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Business models in the shared electric mobility field: A market overview towards electric Mobility as a Service (eMaaS)

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Abstract

In response to the increasing demand for shared mobility and multimodal passenger transport services, new mobility concepts such as Mobility as a Service (MaaS) and electric Mobility as a Service (eMaaS) are becoming commonplace. However, in order for new MaaS and eMaaS providers to become competitive, innovative business models (BMs) and effective market strategies are needed. This paper presents a market analysis of 229 existing providers and mobile apps within the Shared Electric Mobility (SEM) field. The goal of the analysis presented in this paper is to provide an overview of both the current BMs used in practice and the state of the market for MaaS and eMaaS endeavours. The results of the analysis determine which are the strengths of the key players within the SEM market, and how the core characteristics of their BMs can contribute to the further development of eMaaS.

Keywords: Business Model; Mobility as a Service (MaaS); electric Mobility as a Service (eMaaS); Market Analysis; Shared Electric Mobility (SEM)

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1. Introduction

Mobility as a Service (MaaS) is an innovative mobility concept that combines different transport modes to offer consumers the possibility to go from A to B in a flexible, personalized, on-demand and seamless way through a single interface (Burrows, Bradburn, & Cohen, 2015). Similarly, electric Mobility as a Service (eMaaS) is a concept that refers to the notion of achieving multimodal, seamless and eco-friendly mobility by combining MaaS with electric mobility systems and shared electric mobility services (Reyes García, Lenz, Haveman, & Bonnema, 2019). Furthermore, eMaaS connects electric vehicles' sharing services to other eco-friendly modes of mobility and puts users at the centre (eMaaS project, 2018). In the context of this paper, the definition of eMaaS proposed by Reyes García et al. (2019) will be used as our working definition, this is:

electric Mobility as a Service (eMaaS) refers to the integration of multiple forms of (electric) transportation modes –including public transport– and shared electric mobility services (e.g. e-car sharing, e-bike sharing, e-scooter sharing, e-bus, e-taxi) into a single mobility service that allows travellers to plan and go from A to B (and/or from B to C and/or vice versa) in an eco-friendly and seamless way. The service is offered through a single customer-centred interface and it also involves the prearrangement of electric mobility technologies and infrastructure (e.g. charging stations, energy contracts). (p. 2)

The (e)MaaS model is founded on the collaboration of multiple actors and stakeholders (Karlsson et al., 2016; Jittrapirom, 2018; Smith et al., 2019). Thus, the (e)MaaS market can be expected to be a collaborative market, where sharing resources (e.g. information, vehicles, data, users) will become commonplace. Likewise, the number of MaaS operators, as well as the number of shared mobility and MaaS users, is expected to significantly increase during the coming years (Freese & Schönberg, 2014; Frost & Sullivan, 2016; Kaas et al., 2016; PwC, 2017). However, in comparison to single-mode transport operators, the list of MaaS and eMaaS operators is still very short (see: Durand et al., 2018; Jittrapirom et al., 2017; Kamargianni et al., 2016). Therefore, in order to meet users' expectations, MaaS and eMaaS operators will need unique business models (BMs) and distinguishing features that allow them to successfully enter the market and also give them a competitive advantage.

Goal and research questions

The overall goal of this study is to provide an overview of the state of the market for (e)MaaS and to identify the strengths of current business models used in practice to contribute to the further development of eMaaS. The research questions that lead the analysis are the following:

1. What are existing technologies, potential competitors, and their distinctive features within the shared electric mobility market?
2. Which business models successfully compete within the current shared electric mobility market?
3. How do the characteristics of current business models contribute to the further development of eMaaS?

2. Methodology and focus of the analysis

In the context of the “eMaaS project” (2018), the analysis presented in this paper is based on a market review of the mobility services and MaaS' functionalities offered by Shared electric Mobility Providers (SeMPs). The focus is on the European market, and especially on the eMaaS project partners' origin countries. We reviewed the Shared Electric Mobility (SEM) market of the following countries: Austria, Belgium, Denmark, Finland, France, Germany, Hungary, The Netherlands, Norway, Sweden, Switzerland and the United Kingdom.

Based on our working definition of eMaaS and the scope of the eMaaS project, the analysis presented in this paper is focused only on the SEM market. However, our findings show that many players in the market do not offer exclusively electric vehicles or electric mobility services. Therefore, along this paper we have used the term ‘electric’ between parentheses [i.e. (electric)] or its abbreviation (e-) to refer to those providers or services that are not exclusively electric but do offer or contain electric vehicles (EVs) within their fleets or services. A list with all the abbreviations and acronyms used along this paper is presented in the Appendix C.

Providers outside the scope of this study are: ride sharing providers (i.e. carpooling), taxi companies, ride hailing operators (e.g. Uber), traditional^a car rental providers, traditional car leasing providers, traditional bike rental

^a Traditional- car rental providers, car leasing providers and bike rental providers are referred as those providers that do not focus their business on offering EVs as part of their mobility service, and/or the renting process has to be done on site, in front of a desk.

providers and single-mode (non-electric) public transport operators^b. Community-based^c car- and bike- sharing programmes are also outside the scope of this study. Some exceptions are made for providers that include EVs in their offer even when EVs are not be the biggest part of the transport service provider's fleet, for example for Multi Transport Integrators^d (MTI).

When exploring the SEM market a wide variety of results were found. Therefore it was needed to establish a useful approach to organise those outcomes. A classification of three main groups was defined. This classification allowed us to make a more equitable comparison in terms of the services and functionalities offered between businesses. The three groups under study are:

1. Shared electric Mobility Providers (SeMPs). Under this group, (e-)car sharing, micro (e-)mobility sharing^e (incl. Light Electric Car^f sharing), Multi Transport Integrators (MTI) and Multimodal Trip Planners^g (MMTP) are investigated.
2. (electric) Mobility Mobile Apps (MMAs). Under this group, mobile apps linked to SeMPs (including the ones in the first group), Mobility Transport Aggregators (MTA) and Multimodal Trip Planners (MTP) are investigated. If SeMPs from the previous group have something else to offer than a MMA, or if the functionalities of its MMA are also available in the website, then we considered only such providers under the first group, if not, we addressed them also under this group.
3. Mobility-related technology providers. This group consists of providers that offer technology solutions that are employed for providing (e-)mobility services.

After the groups were created, we conducted a thorough data collection process. We visited the official website of all (e-)mobility providers to collect the data. We also obtained data contained in official documents issued by such providers, and used mobility market literature, web search engines and mobility aggregator websites (e.g. *urbi.co*) to be referred to (e-)mobility providers. The final result of the data collection process is a database of 136 SeMPs, 93 MMAs (from which 90 correspond to the SeMPs in the first group), and 44 mobility-related technology providers. The difference between the first group and the second group lies on the assessment criteria for each of them. The criteria for the first group are based on the business model of the SeMPs, whereas the criteria for the second group are based on the functionalities of the MMAs. A complete description of such criteria is presented in the following subsections. A list with all providers included in the market study is shown in the Appendix A1.

2.1. Shared electric Mobility Providers (SeMPs)

The criteria to determine how Shared electric Mobility Providers (SeMPs) can successfully compete within the eMaaS market is by assessing the characteristics of their business model (BM). A BM defines how enterprises create and deliver value to customers (Teece, 2010). In the literature, BMs have been employed mainly in trying to address or explain three phenomena (Zott, Amit, & Massa, 2011): 1) e-business and the use of information technology in organizations, 2) strategic issues (e.g. competitive advantage, firm performance), and 3) innovation and technology management. In the context of this paper, BM are used to assess the competitive advantage of SeMPs within the eMaaS market.

Based on BM literature of Mobility as a Service (MaaS) schemes and Shared Mobility Providers (SMP) (e.g., see Abdelkafi et al. (2013); Briggs (2015); Cohen & Kietzmann (2014); Freese & Schönberg (2014); König et al. (2016); Lane et al. (2015); Laurischkat et al. (2016); Peng (2017); Sarasini (2018); Sarasini et al. (2015); Schiller et al. (2017)) we made a classification of six categories to identify the BM of SeMPs. The categories are: 1) Mobility service, 2) Market model, 3) Parking model, 4) Payment model, 5) Pricing model, and 6) Information and Communication Technology (ICT) offered. These categories are explained in Table 1. We use the criteria

^b Public Transport Operators (PTOs) were only selected for this study if they offer electric mobility and integrate multiple modes of (electric) transportation as part of their mobility service. For example the Dutch railways (NS), which in addition to the (electric) train service also offers bike sharing services. An example of single-mode (non-electric) PTOs are traditional local bus(es) operators, which are therefore excluded from this study.

^c Community-based sharing mobility refers to car sharing or bike sharing programmes that are exclusively for the use of a closed group of people (usually neighbours in a village or small community) and the general public or businesses cannot hire or have access to the service.

^d A Multi Transport Integrator (MTI) is a mobility provider that offers the service of multiple modes of transportation on a single contract. An example of a MTI is the NS Business card in the Netherlands that can be used to access all modes of Public Transport in the country and also (e-)car sharing and bike sharing services. In this study, mobility providers under this category offer at least 3 different modes of transportation.

^e Micro (e-)mobility sharing refers to sharing mobility programmes provided by means of micro Electric Vehicles (EVs). micro EVs are referred as small personal EVs that can carry one or two persons (e.g. all kind of bicycles, all kind of scooters, Light Electric Cars).

^f Light Electric Car (LEC): refers to a small, 1- or 2-seater electric car within the Le6 or Le7 vehicles' category as specified in EU regulation No 168/2013. An example of a LEC is the Renault Twizy.

^g A Multimodal Trip Planner (MMTP) is a digital tool, usually in the form of a mobile app or website portal, where users can plan a trip combining or by means of different modes of transportation. A common example of a MMTP is the *Google Maps* trip planner.

described in the table to analyse the BMs of the 136 SeMPs in our database. In addition to the seven criteria, the analysis regarding the SeMPs group also included a classification by the country where the services are offered.

Lastly, we made a final selection of 85 SeMPs. This selection was based on the quality of information we had available. With all the information properly categorised, we conducted the qualitative analysis that is presented in the next section.

Table 1. Business Models for Shared (electric) Mobility Providers (SeMPs).

