaboration and interconnectedness within the MaaS ecosystem. This collaboration is facilitated by the integration of Application Programming Interfaces (APIs) and the development of integrated platforms, which allow the connectivity among complementary service partners. The increasing digitization of processes and enhancements in the physical network and routes stand out as the most significant changes that occurred as for value delivery.

Instead, technology providers have directed their efforts in adapting their products and services to the evolving market conditions. They focused on providing digital solutions that enable real-time data sharing, seamless transactions, and the integration of mobility planning. Additionally, they have developed an array of mobility management solutions, including white-label MaaS applications, fleet management systems, parking systems, recharging infrastructure, and mobility data platforms. These solutions have broadened their product portfolio and complemented their existing offerings. After embracing MaaS, technology providers adopted new value capture mechanisms. Notably, they have engaged in partnerships, joint ventures, or mergers and acquisitions, to access essential resources for developing advanced mobility solutions. Collaborative agreements also have led to revenue-sharing opportunities. Moreover, MaaS opened new revenue streams. Their new software solutions expanded the potential for licensing and implementation fees. They have shifted their focus on providing subscription-based Software as a Service (SaaS) models, thus ensuring consistent revenues and, at the same time, fostering deeper engagements with customers. Finally, new value delivery mechanisms have emerged. Leveraging cloud technology, they have introduced robust systems that facilitate troubleshooting, software updates, and integration with clients. Through regular updates and ongoing innovations, technology providers ensure that their solutions remain pertinent, efficient, and capable of adapting to the evolving needs of their clients. They still rely on project management, training, and knowledge transfer as pivotal mechanisms for value delivery. This is because project management ensures the perfect integration of their technology products within the clients' existing systems, while training empowers clients to effectively utilize these products and thus maximize their benefits.

Although service and technology providers have specific differences depending on the sector they primarily belong to, it is possible to state that there have been some commonalities in their responses to MaaS introduction. First, they strategically relied on partnerships and collaborations as main mechanism not only to expand and enrich their service offerings, but also to enter into new markets, secure key resources and foster knowledge sharing and capabilities development (Dyer et al., 2018). This has been widely recognized by the literature as key mechanism that can enable MaaS ecosystems (Kamargianni and Matyas, 2017; MaaS Alliance, 2017; Polydoropoulou et al., 2020; Kandanaarachchi et al., 2022) and our study confirms this tendency among established organizations in the mobility realm. Certainly, service providers frequently engage with technology providers to advance their digitalization efforts and create innovative solutions, including the development of MaaS applications, aiming at enhancing the customer experience, while at the same time they often establish partnerships with other service providers to enable their MaaS service or to access new markets. On the other hand, technology providers typically form alliances with other technology firms to leverage their knowledge and expertise for research and development endeavours or to extend their product lines, as well as with service providers to reach a broader audience for their products and services. Second, the adoption of technology-based solutions and digitalization has been a fundamental shift for both categories. They heavily invested in emerging technologies such as AI, machine learning, and EVs, to align their services with the evolving mobility landscape. Third, both service and technology providers have adopted customer-centric approaches when developing of their products and services. Service providers concentrated their efforts on enhancing the overall travel experience of users. They achieved this by developing integrated mobility services, creating user-friendly interfaces that facilitate the decision-making and the selection process, and improving the reliability and accessibility of their transportation offerings. On the other hand, technology providers relied on personalization of services, enhancing their software solutions, and emphasizing project management, to ensure a perfect implementation of their technology into their clients' systems. Finally, both service and technology providers view the advent of MaaS as a strategic opportunity to expand their market reach, increase their customer base and diversify their revenue streams. They instinctively incorporated MaaS in their value proposition, demonstrating their commitment to quickly follow the prevailing market trends, strengthen their competitive position, and

[56] Siemens AG, 2019. "Annual Report 2019"; Masabi Ltd. "Products: Justride".
[57] Siemens AG, 2020. "Annual Report 2020"
[58] Mercedes-Benz Group AG, 2022. "Annual Report 2022". Siemens AG, 2022. "Annual Report 2022".

capture new market shares.

5.1. Implications for theory

The findings of this research bring contributions to the ongoing academic literature related to MaaS and to BMI. On the one hand, we extend the theoretical knowledge on MaaS business models (e.g. Polydoropoulou et al., 2020; Krauss et al., 2022; Aapaoja et al., 2017a; König et al., 2016). Indeed, our study sheds new light on the main macro and micro-level mechanisms that firms belonging to the service and technology providers categories may employ to create, capture, and deliver new value by incorporating MaaS into their value proposition, with some variations between these two organization types. Therefore, it enriches the previous knowledge, which predominantly revolved around conceptualizing MaaS providers' ideal business models, by highlighting the different strategies that existing firms may adopt to naturally develop MaaS systems. Additionally, our study delves into MaaS emphasizing its transformative potential and studying its impacts mainly related to the organizations belonging to MaaS ecosystems (e.g. Srivastava and Wong, 2023; Hensher, 2017; Mulley and Nelson, 2020). We thus contribute to the analysis of the effects of MaaS by particularly uncovering and deepening understanding of its influence on business strategies, operational dynamics, and value creation and value appropriation mechanisms for different actors within the service providers (as ride-hailing, public transport, and micro-mobility companies) and the technology providers (as car manufacturers and digital solutions providers) domain. On the other hand, our contributions extend to and enrich the broader topic of BMI within the mobility sector in response to new phenomena (e.g. Sarasini and Linder, 2018; Cohen and Kietzmann, 2014; Turoń and Kubik, 2021). Specifically, we describe the evolution of the business models of the actors under analysis after the emergence of a disruptive concept like MaaS. By applying the value creation, capture, and delivery framework (Bocken et al., 2015; Lepak et al., 2007) we provide new insights on the main strategies and value mechanisms adopted by service and technology providers in their transition process toward MaaS. The paper advances theoretical understanding by acknowledging that some patterns and common themes exist between categories, although the micro-level strategies adopted are contingent on the nature of the organization and its core competencies.

