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Contents

1. Executive Summary

Digitalization, technology innovations, sharing economy and the need to be more sustainable due to the climate crisis have boosted the explosion of new innovative mobility services with the aim of covering people's mobility daily needs in the best possible way. However, there is no single transportation mode that can meet all the diverse and dynamic travel requirements of today citizens. Hence, Mobility as a Service (MaaS) is seen as the solution to improve intermodal access to public and private mobility services while aligning with the sustainable cities approach.

MaaS is a platform that integrates a variety of transportation modes, either traditional (e.g., bus, metro, and taxis) or innovative (e.g., car sharing, bike sharing, and ride sharing), in combination with other transport-related services (e.g., ticketing, booking, and payment systems). It has emerged as an innovative concept expected to offer the best transportation experience for users. It allows the users to plan, book and pay for the services selected as well as other transport related services such as parking. In fact, users are the main actors in the MaaS ecosystem and the market segmentation to address the needs of the different kinds of users, with tailored mobility packages, is one of the main challenges ahead.

It is widely claimed that MaaS could bring considerable societal benefits, such as an improve air quality, reduce the energy requirements, improvement of road safety and the efficiency in the transport system. Additionally, advocates of MaaS argue that it could reduce social exclusion and bring new opportunities for economic growth. However, its successful implementation depends not only on the public acceptance (which can be considered as a precondition), but also, on three factors: Disruptive Technologies, New Business Models, and Regulations.

The speed of innovation in technology makes that technological changes are not dynamic anymore, but disruptive. The Internet of Things is a disruptive technology that has a broad number of applications in the transportation sector, including Intelligent Transport Systems. This disruptive technology is supported by:

- An infrastructure of sensors: the autonomous/connected vehicles offer a new set of sensors which allow to gather updated information from any place where there is, at least, a vehicle.
- The connectivity to networks: The 5G technology satisfies the needs of efficient communication in the Intelligent Transport Systems, since the current technologies, such as 4G, don't allow this interchange of the data generated by the transport infrastructure and the new connected vehicles.
- The ability to rapidly compute incoming data: As a consequence of the huge amount of data gathered, new ways to process and analyse data in real-time is required to optimise the use of infrastructures, as well as to enhance the user experience. Big Data Analytics allows to carry out this task.

In the last years, new business models in the mobility sector have changed the transportation sector from a traditional and static model, to a flexible and innovative scenario with new interrelated players. Indeed, the mobility sector has grown in app-based on-demand shared transport initiatives. There are two types of Shared Mobility Business Models: (1) ride-sourcing, which includes all on-demand and pre-book services which offer a ride (e.g., ride-hailing and ride-sharing), and (2) vehicle sharing, which is based in renting vehicles for short periods of time and where different users can use them during the day (e.g., car-sharing, scooter-sharing, and bike-sharing). Nowadays, some cities are almost full of local, global, public and private providers that offer similar services with the aim of covering people's mobility daily needs in the best possible way. So, they are facing tough competition, and many of these transport services are unprofitable. That makes that many companies have to close down and/or move to other cities, or even, change their business model.

The report shows a comparative analysis of business models of the most relevant ride-hailing, carsharing and aggregator services in Amsterdam, Budapest, Barcelona and Madrid. The results show few differences among them, which does not distinguish any sustainable advantage. On the other hand, the report shows that differences in the deployment of some new mobility services do not depend on the national regulations, but the city ones, such as the case of carsharing between Barcelona and Madrid.

One of the success factors in the deployment of MaaS is related to the national, regional, and city regulations of MaaS, but also the regulations related to access mobility market and the regulations and polices for promoting the use of MaaS (both citizens and companies). On the other hand, the lack of consistency among them is detrimental to its launch. For example, Finland resolved this situation creating a national law integrating them.

2. Introduction

The landscape of the mobility into the cities is changing very fast enabled by the digital transformation of the mobility sector. The rapid penetration of smartphones, the increased confidence in digital payments, the development of journey planners with GPS and geolocation technology, the 5G networks and Big Data Analysis, among others, have enabled the integration of transport, and by doing so, the emergence of new transport services in many cities.

Nowadays, there is a great amount of different transportation modes. A great amount of new mobility service providers offers innovative and sustainable mobility options (e.g., car sharing, bike sharing, and ride sharing) that complement traditional transportation. However, none of them, separately, can offer the most convenient service for a door-to-door transport, therefore, their aggregation is seen as the solution for this new mobility ecosystem.