CATEGORY	DESCRIPTION
1. Mobility Service	Type of service offered by SeMPs or mobility-related service providers — i.e. (e-)car sharing, (e-)bike sharing, (e-)scooter sharing, multi transport integrator or multimodal trip planner.
Vehicles offered	Type of vehicles offered by the SeMP — i.e. only Electric Vehicles (EVs), some EVs, Light Electric Cars (LECs), Micro EVs (i.e. e-bikes, e-scooters).
2. Market model	Type of market covered by the SeMP.
Business to Business (B2B)	SeMPs offer their services only to other businesses.
Business to Consumer (B2C)	SeMPs offer their services directly to consumers.
Peer to Peer (P2P)	Consumers directly interact to get/offer vehicle sharing services via an online platform.
Consumer to Business to Consumer (C2B2C)	SeMPs work as an intermediary between consumers. SeMPs manage consumers vehicles and offer them to other consumers within a vehicle sharing scheme.
B2B Corporate vehicle sharing	SeMPs do not offer their own shared vehicles' fleet, instead they manage other business' vehicles fleet under a vehicle sharing scheme.
3. Parking model	Options offered by the SeMP for returning the shared (e-)vehicles.
Station-based	Users must return the shared (e-)vehicle to the same spot/station where it was picked up.
Multi-station-based	Users have the possibility to return the shared (e-)vehicles at any spot/station managed by the same SeMP.
Free-floating	Shared (e-)vehicles can be parked/returned at any place within the area of operation of the SeMP (vehicles can usually be used also outside that area but must be returned to the operation zone).
4. Payment model	Type of payment scheme used by the SeMP.
Pay-as-you-go	Users pay each time they use the service. Depending on the SeMP, payment could be done beforehand (e.g. for public transport) or after the trip (e.g. taxi).
Subscription-based	Users pay a periodic fee for the use of the service and usually get access to some benefits and cheaper fees as compared to the pay-as-you-go model.
One-off registration fee	In some cases users are requested to pay a one-off registration fee (i.e. an extra fee, to be paid only once, when registering for the first time) in order to use the service.
5. Pricing model	Type of pricing model used by the SeMP or mobility-related service provider.
By time	Users pay according to the time they use the service. This could be by the second, by minute, by hour, by part of the day, by day, by weekend, by part of the week, by week or by month. Depending on the SeMP a certain period of time could be included in the initial rental price.
By distance	Users pay according to the distance they travel with the shared (e-)vehicle. Depending on the SeMP some kilometres can be included in the initial rental price.
Combination	Users pay for both the time and distance they travel with the shared (e-)vehicle. Depending on the SeMP some kilometres or minutes can be included in the initial rental price.
Fixed	Fixed cost for the use of the shared (e-)vehicle regardless the time or distance travelled.
6. ICT offered	Information and Communication Technology (ICT) offered by the SeMP to complement its mobility service.
Mobile app	Smart mobile app. Usually with at least one of the following capabilities: trip planning, trip booking (reservation), trip payment, vehicle location, vehicle access.
Website / Software platform	Website or software platform with at least one of the following capabilities: trip planning, trip booking (reservation), trip payment, vehicle location.
Keyless technology to access the shared (e-)vehicle	Via a mobile phone, smart card or smart lock.

2.2. (electric) Mobility Mobile Apps (MMAs) and Mobility-related technology providers

Regarding (electric) Mobility Mobile Apps (MMAs), the criteria to assess how these successfully compete in the market is by quantitatively analysing their number of downloads, and by making a classification of them based on the average rating users have given them in the MMAs' marketplace. For the evaluation of MMAs, data come from the mobile apps' website or from the *Google Play* mobile apps' marketplace (i.e. <https://play.google.com>). Since almost 90% of the mobile phone's market share is covered by Android OS (Gartner, 2018), it was decided not to include data (i.e. number of downloads and users' rating) from iOS systems.

Finally, for the mobility-related technology providers' group, this study has been limited to make a classification of the main solutions and services offered by this kind of providers. Having this information at hand is considered to be useful for SeMPs that are missing (some) (e)MaaS capabilities or are willing to improve or expand those that they already have. The list of all Mobility-related technology providers encountered during our study is presented in Table 5 in the Appendix A3.

3. Analysis and results

In this section each of the groups under study is analysed independently and based on the criteria explained before (see Table 1). The results of the analysis, on the one hand, determine which are the strengths of the key players within the shared (electric) mobility market. On the other hand, the results are helpful to identify the business models that should be taken into account by SeMPs that are willing to enter the eMaaS market.

3.1. Shared electric Mobility Providers (SeMPs)

As a first step, the results of the analysis focus on the different types of mobility services offered by Shared electric Mobility Providers (SeMPs) within the European mobility market. Fig. 1 shows the main distribution of the 136 SeMPs included in our study according to the mobility service that they offer.

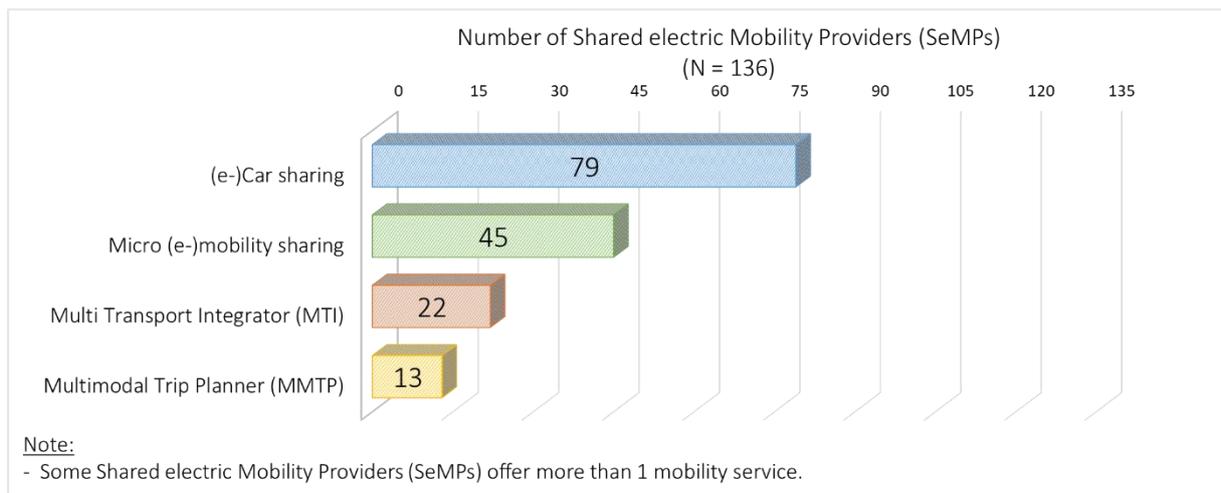


Fig. 1 Number of SeMPs in our study that offer the above-mentioned mobility services

As depicted in Fig. 1, our findings show that the Shared Electric Mobility (SEM) market is composed of four main groups. Currently, the SEM market is dominated by (e-)car sharing providers, which correspond to the first group in our SeMPs classification. In total, 79 SeMPs (58% of the total providers in our study) offer (e-)car sharing services (including 64 providers that exclusively offer this type of service, and 40 SeMPs that offer only EVs in their fleets). The second group is composed of 46 Micro (e-)Mobility Sharing (MeMS) providers, which are 33% of the total providers in our study (including 30 MeMS providers that exclusively offer this type of service and also 30 that offer only micro EVs).

The third group corresponds to Multi Transport Integrators (MTIs) which in total compose 16% of the SeMPs analysed in our study (22 MTIs in total, including 19 MTIs that offer shared (electric) mobility options within their service). Finally, Multimodal Trip Planners (MMTPs) compose the 9% of the total SeMPs in our study (13 MMTPs in total), including 3 providers that exclusively offer this type of service.

Table 2 below shows a sub-classification within the aforementioned groups. This sub-classification is focused on the type of vehicles offered by the SeMPs (i.e. electric, non-electric, Light Electric Cars (LECs) or public transport), and on the combination of (e-)mobility services. In total, 51% of the SeMPs included in our study use only EVs for the mobility service and only 2% (3 out of 136) do not offer shared (electric) mobility options in the form of passenger cars or micro mobility vehicles. However, those three SeMPs do include (electric) public transport (e.g. train, tram) mobility options in their mobility service. As an important remark, in total, 111 providers (81% of the total SeMPs analysed in our study) offer only one type of shared (electric) mobility service.

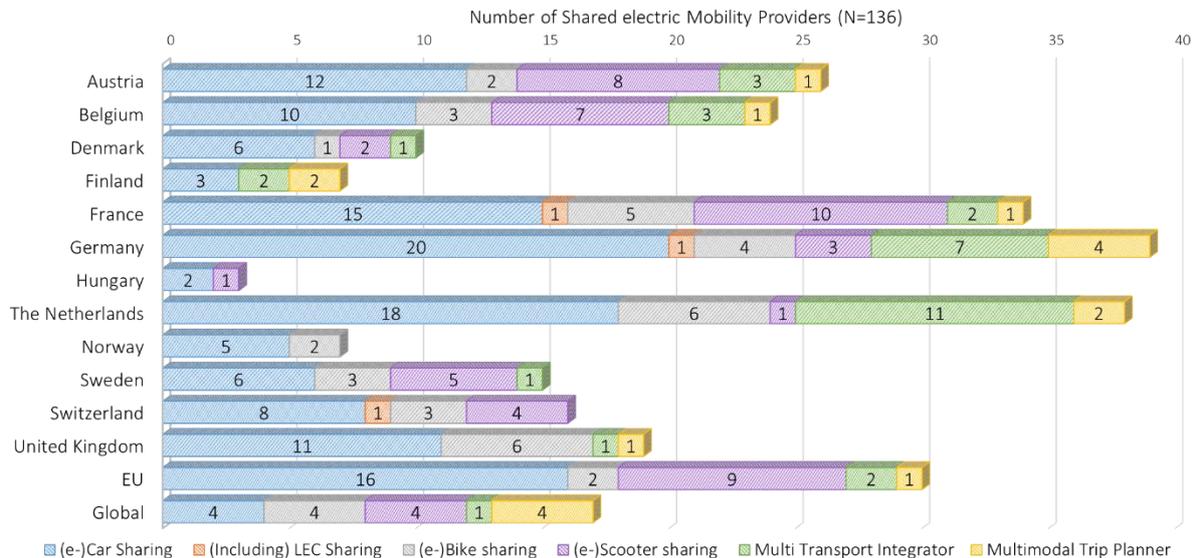
Table 2. Number of SeMPs in our study that offer the below-mentioned mobility services*.

<u>(e-)Car sharing (Total = 79)</u>		<u>Multi Transport Integrators (Total = 22)</u>	
Only e-cars	40	Including some shared EVs (excl. PT)	19
Some e-cars	39	Including only shared EVs (excl. PT)	0
(e-)Car sharing including LECs	1	Including public transport	18
+ other (e-)mobility services	15	Established by public transport operator	7
<u>Micro electric Mobility Sharing (Total = 46)</u>		+ other (e-)mobility services (have a MMTP)	
Only micro-EVs	30	<u>Multimodal Trip Planer (Total = 13)</u>	
Some micro-EVs	16	Including shared (with only EVs) mobility options	0
(e-)Bike sharing	23	Including shared (non-electric) mobility options (excl. PT)	5
(e-)Scooter sharing	20	Including shared (with some EVs) mobility options (excl. PT)	7
(e-)Kick scooter sharing	8	With no shared (e-)mobility options (excl. PT)	1
(e-)Moped sharing	12	Owned by Transport Operator	5
LEC sharing	2	+ Other (e-)mobility service(s)	10
+ Other (e-)mobility service(s)	16		

* Some SeMPs offer more than one mobility service
 - Total SeMPs in our study: 136

- EV: Electric Vehicle
 - MMTP: Multimodal Trip Planner
 - LECs: Light Electric Cars
 - PT: Public Transport

A classification by country is also part of the results of the analysis. A list with all SeMPs, distributed by each country where they are present, is shown in the Appendix B. In addition Fig. 2 shows the total number of SeMPs distributed by their mobility service in each country. Some providers are available in more than one country in Europe, in that case such SeMPs are considered in the graph for each country where they operate and for the “EU” bar in the graph. The same condition applies for SeMPs that are available in more than one continent. In that case, providers are counted in each country where they operate and also counted for the “Global” bar in the graph.