5.2. Implications for practice

Our research holds straightforward implications for practitioners and policymakers. It mainly informs about the evolutionary trajectory of business models within firms operating in MaaS ecosystems and highlights the strategies and value mechanisms used by them to navigate the challenges and opportunities presented by MaaS. Hence, understanding their dynamics can be crucial for managers, as it can guide the decision-making process and the implementation of strategic plans that align with evolving market conditions. Indeed, our findings may help them allocate resources effectively, prioritizing investments in key areas such as technology development, partnerships, or customer experience to stay competitive or, in some cases, gain a significant competitive advantage. Finally, policymakers responsible for urban planning, transportation regulation, and sustainable mobility initiatives can draw upon our research to design policies that foster innovation, emphasizing digitalization and cross-sector collaboration among firms. Our research underscores the critical role of digitalization and data in enhancing mobility services. Companies extensively engage in sharing, storing, and analysing data across various transport modes. Yet, the establishment of comprehensive data sharing and interoperability standards remains pending. With MaaS companies operating on a global scale, there is a pressing need for international standards to facilitate the integration and widespread adoption of MaaS. Finally, given the crucial importance of partnerships and collaboration, policy makers can foster them by offering tax incentives or grants to ensure economic convenience. Policies could include mechanisms for shared revenue or cost-saving opportunities for collaborative projects, encouraging companies to work together towards common goals in the mobility ecosystem.

5.3. Limitations and future research directions

This work presents some limitations that may provide an opportunity for further research.

First, our study primarily employs a macro-level perspective, focusing on overarching strategies and outcomes of companies transitioning towards MaaS. This approach may not delve into the detailed, micro-level dynamics such as decision-making processes, internal challenges, and the step-by-step evolution of business model innovations within these firms. This gap suggests a valuable direction for future research, emphasizing a more detailed, within-the-firm analysis that explores the nuances of implementing MaaS, including the obstacles, uncertainties, and strategic decisions faced by companies. Further research could benefit from a qualitative approach, examining case studies or conducting interviews with decision-makers to "look inside of the box" and how MaaS actually influenced the companies within the mobility sector.

Second, the generalizability of our findings may be constrained by the case study approach. Our inductive and qualitative insights can be enriched through the collection of quantitative data. Quantitative analysis allows for a more comprehensive evaluation of the impact of MaaS on businesses. This could be achieved by monitoring some key performance indicators (KPIs) such as, for instance, market share, revenue growth, customer retention rates, and profitability of the organizations under analysis before and after MaaS introduction. Furthermore, other metrics could be created ad hoc to track other significant aspects of MaaS impacts for businesses, such as the financial implications, the operational efficiency, the stakeholder relations, or the innovation process.

Third, the research sample comprises a total of six companies. These were divided into three firms belonging to the service providers category and three to the technology providers category. Hence, we derived our insights from a relatively small group of companies, and we may have not fully captured the diversity of responses to MaaS introduction. Further research could expand the sample size to provide and explore whether similar patterns emerge across a broader spectrum of organizations and regions, therefore adding more generalizability and robustness to the findings.

Fourth, we selected in our research sample only full established players in the industry, which have successfully implemented MaaS in their value proposition. This might introduce a bias in our results, as we did not account for smaller firms or new entrants in the market which may face different challenges and respond differently to MaaS adoption. Further research could conduct separate studies mainly focused on startups or small and medium-sized enterprises and compare their responses and strategies with those of incumbents. This comparative analysis would provide a more comprehensive view of how different organizations navigate into MaaS.

Fifth, we recognize that our study is certainly limited in scope. We mainly analysed the evolution of service and technology providers' business models in response to MaaS introduction. However, it is essential to acknowledge that the MaaS ecosystem comprises a broader range of stakeholders, such as regulators, infrastructure providers, investors, whose dynamics are undoubtedly impacted by MaaS. Therefore, to address this limitation and offer a holistic view of MaaS impacts on organizations, future research can expand the scope and include different types of firms within the ecosystem.

Finally, it is important to underscore that MaaS is still an evolving concept, and market dynamics are quickly changing over time. As it progresses, new and more refined business models will continue to emerge, designed to maximize the long-term sustainability and profitability. Accordingly, business strategies will adapt to remain aligned

with the changing market conditions. By adopting a longitudinal analysis, future research might keep track of MaaS evolutions and delve into how organizations strategize to position themselves in the market and try to gain competitive advantage.

CRediT authorship contribution statement

Nunzia Carbonara: Visualization, Validation, Supervision, Methodology, Data curation, Conceptualization. **Antonio Messeni Petruzzelli:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Data curation, Conceptualization. **Umberto Panniello:** Visualization, Validation, Supervision, Methodology, Data curation, Conceptualization. **Davide De Vita:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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