Mobility as a Service (MaaS) aims to offering an appealing combination of different transportation modes offered by either public or private operators. Additionally, it aspires to reduce the use of private cars. MaaS is portrayed as a single mobile service accessible on demand, where the user can plan, book, and pay their journeys. Indeed, it has a user-centric approach. MaaS is characterised by: door-to-door convenience; seamless, integrated, multi-modal travel; and ease of payment/billing (see, Lyons et al., 2019; p. 23). However, its successful implementation depends on the evolution of several disruptive technologies, the subsistence of new business models of mobility services, and an adequate regulatory framework.

This report aims to offer a brief overview of the Mobility-as-a-Service (MaaS) concept and, more specifically, an outline of some of the disruptive technologies, and a comparison of the business models of different new mobility services. Additionally, it provides some considerations about the regulations applied to these new mobility services.

3. Methodology

The findings and analyses of this report are mainly based on a literature review. A sequential three-step approach was followed as to perform this literature review.

Stage 1: Data collection from academic databases and grey literature

In order to retrieve relevant studies to inform our report, an online search was conducted across several searchers were performed in several databases (i.e., Web of Science, Scopus, Google Scholar). In order to be as inclusive as possible, we used several keywords to perform the searches. For instance: “Mobility-as-a-Service”, “MaaS”, “MaaS adoption”, “New Mobility Services”, “Smart mobility”, “Transport policy”, “Smart mobility regulation”, “Mobility on demand”, and “Shared transport services”. And, even some keywords combinations we used in which the following keywords appeared: “Governance”, “Policy”, “Sustainability Transitions”, “Collaborative Innovation”, “Digital disruption”, “Transport”, “Public-private partnership”, “Community transport”, “Service package”. No time limits restrictions were considered. Due to the newness of the topic, we have considered not only articles, but also, chapters, books, and conference proceedings. Since this search resulted in a large number of papers, we withheld only those articles that referred to mobility business models or to MaaS business models, to technologies related to MaaS or to regulations related to Maas or to mobility services. Likewise, we supplemented our review of the academic literature with a search into the grey literature. Several reports frequently cited in the academic literature were considered.

Stage 2: Data collection from Pro-MaaS Partners

While working on the previous stage, the Pro-MaaS partners (cities and universities) were contacted to ask them about any information that they considered relevant to share to help us achieve our purpose. Cities provided documents about new mobility services in their cities. Also, they shared their vision of the future mobility, which allowed us comparing the mobility services offered among cities participating in the project, as well as their strategies. That is why, in this report we refer to some specific cities from The Netherlands, Hungary, and Spain. Namely, Amsterdam, Budapest, Barcelona and Madrid. In the case of Spain, two cities were considered: Barcelona and Madrid. Barcelona is one of the partners’ cities. Madrid was added since, even though it is in the same country, the existing regulation related to mobility services is different, which led us to show the enable or disable effects of regulation for the deployment of the MaaS.

Stage 3: Collating, summarizing and reporting the results

The literature review done allowed to identify disruptive technologies affecting the MaaS, and differences between business models of different new mobility services have been presented. This has allowed to provide a first classification of the regulations applied to these new mobility services.

4. Mobility-as-a-Service (MaaS)

A recent Deloitte report starts like this: "The entire way we travel from point A to point B is changing, creating a new ecosystem of personal mobility." (2017, p. 1). Indeed, new technologies, products and services are fundamentally shifting the transport sector together with customer expectations and opportunities.

There has been an explosion of new, innovative mobility services seeking to offer cities residents and visitors more options to complete their daily travel needs in a more sustainable way. Maybe due to the fact that the increase in urban population has also come together with exponential growth in private vehicle usage, which lead to congestion and pollution issues that have raised serious concerns among users and governments alike (Matyas, 2020). In fact, new mobility services are seeking to address the growing concern about the environmental problems that causes urban mobility. For instance, greenhouse gas emissions, public health concerns and social equity implications (see, Chapman, 2007; Mackett & Thoreau, 2015).

The reduction of private vehicle ownership and use, which are considered significant contributors to traffic, air pollution and inefficient land use (Jeekel, 2016; Stevenson et al., 2016; Gärling & Steg, 2006), is a crucial area of interest. Shared mobility services offer an interesting solution in that sense. There is evidence on the positive effects of shared modes. For instance, car sharing significantly decrease vehicle miles of travel (VMT) (Martin et al., 2010; Clewlow, 2016), and the fuel economy of car sharing vehicles is more efficient than privately owned vehicles (Clewlow, 2016). As a result of these two factors, car sharing lead to significant reductions in greenhouse gas emissions (Chen & Kockelman, 2016). But also, other shared modes have shown a number of environmental and health benefits (e.g., Rojas-Rueda et al, 2011; Woodcock et al., 2014).