Notes:

- Some SeMPs are available in more than 1 country. SeMPs are listed for each country where they operate.
- EU: Providers operating in at least 2 countries in Europe.
- GLOBAL: Providers operating in at least 2 continents.
- (e-)Car Sharing: Including corporate (e-)car sharing, P2P (e-)car sharing, and e-car rental providers.
- LEC: Light Electric Car. Only in France and Switzerland there is one provider that offers LEC sharing. In Germany, LEC sharing is provided as part of an e-car sharing provider (e-WALD) service.
- (e-)Scooter sharing: Including e-kick scooters and (e-)mopeds.
- (e-)Bike sharing: Including corporate (e-)bike sharing, (P2P) (e-)bike sharing, and two bike sharing providers (INDIGO weel & VelHop) that offer another kind of shared (e-)mobility service.

Fig. 2 Number of Shared (electric) Mobility Providers by country where they are present

As depicted in Fig. 2, our findings show that Germany and The Netherlands are leading the shared electric mobility market both with 36 SeMPs. Austria, Belgium and France are also in a good position in the market with 24, 20 and 30 SeMPs respectively. These first 5 countries are the only ones in our study that offer all four different types of (e-)mobility services as classified before (i.e. (e-)car sharing, micro (e-)mobility sharing, multi transport integrators and multimodal trip planners). An average number of SeMPs can be found in Denmark (with 11 SeMPs), Sweden (with 12 SeMPs), in Switzerland (with 14 SeMPs) and in the United Kingdom with 17 SeMPs. Finally, the rest of the countries in our analysis have less than 7 SeMPs, being Hungary the last in the list with only 3 SeMPs. According to our findings, 16 SeMPs operate at a global level (i.e. in at least two different continents) and 34 SeMPs have operations in at least 2 countries within Europe.

Accordingly with what was shown before in Fig. 1, (e-)car sharing providers dominate the shared electric mobility market. Another interesting insight is the number of (e-)scooter sharing providers, which is the second largest group. (e-)Scooter providers are available in almost every country within our study (the exception are Finland, Norway and the United Kingdom), being France the country with the most (e-)scooter sharing services (10 in total). Similarly, (e-)bike sharing providers are not available only in two countries: Finland and Hungary. Countries with more (e-)bike sharing providers are The Netherlands and the United Kingdom with 6 providers each. Finland is the only country in our study with no shared micro electric mobility providers.

Regarding Multi Transport Integrators (MTIs), The Netherlands and Germany are leading the market, with 11 and 7 MTIs respectively. As shown in Table 2, most of the MTIs in our study include shared (electric) vehicles and some of them even have their own MMTP. In this sense, MTIs are the closest to an eMaaS provider as described in our working definition of eMaaS. Therefore, it can be argued that both Germany and The Netherlands, are leading the (still-under-development) eMaaS market. On the other hand, the rest of the countries within the scope of our study are (with less than 3 MTIs with shared (electric) mobility options included, in each country) clearly lagging behind regarding the development of an eMaaS market. This is especially the case for Hungary, Norway and Switzerland where no MTIs with shared (electric) mobility options included are available in the market.

Business Models of Shared electric Mobility Providers (SeMPs)

In this section a quantitative analysis based on the criteria presented in section 2 (see Table 1) is conducted. This analysis consist of a comparative exercise between BMs' characteristics from 85 SeMPs. With the results of the exercise, conclusions can be drawn about key competitive characteristics of such BMs. Fig. 3 shows the distribution of the BM criteria within the selected SeMPs.

The first two criteria to look upon are the mobility service and market model of the providers in our market study. As depicted in Fig. 3-b), the majority of SeMPs in our sample (78%) operate within the Business to Consumer (B2C) market. Also, as depicted in Fig. 3-b) (and accordingly to what previously shown in Fig. 1 and Fig. 2), (e-)car sharing is the mobility service that most providers within the shared (electric) mobility market offer (64%). An important remark here is that SeMPs usually combine different BMs' characteristics within single criterion. For example, 45% of SeMPs operate within both the B2C and the Business to Business (B2B) market. Similarly, 23% of SeMPs in our BM study offer more than one (electric) mobility service.

In relation to the parking model, as depicted in Fig. 3-c), our findings show that "station-based" schemes are offered much more than "free-floating" schemes which are only offered by 23% of the SeMPs in our analysis. Regarding payment models, as depicted in Fig. 3-d), most providers (85%) offer a "pay-as-you-go" scheme and most of them do not charge a registration fee (62%). When it comes to the vehicles offered, our market study is focused only on mobility providers that offer the possibility to use electric vehicles. In this sense, as depicted in Fig. 3-f), our findings show that most SeMPs (61%) are only using some EVs as part of their regular fleets. As stated before, this is mainly the case for MTIs and for SeMPs shown in multimodal trip planners. On the other hand, micro (shared) mobility providers offer mainly EVs for their services. With respect to the pricing model, as depicted Fig. 3-e), all SeMPs base their prices on the time of usage, being the most common pricing model by hour (67% of SeMPs). Additionally, some SeMPs (54%) also base their prices on the distance (i.e. total km) of the trip.

Finally, a key characteristic of future eMaaS providers is the Information and Communication Technologies (ICT) that they include as part of their BM. In this regard, as depicted in Fig. 3-g), our study shows that most of the SeMPs (64%) already offer the possibility either to plan a trip, to locate a vehicle, to open or close a vehicle, to lock or unlock a vehicle, to book a trip or vehicle, to pay for a trip, or to do all of these actions via a mobile app. Another ICT function that SeMPs usually offer is the possibility to open or unlock a vehicle without a key. In this case, as also depicted in Fig. 3-g), 44% of SeMPs offer the user a smart card to access the vehicle and 41% have

the technology to access the vehicle via a mobile phone. Similarly, for most of the SeMPs we investigated (62%), booking is possible via the mobile app.

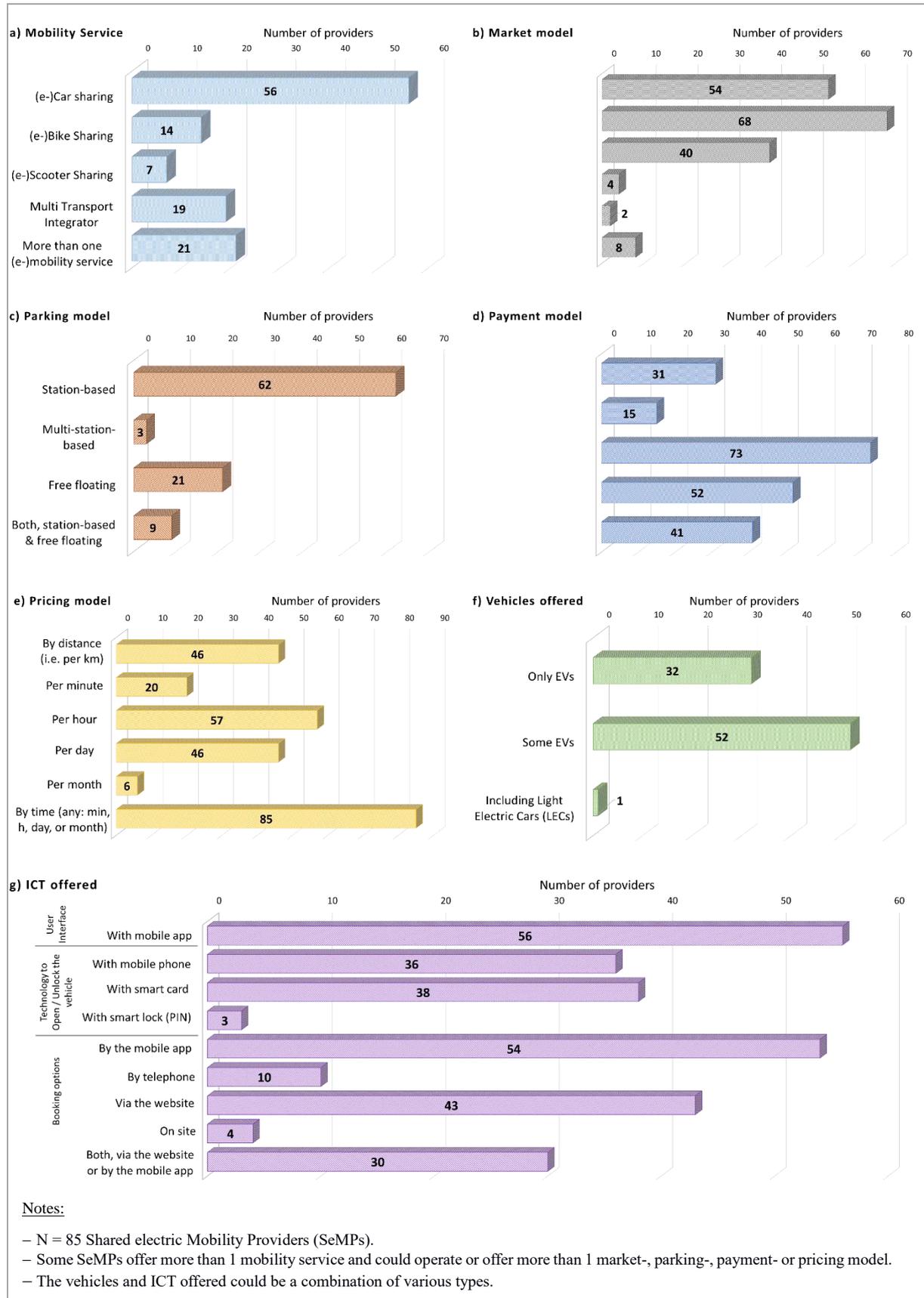


Fig. 3 Business Model' elements in the Shared (Electric) Mobility market

3.2. (electric) Mobility Mobile Apps (MMAs)

In this section we review 93 (electric) Mobility Mobile Apps (MMAs). From that total, 90 MMAs correspond to SeMPs studied in the previous section, and the rest 3 correspond to Multimodal Trip Planners (MMTPs). The difference between the analysis presented in the previous section for SeMPs, and the analysis presented in this section, lies on the assessment criteria for each group under study. The criteria for the analysis of SeMPs are based on their business model, whereas the criteria for the analysis of (electric) MMAs are based on their functionalities. The complete list of (electric) MMAs included in our study, including a reference to their corresponding SeMP, is shown in the Appendix A1.

Similar to the analysis done for SeMPs, we firstly made a classification of (electric) MMAs according to the service they offer. Fig. 4 below shows the basic distribution of such apps according to that criterion. An important observation regarding MMAs is that, under this group, Mobility Transport Aggregators (MTAs) are included. MTAs are mobility-related service providers, usually in the form of a mobile app or website, that offer an overview of different transportation providers available within certain area but do not offer a transportation service. MTAs can also include a MMTP in their interface.