However, there is no single transport mode that can meet all the diverse and dynamic travel requirements of today's urbanites. Not even public transport can solve all mobility needs. According to Matyas (2020), "multimodal options are needed to service the unique travel requirements of each individual" (p. 1). The truth is that, nowadays, transportation is much more than private vehicles juxtaposed with public transit. It is a complex and multi-layered realm facing challenges but also, new opportunities. Mobility as a Service (MaaS) is seen as the solution to improve intermodal access to public and private mobility services while aligning with the sustainable cities approach. Even MaaS has been considered "the biggest transport revolution of the 21st century"[1].

The aim of this section is to review the MaaS concept, showing contemporary approaches and perspectives.

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[1] See: https://skedgo.com/mobility-future/what-is-mobility-as-a-service-maas/

4.1. Shared mobility and Shared Micromobility

The sharing economy has attracted a great deal of attention in the last years. The term covers a sprawling range of digital platforms and offline activities, which can be classified into four broad categories (Schor, 2014): recirculation of goods, increased utilization of durable assets, exchange of services, and sharing of productive assets. In short, sharing economy "converges around activities facilitated through digital platforms that enable peer-to-peer access to goods and services" (Richardson, 2015, p. 121). Of course, this could not be done without today ubiquitous availability of digital technologies that are triggering new business models and leading to innovations in various industries (Caiati et al., 2020).

Thus, the sharing economy represent an opportunity to be able to make a transition in the mobility system. There is a shift from an asset centric approach to a service centric one, where intermediary interfaces facilitate the interaction between suppliers and customers. There is little doubt that the transportation sector is involved in a disruption process, which is affecting the way transportation companies are delivering their services (i.e. business model changes), and people organize, execute and experience their trips (Caiati et al., 2020). Also, technological progress (e.g., systems for data gathering and handling, and wireless communication) is changing the provision of mobility services, and consequently the interaction between suppliers and customers. As Caiati et al (2020) put it: "Reliable real time information about transit routes, schedules and delays, user-friendly multimodal navigation systems, and digitization of ticket and payment systems are acting together to offer better service provision to travelers during all stages of their journeys and contribute to enhancing the overall quality of their travel experiences" (p. 124).

Under the framework of sharing economy, the shared mobility has emerged as a strategy to achieve more sustainable travelling, and prompting servitization. In 2016, Shaheen et al. defined shared mobility as the short-term access to shared vehicles according to the user's needs and convenience, instead of requiring vehicle ownership. A few years later, a new term (and service) emerged: shared micromobility. It refers to the shared use of a bicycle, scooter, or other low-speed mode, and appeared as "an innovative transportation strategy that enables users to have short-term access to a mode of transportation on an as-needed basis" (Shaheen & Cohen, 2019, p. 3). The on-going widespread uptake of these services is boosted by other emerging trends that are changing people's values and behaviours. For instance, the pervasiveness of mobile devices and constant mobile connectivity (OECD, 2017).

The truth is that the panel of transport modes available has expanded significantly, and with that the difficulty for users to navigate through the silos of all the information sources, applications, tickets and journey planners (Kamargianni et al., 2016; Matyas, 2020). Thus, the need for a single, user-friendly platform that integrates all services has led to the birth of Mobility as a Service (MaaS) (Arias-Molinares & García-Palomares, 2020; Matyas, 2020).

4.2. What is MaaS?

Mobility-as-a-Service (MaaS) is a relatively new concept, introduced by Heikkilä (2014) and Hietanen (2014). Since its inception has had a great deal of attention, maybe because it has emerged as "an innovative concept expected to transform the paradigm of urban mobility" (Caiati et al., 2020, p.124). Some authors (Giesecke et al., 2016; Kamargianni & Matyas, 2017) emphasize the paradigm shift in the way mobility services are distributed, mainly because it is an on-demand service via mobile applications, that would incorporate all transport modes. According to Kamargianni & Matyas (2017), it aims to "bridge the gap between public and private transport operators on a city, intercity and national level, and envisages the integration of the currently fragmented tools and services a traveller needs to conduct a trip (planning, booking, access to real time information, payment and ticketing). It has the potential to eradicate dependence on private vehicles and deliver seamless mobility as it allows the integration and cooperation across transport operators, the bundling of transport services and their provision to travellers as one product via a single interface." (p. 3). In fact, MaaS is portrayed as an appealing alternative to owning and using a private car (Lyons et al., 2019).