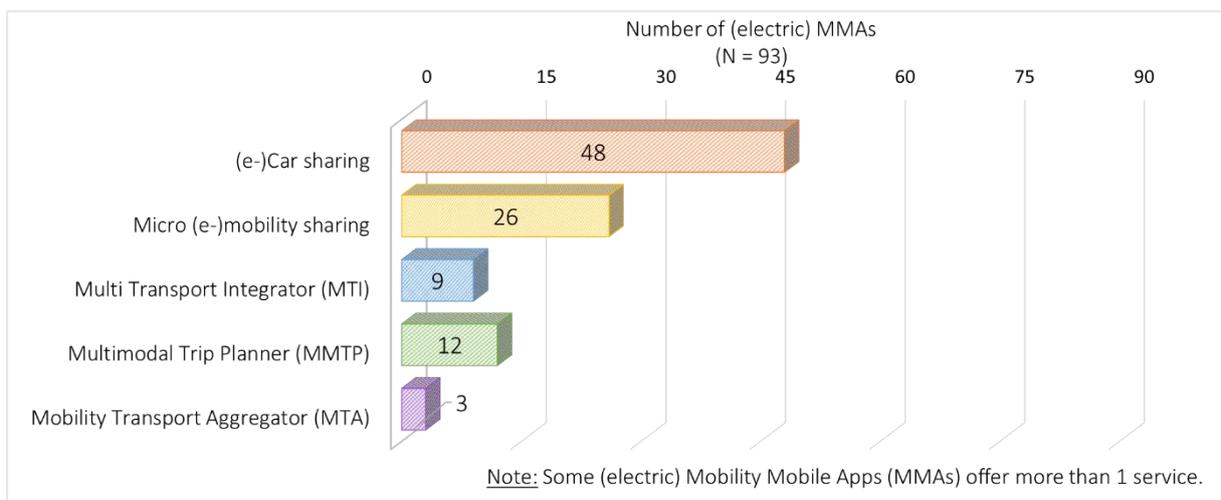


Fig. 4 Number of (electric) Mobility Mobile Apps by the type of service they offer

In accordance with what was also previously shown in Fig. 1, (e-)car sharing providers dominate the (electric) MMAs market. In this case, 51% of the apps come from (e-)car sharing providers; 27% from micro (e-)mobility sharing providers; 12% from Multimodal Trip Planners (MMTPs); and finally, 9% and 3% of (electric) MMAs come from Multi Transport Integrator (MTIs) and MTAs providers, respectively. As with SeMPs, some (electric) MMAs are linked to more than one (electric) mobility service.

Next, our study looks into the number of users and the rating of (electric) MMAs. With this information, we want to offer insight into the user preferences and the most successful (electric) mobility business models. For example, aiming to highlight the most downloaded (electric) MMAs, Fig. 5 shows the Top 4 most downloaded (electric) MMAs in the *Google Play* marketplace. An overview of the number of downloads of all MMAs included in our study is presented in Table 3 on the following page.

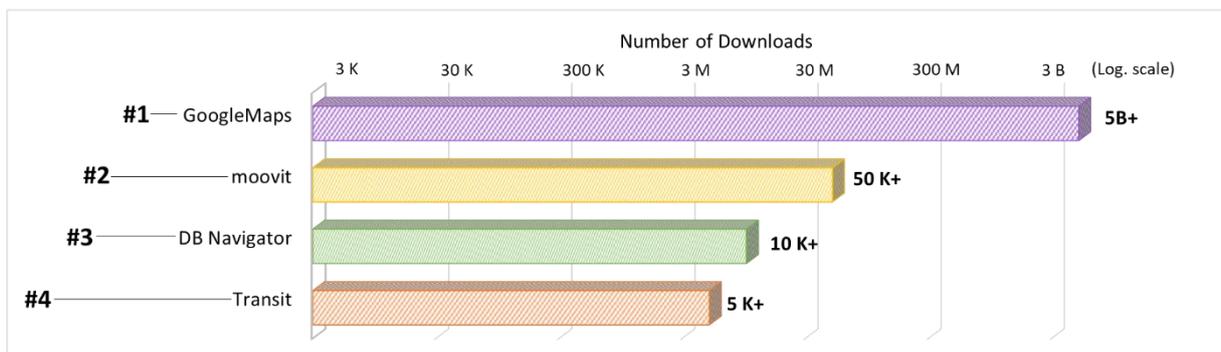


Fig. 5 Top 4 most downloaded (electric) Mobility Mobile Apps (MMAs) in the *Google Play* marketplace (as of April 2019).

Not surprisingly, the well-known *Google Maps* mobile app is the most downloaded (electric) MMA in the market. *Google Maps* does not only allow users to locate a place (almost) anywhere around the world, but it also serves as a Multimodal Trip Planner (MMTP) that includes the possibility to plan a journey using shared electric mobility options (i.e. shared electric kick scooters and shared electric bikes). With more than 5 billion downloads, *Google Maps* is by far the preferred (electric) MMA by users all around the world for planning their mobility.

In second place, *moovit* is also a MMTP. The *moovit* app focuses on public transport mobility but also includes shared mobility options (bike sharing) in some cities around the world. In third place, *DB Navigator* is another MMTP. It focuses on public transport and is only available for the German network. The *DB Navigator* app is also part of the offer to business users of the Multi Transport Integrator *DB Connect* which includes car sharing and bike sharing mobility options. In fourth place, *Transit* is another MMTP. With *Transit* users can plan their trips using public transport, buy a shared bike pass, request a ‘ride-hailing’ car, or book a shared car.

Finally, the fifth place of the Top 5 most-downloaded (electric) MMAs is shared by seven mobile apps. Interesting to see is that among those seven apps there are two more MMTPs, which operate at a local level (*HVV* in Hamburg and *NS* in The Netherlands). The other five MMAs are mobile apps from Shared electric Mobility Providers that operate at a global level. 3 MMAs from (e-)car sharing providers (*Car2Go*, *TURO* and *Zipcar*) and 2 MMAs from micro e-mobility sharing providers (*Bird* and *Lime*). For a more general overview, Table 3 below shows a classification of all the (electric) MMAs included in our analysis based on the number of downloads in the *Google Play* marketplace.

Table 3. Overview of all (electric)MMAs included in the market analysis based on the number of downloads in the *Google Play* marketplace (ordered in groups from bigger to smaller number of downloads and alphabetically in each group)

More than 5,000,000		1M+ from 1,000,001 to 5,000,000		(500k+) from 500,001 to 1,000,000	
1. DB Navigator (10M+)	3. Moovit (50M+)	5. Bird	9. NS	12. DriveNow	14. Free2move
2. Google Maps (5B+)	4. Transit (5M+)	6. Car2Go	10. TURO	13. Drivy	15. Moovel
		7. HVV	11. Zipcar		
		8. Lime			

(100k+) from 100,001 to 500,000		(50k+) from 50,001 to 100,000		(10k+) from 10,001 to 50,000		(5k+) from 5,001 to 10,000	
16. blinkee.city	26. mobility	37. Cambio	40. Bluely	49. Nabobil	58. BerlinMobil		
17. Cityscoot	27. myVRN	38. emmy	41. Felyx	50. Poppy	59. Bluecub		
18. coup	28. TaM	39. SnappCar	42. GreenGo	51. Scooty	60. Catch A Car		
19. Enterprise car club	29. TIER		43. Green Mobility	52. Spinlister	61. Milo		
20. Flinkster	30. TripGo		44. GreenWheels	53. stadtmobil	62. MyWheels		
21. GoMore	31. Urbi		45. HiyaCar	54. TADAA!	63. ÖAMTC easy way		
22. GVH	32. Velib		46. Kyyti	55. TeilAuto	64. Sco2t		
23. Hertz 24/7	33. voi		47. MOL Limo	56. Troty	65. Totem Mobi		
24. IINDIGO weel	34. wegfinder		48. Moov'in.paris	57. Whim			
25. JUMP	35. WienMobil						
	36. WIND						

(1k+) from 1,001 to 5,000		(500+) from 501 to 1,000		(100+) from 101 to 500		(10+) from 10 to 100	
66. aimo	73. GoAbout	80. Enuu	87. Juuve	92. privateshare			
67. Billy	74. goUrban	81. MoveAbout	88. Onzeauto	93. Shuttel			
68. Carvelo 2 Go	75. MOBILEEEEE	82. OP-yhteisauto	89. TURNN				
69. Co-wheels	76. Share a starcar	83. City Roul	90. Combitrip				
70. GoodMoovs	77. UFO Drive	84. LetsGo	91. Share2use				
71. E-Car Club	78. Urbee	85. Partago CVBA					
72. Eko-Rent	79. ZenCar	86. Sharetoo					

In addition, Fig. 6 shows the Top 10 best-rated (electric) MMAs according to the rating given by their own users in the *Google Play* marketplace (as of April 2019). The highest possible rate is 5. In Fig. 6, a higher or lower position in the ranking, when the same rating has given to the MMAs, depends on the percentage of users that have rated them in relation to the total number of downloads of the MMA. The complete list of (electric) MMAs and their rating can be found in Table 4 in the Appendix A2.

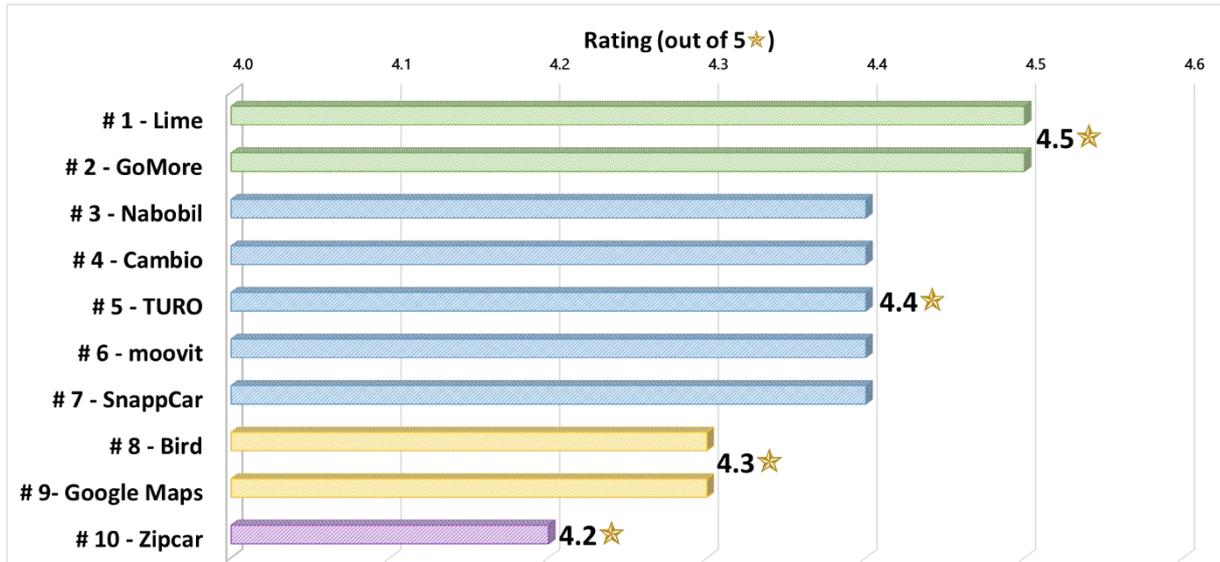


Fig. 6 Top 10 best-rated (electric) Mobility Mobile Apps in the market (with more than 100 reviews)

An interesting remark from Fig. 6 is that, contrary to the Top 5 most-downloaded (electric) MMAs' graph which is clearly dominated by Multimodal Trip Planners (MMTPs), the Top 10 best-rated (electric) MMAs' graph is led by a MMA from a micro e-mobility sharing provider (*Lime*) and most of the (electric) MMAs in the graph come from (P2P) (e-)car sharing platforms (*GoMore*, *Nabobil*, *TURO*, *SnappCar*). Nonetheless, two MMAs from MMTPs (*Google Maps* and *moovit*) appear in both graphs. Similarly, two out of the three (e-)car sharing providers present in the previous graph also appear in this graph (*TURO* and *Zipcar*). Both micro (e-)mobility sharing providers present in the Top 5 most-downloaded MMAs' graph also appear in this Top 10 best-rated MMAs' graph (*Bird* and *Lime*).

A final remark regarding our analysis of SeMPs and (electric) MMAs is that the shared electric mobility market is very dynamic. Only during the course of our investigation (September 2018 – April 2019) some mobility providers changed their business model (e.g. *Car2Go* is now active in the B2B market). Other SeMPs added new services (e.g. *Mobike* added e-bikes in 2019). Others shut down operations (e.g. *Zipcar* in Barcelona, Brussels and Paris; *IONIQ* in Amsterdam; *BattMobile* in Lyon; *easyCar club* in the UK). Others expanded operations (e.g. *BIRD* started a pilot in Paris and is now present in many cities in Europe; e-bikes and e-kick scooters from *JUMP* (Micro e-mobility trademark of *UBER*) are now available in Berlin & Lisbon and Madrid & Paris respectively; *Lime* is now available in Portugal, South America, and in more cities in EU). Others changed name (e.g. *Auto Bleue* changed to *izzie*, *Moovel* changed to *ReachNow*). And others even joined services with competitors (e.g. the two largest car sharing companies in Europe *DriveNow* and *Car2Go* are now branded together as *ShareNow*). Also, some new operators entered the SEM market (e.g. *Moov'in.paris* in Paris, *aimo* in Stockholm, and *TIER* started in Vienna and is now available in many cities in Europe). Especially the e-scooter market is growing very fast, examples of new (as of April 2019) operators are *dott* and *Flash* which operate in Brussels and some other European cities.

3.3. An effective Business Model for electric Mobility as a Service (eMaaS) providers

In this section we conduct a qualitative analysis that cross-references the results of the Business Models' (BMs) analysis of Shared electric Mobility Providers (SeMPs) investigated in §0 with the outcomes of the analysis over (electric) Mobility Mobile Apps presented in §3.2. With this analysis we aim to translate the characteristics of BMs that successfully compete in the shared electric mobility market into an exemplification of an effective BM that future electric Mobility as a Service (eMaaS) providers can use as a reference when building up their business' strategies to enter the eMaaS market.

As starting point, we made a selection of the top SeMPs in our study. For this selection we took into account three criteria. Firstly, based on our working definition of eMaaS and the analysis presented in §3.2, we only considered SeMPs that have a mobile app. Secondly, we only considered the SeMPs with MMAs rated with at least 4 out of 5 stars. And thirdly, we only considered SeMPs with a mobile app that have more than 50,000 downloads. SeMPs

in the selected group are not necessarily the only ones in our study with successful BMs, but they certainly have a background that has been proven (by the number of users and the rating they have received) successful. A downside of the criteria considered for this analysis, though, is that the number of downloads of a mobile app could not necessarily (or directly) reflect the actual number of users of the SeMP or the actual usage of the MMA.

The result of our selection comprises 19 SeMPs from which we made an analysis of their BMs based on the criteria presented in Table 1. The list of the top SeMPs included in this analysis can be found in the Appendix A1 of this paper. For the definition of an effective eMaaS business model, we only considered the BM's elements that more than 50% of the SeMPs investigated here shared in common. Based on such elements, Fig. 7 depicts an exemplification of what an effective business model for future eMaaS providers would be.

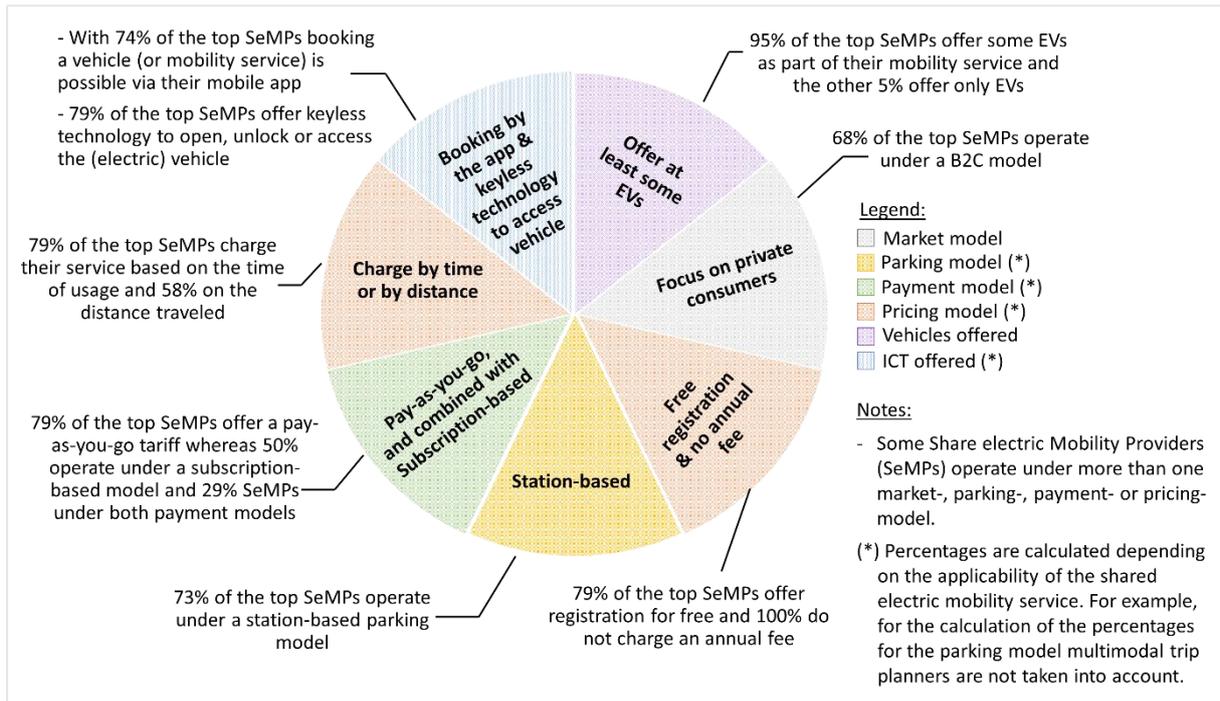


Fig. 7 Exemplification of an effective business model for future electric Mobility as a Service (eMaaS) providers based on the analysis of top Shared electric Mobility Providers (SeMPs)

As shown in Fig. 7, top SeMPs have many business models' elements in common. A remarkable example is that none of the top SeMPs charge an annual fee for its service (additional to its regular time-based subscription). And of course, since our work is focused on electric mobility, all of them also have in common that they offer at least some electric vehicles as part of their mobility options.

From the figure we can also observe that the same (high) percentage of SeMPs (79%) do not charge a registration fee, (when applicable) they offer keyless technology to access their vehicles and (when applicable) they charge their service based on the time of usage (i.e. per minute, per hour or per day). On a lower degree, but still the great majority of top SeMPs (74%) offer the possibility to book their mobility service directly in their mobile app.

Interesting to notice is that (when applicable) most SeMPs operate under a station-based parking-model (73%) and under a pay-as-you-go payment model (79%). In accordance with the results previously shown in §0, this analysis also shows that most of the top SeMPs (68%) operate under a business to consumer (B2C) model.

As a final remark, this analysis also showed that 84% of the top SeMPs focus their business only on one (e-)mobility service. In pursuit of becoming eMaaS providers, this situation should change and many more electric mobility services must be integrated among SeMPs.

4. Concluding remarks and future work

4.1. Concluding remarks

Based on a qualitative analysis, we determined the key elements of successful Business Models (BMs) currently used in practice. Our findings demonstrated that the electric Mobility as a Service (eMaaS) market can be founded on the characteristics of current Shared electric Mobility Providers (SeMPs). Furthermore, based on an analysis focused on the Business Models (BMs) of the top SeMPs found in our study, we presented an exemplification of an effective Business Model for future eMaaS providers. Such an exemplification can be used as a reference, not only by SeMPs interested in joining the eMaaS market but also by other stakeholders (such as policy makers, researchers or potential users) who are interested in better understanding the value proposition and business models behind eMaaS. In this sense, it can be considered the current BMs' characteristics of SeMPs contribute to the further development of eMaaS both from a business perspective and from a learning perspective.

Evidence suggests that four main groups are already active within the eMaaS market. In its current state, these groups are led by (e-)car sharing providers, followed by Micro (e-)mobility providers and finally by Multi Transport Integrators (MTIs) and Multimodal Trip Planners (MMTPs). However, based on the users demands and expectations (which gave birth to the concept of eMaaS in the first place), it is predictable that the amount of MTIs and MMTPs will significantly increase in the coming years.

In our BM analysis we included Multi Transport Integrators, but this kind of mobility service providers might need different BM evaluation criteria. The reason for this is that these providers offer many mobility services at the same time, therefore the criteria considered in this study are not always applicable. Furthermore, in our study we encountered many Multimodal Trip Planners (MMTPs); all countries we researched have at least one mobile app or on-line platform that allow users to plan their trip, and in many cases booking or buying a ticket is also possible. However, the great majority of MMTPs do not yet include shared electric mobility options. Most MMTPs only cover public transport routes. In a few cases MMTPs include (non-electric) bike sharing, (non-electric) car sharing, (non-electric) taxi or (non-electric) ride-hailing options (like *Uber* or *Lyft*). The results of our research show that, in Europe, only *Urbi*'s and *Google Maps*' MMTP allow to plan a (multi-leg) journey including shared (e-)mobility options. Nevertheless, some MMTP such as the one by *VRN*, *Wiener Linien* and *TaM* show nearby shared (e-)cars in their MMTP map. These locations might be taken into account by the users when planning their journey, but planning a (multi-leg) door-to-door route that includes the (actual) usage of a shared (e-)vehicle is not possible.

Regarding Multi Transport Integrators (MTIs), only 3 SeMPs (*HVV*, *MobilityMixx* and *Whim*) do not include shared electric mobility options (excluding electric public transport). Especially in Germany and The Netherlands, where most of the MTIs with shared (electric) mobility services and public transport are included, forthcoming eMaaS providers can already find a solid market (with respect to electric vehicles and charging infrastructure) where they can develop. Currently, most of the MTIs found in our study operate under a Business to Business (B2B) model. In fact, the only MTI found in our study that operates globally (*Urbi*), offers its multi transport services only for business, whereas its service as Mobility Transport Aggregator (MTA) is also offered within a Business to Consumer (B2C) model. With the further development of (e)MaaS we also expect this situation to change and that many MTI include a Business to Consumer (B2C) offer in their business model.

In our market study we limited the inclusion and analysis of Public Transport Operators (PTOs) to electric and non-single-mode PTOs. We believe that PTOs will play a key role in the eMaaS market but only when they integrate shared electric mobility options into their mobility services, or the other way around, when Shared electric Mobility Providers (SeMPs) include PTOs as part of their mobility services. PTOs-SeMPs integration is already happening in some of the countries we reviewed. For example, out of the 22 MTIs reviewed in our analysis only 4 do not include PTOs (*Moovel*, which removed PTOs from its services in March 2019; *Switchh*, *tim* and *Urbi*) as part of the mobility options for the users.

Another important observation is that the shared electric mobility market is very dynamic. These dynamics might, on the one hand, limit the accuracy of the data presented in this paper to a short period of time. On the other hand, they prove the importance of having well-founded BMs that ensure Mobility Service Providers (MSPs), including SeMPs, to remain competitive in the market. Furthermore, since the (e)MaaS market is expected to be a collaborative market, if SeMPs are willing to enter this market their BM should be flexible enough to deal with its dynamism while at the same time be structured in a way that allows for open collaboration with other mobility and mobility-related service providers.

In conclusion, it can be argued that there is already a well-established shared-electric-mobility market in Europe that will definitely be beneficial for the further development of eMaaS. However, Shared electric Mobility Providers (SeMPs) are only one part of eMaaS. To make the eMaaS concept a reality, all those SeMPs should not only interact within the same market but they should be able to integrate with each other. One of the core ideas behind eMaaS is that users can access the services of multiple SeMPs at the same time, and without the hassle of following different kind of procedures for each of the services provided. With the analysis presented in this paper, SeMPs can identify their competitors and their business models, and think about possible manners of integrating them into their own offer and how to combine them all in a one-stop electric mobility service as proposed by eMaaS.

4.2. Future work

During the course of our investigation we encountered many providers from European countries outside the scope of our analysis (especially in Italy and Spain), as future work, it might be convenient to add Shared electric Mobility Providers (SeMPs) from such countries in order to make this study more robust. In addition, an extended analysis that includes SeMPs such as traditional (e-)car rentals, e-ride sharing and e-ride hailing, might also give valuable insights for the further development of eMaaS.

Moreover, with the database formed as a result of this market study many future analyses can be conducted. For example, the database can be used to make an analysis of the level of integration of these providers regarding the levels of MaaS as presented in the literature (for example by Kamargianni et al. (2016) or Sochor et al. (2017)). The authors of this paper are now working on this kind of study, including an extended business models' analysis concerning the mobility mobile apps presented in this paper.

Declarations

Availability of data and materials

All data analysed during the current study come from publicly available websites. The datasets generated for the accomplishment of this work are available from the corresponding author on reasonable request.

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Competing interests

The authors declare that they have no competing interests

Authors' contributions

JRRG conducted most of the market research; collected, processed and analysed most of the data; and was the major contributor in writing the manuscript. SH contributed in the collection and processing of some data and had substantively revised the data analysis and the manuscript in general. MWW collected and processed some data and revised the manuscript. GMB had substantively revised the manuscript. All authors read and approved the final manuscript.

References

- Abdelkafi, N., Makhotin, S., & Posselt, T. (2013). Business model innovations for electric mobility — What can be learned from existing business model patterns? *International Journal of Innovation Management*, 17(01), 41. <https://doi.org/10.1142/S1363919613400033>
- Briggs, M. (2015). Future of Mobility Introducing the New Business Models Revolutionising Urban Mobility. *Frost & Sullivan*.
- Burrows, A., Bradburn, J., & Cohen, T. (2015). *Journeys of the Future - Introducing Mobility as a Service*. Retrieved from https://www.atkinsglobal.com/~media/Files/A/Atkins-Corporate/uk-and-europe/uk-thought-leadership/reports/Journeys of the future_300315.pdf
- Cohen, B., & Kietzmann, J. (2014). Ride On! Mobility Business Models for the Sharing Economy. *Organization &*

- Environment*, 27(3), 279–296. <https://doi.org/10.1177/1086026614546199>
- Durand, A., Harms, L., Hoogendoorn-lanser, S., & Zijlstra, T. (2018). *Mobility-as-a-Service and changes in travel preferences and travel behaviour : a literature review*.
- eMaaS project. (2018). electric Mobility as a Service. Retrieved November 15, 2018, from <http://www.emaas.eu/>
- Freese, C., & Schönberg, A. T. (2014). *Shared Mobility - How new businesses are rewriting the rules of the private transportation game. Think Act*. Munich, Germany.
- Frost & Sullivan. (2016). Infographic: Future of Carsharing Market to 2025. Retrieved September 20, 2018, from <https://store.frost.com/future-of-carsharing-market-to-2025.html>
- Gartner. (2018). Gartner Says Huawei Secured No. 2 Worldwide Smartphone Vendor Spot, Surpassing Apple in Second Quarter 2018. Retrieved September 14, 2018, from <https://www.gartner.com/en/newsroom/press-releases/2018-08-28-gartner-says-huawei-secured-no-2-worldwide-smartphone-vendor-spot-surpassing-apple-in-second-quarter>
- Jittrapirom, P. (2018). Future implementation of Mobility as a Service (MaaS): Results of an international Delphi study. *Travel Behaviour and Society Journal*. <https://doi.org/10.13140/RG.2.2.33918.89924>
- Jittrapirom, Peraphan, Caiati, V., Feneri, A.-M., Ebrahimigharehbaghi, S., González, M. J. A., & Narayan, J. (2017). Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges. *Urban Planning*, 2(2), 13–25. <https://doi.org/10.17645/up.v2i2.931>
- Kaas, H.-W., Mohr, D., & Gao, P. (2016). *Automotive revolution-perspective towards 2030*. Retrieved from [https://www.mckinsey.com/~media/mckinsey/industries/high tech/our insights/disruptive trends that will transform the auto industry/auto 2030 report jan 2016.ashx](https://www.mckinsey.com/~media/mckinsey/industries/high%20tech/our%20insights/disruptive%20trends%20that%20will%20transform%20the%20auto%20industry/auto%202030%20report%20jan%202016.ashx)
- Kamargianni, M., Li, W., Matyas, M., & Schäfer, A. (2016). A Critical Review of New Mobility Services for Urban Transport. *Transportation Research Procedia*, 14(0), 3294–3303. <https://doi.org/10.1016/j.trpro.2016.05.277>
- Karlsson, I. C. M. M., Sochor, J., & Strömberg, H. (2016). Developing the “Service” in Mobility as a Service: experiences from a field trial of an innovative travel brokerage. *Transportation Research Procedia*, 14, 3265–3273. <https://doi.org/10.1016/j.trpro.2016.05.273>
- König, D., Eckhardt, J., Aapaoja, A., Sochor, J., & Karlsson, M. (2016). *MAASiFie: Business and operator models for MaaS (Deliverable nr. 3)*. Retrieved from https://www.vtt.fi/sites/maasifie/PublishingImages/results/cedr_mobility_MAASiFiE_deliverable_3_revised_final.pdf
- Lane, C., Zeng, H., Dhingra, C., & Carrigan, A. (2015). *CarSharing - A Vehicle for Sustainable Mobility in Emerging Markets?* Retrieved from https://www.wri.org/sites/default/files/WRI_Report_Carsharing.pdf
- Laurischkat, K., Viertelhausen, A., & Jandt, D. (2016). Business Models for Electric Mobility. <https://doi.org/10.1016/j.procir.2016.03.042>
- Peng, B. (2017). *Car sharing business - Development trends, business model and solutions*.
- PwC. (2017). *The 2017 Strategy& Digital Auto Report - Fast and furious: Why making money in the “roboconomy” is getting harder*. Retrieved from www.strategyand.pwc.com
- Reyes García, J. R., Lenz, G., Haveman, S., & Bonnema, G. M. (2019). State of the art of electric Mobility as a Service (eMaaS): an overview of ecosystems and system architectures. In *Proceedings of the Electric Vehicle Symposium EVS32*.
- Sarasini, S. (2018). *iMove - Deliverable D1.2 Sustainable MaaS Business Model - a typology (part 1)*.
- Sarasini, S., Langeland, O., Viktoria, R., & Langeland, O. (2015). Business model innovation for car sharing and sustainable urban mobility, 1–28. Retrieved from https://www.viktoria.se/sites/default/files/pub/viktoria.se/upload/publications/ist_2017_sarasini_langeland_ds.pdf
- Schiller, T., Scheidl, J., & Pottebaum, T. (2017). Car Sharing in Europe - Business Models, National Variations and Upcoming Disruptions. *Monitor Deloitte*, (6), 1–8.
- Smith, G., Sochor, J., & Karlsson, I. C. M. (2019). Intermediary MaaS Integrators: A case study on hopes and fears. *Transportation Research Part A: Policy and Practice*. <https://doi.org/10.1016/j.tra.2019.09.024>
- Sochor, J., Arby, H., Sarasini, S., & Sochor, V. (2017). A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals. In *ICoMaaS Proceedings* (pp. 187–208). Retrieved from https://www.viktoria.se/sites/default/files/pub/viktoria.se/upload/publications/sochor_et_al_2017.pdf
- Teece, D. J. (2010). Business Models, Business Strategy and Innovation. *Long Range Planning*, 43(2–3), 172–194. <https://doi.org/10.1016/J.LRP.2009.07.003>
- Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, 37(4), 1019–1042. <https://doi.org/10.1177/0149206311406265>

Appendix A – List of Shared electric Mobility Providers, (electric) Mobility Mobile Apps and Mobility-related technology providers

A.1 – Shared electric Mobility Providers (SeMPs)

The list presented below shows the Shared electric Mobility Providers (SeMPs) and Mobility Mobile Apps (MMAs) included in our market analysis. The “e-” and “(e-)” in front of the mobility service description indicate whether the SeMP includes exclusively EVs when providing its mobility service or only some EVs, respectively. SeMPs marked with an asterisk (*) next to its name were selected for the BM analysis presented in §0, and SeMPs shown with the text “TOP” next to its name were selected for the exemplification of an eMaaS BM in §3.3. SeMPs marked with a mobile phone symbol (☐) next to its name have a mobile app which was also included in the MMA analysis presented in §3.2. SeMPs marked with a mobile phone symbol between square brackets [☐] next to its name have a mobile app but it is not available in the *Google Play* mobile app marketplace and therefore was not included in the MMA analysis presented in §3.2. The rest of MMAs included in our study are presented at the bottom of the SeMPs’ list.

Shared (e-)Mobility Provider	Type of (e-)Mobility Service		
1. 2EM	(P2P) (e-)Car sharing	42. elektrip *	e-Car sharing (incl. LEC Sharing) and e-ride sharing
2. aimo * ☐	e-Car sharing	43. emmy ☐	e-Scooter sharing (Moped)
3. Amber * [☐]	e-Car sharing	44. Enuu ☐	LEC Sharing
4. Auto Bleue (izzie)	e-Car sharing	45. Enterprise car club * ☐ TOP	(e-)Car sharing
5. BattMobiel [☐]	(shared) e-Car leasing and (e-)bike leasing	46. Family of Power *	e-Car sharing
6. Bilkollektivet *	(e-)Car sharing and e-bike sharing	47. Felyx * ☐	e-Scooter sharing (Moped)
7. Billy ☐	e-Bike sharing	48. Flinkster * ☐	(e-)Car sharing
8. Bird * ☐ TOP	e-Kick scooter sharing	49. free2move * ☐ TOP	Car sharing and (e-)Mobility Transport Aggregator
9. blinkee.city	e-Scooter sharing (Moped)	50. Go E-Bike	e-Bike sharing
10. Bluecub ☐	e-Car sharing	51. GoAbout * ☐	Multi Transport Integrator & Multimodal Trip Planner with shared (e-)mobility options
11. Bluely ☐	e-Car sharing	52. GoMore * ☐ TOP	(P2P) (e-)Car sharing, (shared) (e-)car leasing and (e-)ride sharing
12. book-n-drive *	(e-)Car sharing	53. GoodMoovs * ☐	(Corporate) e-Car sharing and e-bike sharing
13. bycyklen *	e-Bike sharing	54. Google Maps ☐ TOP	Multimodal Trip Planner with shared (e-)mobility options
14. Cambio * ☐ TOP	(e-)Car sharing	55. goUrban ☐	e-Scooter sharing (Moped)
15. Car2go * ☐ TOP	(e-)Car sharing (incl. LEC Sharing)	56. GreenGo * ☐	e-Car sharing
16. Car Amigo *	(P2P) (e-)Car Sharing	57. GreenMobility * ☐	e-Car Sharing
17. CareCar *	e-Car sharing	58. Greenmove	e-Car sharing
18. Caroo *	e-Car sharing and e-car rental	59. GreenWheels * ☐	(e-)Car sharing
19. caruso *	(e-)Car sharing	60. GVH * ☐	Multi Transport Integrator & Multimodal Trip Planner with shared (e-)mobility options
20. Carvelo 2 Go ☐	e-Bike sharing	61. Hertz 24/7 ☐	(e-)Car sharing
21. Catch A Car ☐	(e-)Car sharing	62. Hirebike *	(e-)Bike sharing
22. Cityscoot ☐	e-Scooter sharing (Moped)	63. HiyaCar * ☐	(P2P) (e-)Car sharing
23. City Roul ☐	(e-)Car sharing	64. HVV * ☐	Multi Transport Integrator & Multimodal Trip Planner
24. Clem	e-Car sharing & other services	65. I Travel Business Card *	Multi Transport Integrator with shared (e-)mobility options
25. Co cars *	(e-)Car sharing and e-bike sharing	66. INDIGO weel ☐	Bike sharing and e-scooter sharing (Moped)
26. co-wheels * ☐	(e-)Car sharing and e-bike sharing	67. JUMP * ☐	Micro e-mobility sharing (e-kick scooters & e-bikes)
27. Combitrip ☐	Multimodal Trip Planner with shared mobility options	68. Juuve * ☐	(e-)Car sharing
28. Coup ☐	e-Scooter sharing (Moped)	69. Kyyti ☐	Multimodal Trip Planner with shared mobility options and on-demand ride sharing
29. Deelootoo * ☐	(e-)Car sharing	70. LetsGo * ☐	(e-)Car sharing
30. Deutsche Bahn Connect GmbH* ☐ TOP	Multi Transport Integrator with shared (e-)mobility options & Train Trip Planner	71. Lime * ☐ TOP	Micro (e-)mobility sharing (e-kick scooters & (e-)bikes)
31. de Mobiliteits Manager* ☐	Multi Transport Integrator with shared (e-)mobility options	72. ListNride	(P2P) (e-)bike sharing
32. DriveCarSharing *	(e-)Car sharing	73. MaaS Global (Whim) * ☐	Multi Transport Integrator
33. DriveNow * ☐	(e-)Car sharing	74. Mo.Point *	(e-)Car sharing and (e-)bike sharing
34. Drivy * ☐ TOP	(P2P) (e-)Car sharing	75. MOBILEEEE * ☐	e-Car sharing
35. e-bike-to-go * [☐]	e-Bike sharing		
36. E-car club * ☐	e-Car sharing		
37. E-Carflex *	e-Car sharing		
38. e-WALD *	e-Car sharing (incl. LECs)		
39. EC Rental *	e-Car rental and e-Car sharing		
40. ecarregio * ☐	e-Car sharing		
41. EkoRent * ☐	e-Car sharing		

76. mobility * []	(e-)Car sharing & e-scooter sharing (Moped)	109. Switchh *	Multi Transport Integrator with shared (e-)mobility options
77. MobilityMixx	Multi Transport Integrator	110. TADAA! * []	e-Car sharing
78. MOL Limo []	(e-)Car sharing	111. TaM * []	Multi Transport Integrator & Multimodal Trip Planner with shared (e-)mobility options
79. Moov'in.paris []	e-Car sharing	112. teilAuto * []	(e-)Car sharing
80. Moovel DE []	Multi Transport Integrator with shared (e-)mobility options	113. Tellis	e-Car sharing
81. Moovit [] TOP	Multimodal Trip Planner with shared mobility options and Maas platform	114. TIER []	e-Kick scooter sharing
82. MouvNGo	e-Car sharing	115. tim *	Multi Transport Integrator with mobility hubs and shared (e-)mobility options
83. MoveAbout * []	e-Car sharing and e-bike sharing	116. Totem Mobi []	LEC Sharing
84. Moveo [] []	(Corporate) e-Bike sharing	117. TripGo [] TOP	Multimodal Trip Planner with shared (e-)mobility options
85. My-e-Car	e-Car sharing	118. Troty []	e-Kick scooter sharing
86. MyWheels * []	(P2P) (e-)Car sharing	119. TURNN []	Multimodal Trip Planner, Multi Transport Integrator (mobility card) with shared (e-)mobility options and Mobility consultancy
87. Nabobil []	(P2P) (e-)Car sharing	120. TURO * [] TOP	(P2P) (e-)Car sharing
88. NS (Business card)* [] TOP	Multi Transport Integrator with shared (e-)mobility options	121. UFO Drive * []	e-Car rental
89. ÖAMTC easy way []	e-Scooter sharing (Moped)	122. Urbee * []	e-Bike sharing
90. Olympus * [] []	Multi Transport Integrator with shared (e-)mobility options	123. Urbi* [] TOP	Multi Transport Integrator with shared (e-)mobility options
91. Onzeauto * []	(shared) e-Car Leasing & car sharing	124. VelHop *	Bike sharing and e-bike rental/leasing
92. OP-yhteisauto []	(Corporate) e-Car sharing	125. Vélib' []	(e-)Bike sharing
93. Oui Car	(e-)Car sharing	126. voi * []	e-Kick scooter sharing
94. OurGreenCar *	(Corporate) e-Car sharing and micro e-mobility sharing (e-kick scooter and e-bikes)	127. VRN * []	Multi Transport Integrator & Multimodal Trip Planner with shared (e-)mobility options
95. Partago CVBA * []	e-Car sharing	128. We Drive Solar * []	e-Car Sharing
96. Poopy []	(e-)Car sharing & e-scooter sharing (Moped)	129. Wheesy [] []	Multi Transport Integrator & Multimodal Trip Planner with shared (e-)mobility options
97. Postfossil *	(e-)Car sharing	130. Wiener Linien* []	Multi Transport Integrator with shared (e-)mobility options
98. privateshare * []	(P2P) (e-)Car sharing	131. Wij Mobiliteitskaart*	Multi Transport Integrator with shared (e-)mobility options
99. Radiuz *	Multi Transport Integrator with shared (e-)mobility options	132. WIND []	e-Kick scooter sharing
100. RUHRAUTOe *	e-Car sharing	133. XXIImo * []	Multi Transport Integrator with shared (e-)mobility options
101. Sco2t []	(e-)Scooter sharing (Moped)	134. Yelo Mobile	e-Car sharing
102. Scooty []	e-Scooter sharing (Moped)	135. ZenCar * []	e-Car sharing
103. Share a starcar * []	e-Car sharing	136. Zipcar * [] TOP	(e-)Car sharing
104. Sharoo []	(P2P) (e-)Car sharing		
105. Shuttel * []	Multi Transport Integrator with shared (e-)mobility options		
106. SnappCar * [] TOP	(P2P) (e-)Car sharing		
107. Spinlister []	(P2P) (e-)Bike sharing		
108. stadmobil * []	(e-)Car sharing		

The list below shows the rest of MMAs included in the market study:

(electric) Mobility Mobile App	Type of (e-)Mobility Service
1. BerlinMobil	Multimodal Trip Planner with shared (e-)mobility options & (e-)Mobility Transport Aggregator
2. Transit TOP	Multimodal Trip Planner with shared (e-)mobility options
3. Wegfinder TOP	Multimodal Trip Planner with shared (e-)mobility options

A.2 – (electric) Mobility Mobile Apps (MMAs)

Table 4 below shows an overview of all (electric) Mobility Mobile Apps included in the market study and the rating given by their own users in the *Google Play* mobile app marketplace (as of April 2019). In Table 4 MMAs are ordered alphabetically. MMAs rated by less than 100 users are not taken into account for the ranking shown in Fig. 6 in §3.2.

Table 4. Overview of (electric) MMAs included in the market study and the rating given by users (as of April 2019)

(electric) Mobility Mobile Apps and rating given by users (max. 5★)			
1. Bird	4.3★	27. Moovel DE	3.6★
2. Blinkee.city	3.1★	28. Moov'in.paris	2.7★
3. Cambio	4.4★	29. Moovit	4.4★
4. Car2go	4.0★	30. MyVRN	3.4★
5. Cityscoot	3.9★	31. Nabobil	4.4★
6. Coup	3.2★	32. NS	4.0★
7. DB Navigator	4.0★	33. Poopy	4.0★
8. DriveNow	3.9★	34. SnappCar	4.4★
9. Drivy	4.2★	35. Spinlister	3.3★
10. Emmy	3.4★	36. Stadtmobil	1.9★
11. Enterprise car club	4.2★	37. TaM	3.3★
12. Flinkster	3.1★	38. TeilAuto	3.2★
13. Free2move	4.0★	39. TIER	2.9★
14. GoMore	4.5★	40. Transit	4.2★
15. Google Maps	4.3★	41. TripGo	4.2★
16. Green Mobility	3.2★	42. Troty	3.7★
17. GreenGo	3.7★	43. TURO	4.4★
18. GreenWheels	3.6★	44. Urbi	4.2★
19. GVH	3.1★	45. Véliib'	2.4★
20. Hertz 24/7	3.3★	46. Voi	3.0★
21. HVV	3.4★	47. Wegfinder	4.0★
22. INDIGO weel	3.4★	48. Whim	3.6★
23. JUMP	3.4★	49. WienMobil	3.0★
24. Lime	4.5★	50. WIND	3.6★
25. Mobility	3.2★	51. ZipCar	4.2★
26. MOL Limo	3.2★		
Rated by less than 100 users or not rated yet			
52. Aimo	3.6★	73. Milo	2.4★
53. BerlinMobil	3.9★	74. MOBILEEEEE	5.0★
54. Billy	4.0★	75. MoveAbout	3.5★
55. Bluecub	4.1★	76. MyWheels	2.7★
56. Bluely	3.2★	77. ÖAMTC easy way	3.0★
57. Carvelo 2 Go	3.1★	78. Onzeauto	3.0★
58. Catch A Car	3.8★	79. OP-yhteisauto	5.0★
59. City Roul	3.1★	80. Partago CVBA	4.1★
60. Combitrip	5.0★	81. Privateshare	-
61. Co-wheels	1.9★	82. Sco2t	4.6★
62. E-Car Club	3.5★	83. Scooty	3.5★
63. EkoRent	3.4★	84. Share a starcar	3.9★
64. Enuu	4.4★	85. Share2use	3.1★
65. Felyx	3.8★	86. Sharetoo	5★
66. GoAbout	3.3★	87. Shuttel	-
67. GoodMoovs	4.0★	88. TADAA!	3.2★
68. GoUrban	3.7★	89. Totem Mobi	3.7★
69. HiyaCar	3.8★	90. TURNN	3.0★
70. Juuve	4.6★	91. UFO Drive	5.0★
71. Kyyti	3.1★	92. Urbee	2.2★
72. LetsGo	3.1★	93. ZenCar	3.5★

A.3 – (electric) Mobility Technology Providers

Lastly, our findings regarding (electric) mobility technology providers are presented below. The results are limited to a classification of the main solutions and services offered by the providers of such technology platforms. The goal of the list of solutions presented in Table 5 below is to offer Shared electric Mobility Providers (SeMPs) an overview of the technologies available in the market that could help them to improve or expand the technical capabilities that they already have and enter the eMaaS ecosystem in an easier way.

Table 5. Mobility-related technology providers.

Provider	Service or Solution	Website
1. Alphacity	Car Sharing platform	https://www.alphabet.com/en-gb/alphacity
2. ARVAL Mobility Link	MaaS platform for businesses	https://www.arval.nl/nl/mobiliteitsoplossingen/arval-mobility-link
3. A-to-Be MoveBeyond	MaaS solutions for businesses	https://www.a-to-be.com/
4. B2B E-Bike	e-bike sharing technology solutions	https://www.b2ebike.com/
5. BNVmobility	Mobility Support Technology	http://www.bnmobility.com/en/home-en/
6. Cityway	MaaS support technology	https://www.cityway.io/cityway/
7. Corethree	Mobility Support Technology	http://www.corethree.net/
8. Cubic	MaaS platform for business	https://www.cubic.com/innovation/insights/mobility-service-maas
9. EcoVelo	bike sharing technology solutions	https://ecovelo.com
10. Electric Feel	shared electric mobility technology solutions	https://www.electricfeel.com/
11. eos.uptrade	Mobility Support Technology	https://www.eos-uptrade.de/en/eos-mobility
12. ESP Group	Transport and Mobility Services	https://www.the-espgroup.com/
13. Fleetster	Cloud software for vehicles management	https://www.fleetster.de/
14. Fluid time	Intermodal mobility platform	https://www.fluidtime.com/en/
15. Free2move	Company and City shared mobility solutions	https://www.free2move.com/solutions/
16. Green-On	e-Bike sharing technology solutions	https://green-on.fr/
17. Here Mobility	Mobility Marketplace	https://mobility.here.com/
18. Hub2Go	Sharing mobility platform	https://www.hub2go.de/

19. ibiola	Car sharing platform and fleet management services	http://ibiola-mobility.com/
20. Ioki	Demand responsive transportation platform and Mobility Analytics & Consulting	https://ioki.com/
21. Kapsch PublicTransportCom	Support platform for MaaS and other transport services	https://www.kapsch.net/kptc
22. Leisure King	Booking and payment platform	https://www.leisureking.eu/website/en
23. Masabi	Ticketing platform for MaaS	http://www.masabi.com/
24. Miveo	Mobility (car sharing) platform	https://www.miveo.se/
25. mobiag	Car sharing & Car rental solutions	http://mobiag.com/en/
26. mobility systems + services	Car sharing software platform	https://www.mobility-systems-and-services.com/
27. Mobbileo	MaaS platform for business	https://www.mobbileo.com/
28. Moovel	Digital mobility solutions for Mobility Service Providers & Transport Operators	https://www.moovel.com/en/our-products/for-public-transit-agencies-operators
29. Moovit	Maas platform	https://www.solutions.moovitapp.com/
30. Mvmant	Ride hailing and mobility platform provider	https://www.mvmant.com/
31. Open Mobility Platform	MaaS for Business	https://opentransport.com/
32. PBSC	Bike sharing technology solutions	https://www.pbsc.com/
33. Radiuz	MaaS platform	https://www.radiuz.nl/
34. Ridecell	Mobility platform	https://ridecell.com/
35. Share too	Car sharing solutions	https://sharetoo.europcar.at/
36. Share2use	Car sharing solutions	http://www.share2use.com/
37. SkedGO	MaaS for Business	https://skedgo.com/
38. Tapazz	Car sharing solutions	https://tapazz.eu/
39. Viaqqio	Software platform for MaaS	https://www.the-espgroup.com/viaqqio/
40. VULog	Car sharing solutions	http://www.vulog.info/
41. Wattworld Mobility Park	e-Bike charging solutions	https://www.wattworld.ch/
42. WeGo	Car sharing platform software	https://wego.nu/wego/
43. Yor24	Mobility Management for businesses	https://www.yor24.com/nl/home
44. Zoov	e-Bike sharing technology solutions	https://www.zoov.eu/en/about/

Appendix B – List of Shared electric Mobility Providers (SeMPs) included in our study, distributed by the country where are present.

Austria (Total=24)		Germany (Total=36)		
· Bird	· Greenmove	· Book-n-drive	· Free2moove	· SnappCar
· Blinkee.city	· Lime	· Cambio	· GreenWheels	· Stadmobil
· Car2go	· Mo.Point	· Car2go	· GVH	· Switchh
· Caroo	· MoveAbout	· Coup	· Hertz 24/7	· TeilAuto
· Caruso	· ÖAMTC easy way	· Deutsche Bahn	· HVV	· TIER
· DriveNow	· Postfossil	· Connect GmbH	· JUMP	· TURO
· Drivy	· Sco2t	· DriveCarSharing	· Lime	· UFO Drive
· Ecarregio	· TIER	· DriveNow	· ListNride	· Urbi
· Family of Power	· Tim	· Drivy	· Moovel DE	· VRN
· Flinkster	· Urbi	· E-Carflex	· Movelo	· Wheesy
· Free2move	· Wiener Linien	· e-WALD	· MOBILEEEEE	· WIND
· GoUrban	· WIND	· Emmy	· RUHRAUTOe	
		· Flinkster	· Share a starcar	
Belgium (Total=20)		Hungary (Total=3)		
· BattMobiell	· Olympus	· Blinkee.city	· GreenGo	· MOL Limo
· Billy	· Partago CVBA			
· Bird	· Poopy			
· Cambio	· Scooty			
· Car Amigo	· TIER			
· DriveNow	· Troty			
· Drivy	· UFO Drive			
· Free2move	· Urbi			
· Hertz 24/7	· Whim			
· Lime	· ZenCar			
Denmark (Total=11)		The Netherlands (Total=36)		
· bycyklen	· SnappCar	· Juuve	· Free2move	· Privateshare
· DriveNow	· TADAA!	· ListNride	· GoAbout	· Radiuz
· free2move	· TIER	· CareCar	· GoodMoovs	· Shuttel
· GoMore	· Urbi	· Combitrip	· GreenWheels	· SnappCar
· GreenMobility	· Voi	· Deelootoo	· Hertz 24/7	· Spinlister
· LetsGo		· de Mobiliteits Manager	· I travel Business Card	· TURNN
		· DriveCarSharing	· Juuve	· TURO
		· e-bike-to-go	· ListNride	· Urbee
		· EC Rental	· MobilityMixx	· Urbi
		· Elektrip	· MyWheels	· We Drive Solar
		· Felyx	· NS Business card	· Wij Mobiliteitskaart
		· Flinkster	· Onzeauto	· XXImo
Finland (Total=6)		Norway (Total=5)		
· DriveNow	· OP-yhteisauto	· Bilkollektivet	· GreenMobility	· Nabobil
· EkoRent	· Urbi	· GoMore	· MoveAbout	
· Kyyti	· Whim			
France (Total=30)		Sweden (Total=12)		
· Auto Bleue (izzie)	· Lime	· Aimo	· GoMore	· SnappCar
· Bird	· Moov'in.paris	· blinkee.city	· Lime	· TIER
· Bluecub	· MouvNGo	· DriveNow	· MoveAbout	· Urbi
· Bluely	· Oui Car	· Free2move	· OurGreenCar	· Voi
· Car2go	· TaM			
· Cityscoot	· TIER			
· City Roul	· Totem Mobi			
· Clem	· Troty			
· Coup	· TURO			
· Drivy	· Urbi			
· free2move	· VelHop			
· GoMore	· Vélip'			
· Hertz 24/7	· Voi			
· INDIGO weel	· WIND			
· JUMP	· Yelo Mobile			
		Switzerland (Total=14)		
		· 2EM	· Enuu	· My-e-Car
		· Bird	· Flinkster	· Sharoo
		· Carvelo 2 Go	· Lime	· Tellis
		· Catch A Car	· ListNride	· TIER
		· DriveCarSharing	· mobility	
		United Kingdom (Total=17)		
		· Bird	· Enterprise car club	· Lime (pilot)
		· Co cars	· Free2move	· Spinlister
		· Co-wheels	· Go E-Bike	· TURO
		· DriveNow	· Hertz 24/7	· Whim
		· Drivy	· Hirebike	· Zipcar
		· E-car club	· HiyaCar	

Appendix C – List of abbreviations and acronyms

B2B	Business to Business
B2C	Business to Consumer
BM	Business Model
C2B2C	Consumer to Business to Consumer
eMaaS	electric Mobility as a Service
EV	Electric Vehicle
LEC	Light Electric Car
MaaS	Mobility as a Service
MeMS	Micro electric Mobility Sharing
MMA	Mobility Mobile App
MMTP	Multimodal Trip Planner
MSP	Mobility Service Provider
MTA	Mobility Transport Aggregator
MTI	Multi Transport Integrator
P2P	Peer to Peer
PT	Public Transport
PTO	Public Transport Operator
SEM	Shared Electric Mobility
SeMP	Shared electric Mobility Provider
USP	Unique Selling Point