In a recent Deloitte report, MaaS has been defined as "a digital platform that integrates end-to-end trip planning, booking, electronic ticketing, and payment services across all modes of transportation, public or private." (2017, p. 114). However, there are many definitions and interpretations of what is and constitutes MaaS. For instance, MaaS Alliance (2017) describes it as a transport concept that combines services from different transport modes to provide customised mobility services via a single interface. Kamargianni and Goulding (2018) as a user-centric, multimodal, sustainable and intelligent mobility management and distribution system, in which a MaaS Provider brings together offerings of multiple mobility service providers (public and private) and provides end-users access to them through a digital interface, allowing them to seamlessly plan and pay for mobility. Even, Sarasini et al. (2017) identified the core elements of MaaS: a unique single platform (app or website), real-time information on all available modes in the city (public and private), multimodal transportation (intermodal journey planners), technological integration to plan, book and pay for mobility needs, and personalized bundled mobility packages according to user's particular requirements.

Considering the above-mentioned, and in agreement with the majority of authors, we will adopt the MaaS definition stated by Caiati et al. (2020):

> "a mobility distribution model that offers the integration of a variety of transportation modes, either traditional (e.g. bus, tram, metro, taxis) or innovative (e.g. car sharing, bike sharing, ride sharing, demand responsive transit), combined with other transport-related services (e.g. travel recommendation system, ticketing, booking and payment services). They are offered by different public and private operators through a single integrated platform accessible to individuals and households through a subscription plan. Thus, MaaS can be described as an umbrella concept encompassing various dimensions of service integration, including technological, organizational and business models, leading to a comprehensive restructuring of the way mobility services are delivered and consumed." (p. 124)

MaaS has attracted the attention of governments in many cities around the world, since it offers a wide range of benefits and advantages (e.g., MaaS Alliance, 2018). For instance, it can decrease the carbon footprint from personal mobility (e.g., Kerttu et al., 2017) and reduced congestion and need for parking (e.g., Falconer et al., 2018). All the previous benefits could lead to higher productivity, improved air quality and fewer traffic accidents (Goodall et al., 2017). Even some (Polis, 2017) argue that MaaS can reduce social exclusion. According to Arias-Molinares and García-Palomares (2020) one of the most expected benefits is "the possibility of achieving higher service quality and competitive pricing, since transport operators will gain detailed data from user travel preferences and profiles, resulting in a wider service offer and prices that are adapted to each individual" (p. 9). Additionally, it will allow to have a constant feedback on the demand and supply side, which can help to improve the ecosystem (Jittrapirom et al., 2018).

In order to implement MaaS, certain basic requirements are needed. Arias-Molinares and García-Palomares outline: "a wide range of diverse transport modes, physical integration of modes, schedule integration, spatial and temporal coverage of the service (24 h in city/suburbs), data sharing, a strong data privacy policy, MaaS regulation (third-party ticket selling, data exchange standardisation formats and fair competition aspects), funding re-arrangement and willingness of citizens to join." (p. 9). In Kamargianni and Goulding (2018) words there are five key "raw ingredients" required for MaaS: (a) transport services and infrastructure (i.e., how prepared they are); (b) ICT infrastructure (i.e., MaaS-enabling technologies); (c) Transport operator openness related to data sharing; (d) Policy, regulation and legislation (i.e., the extent to which they support MaaS); (e) citizen familiarity and willingness to adopt MaaS model of transport provision. Based on these requirements, we identified three large issues to discuss in order to get a MaaS effectively implementation (see **Figure 1**): Disruptive Technologies, New Business Models, and Regulations.

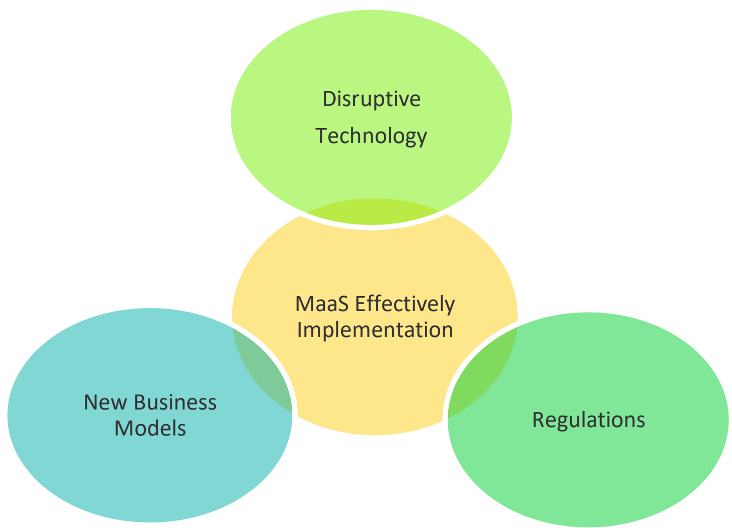

Figure 1 Requirements for a MaaS effectively implementation

5. Disruptive Technologies

Christensen (1997) used the term *disruptive technology* to refer to those new technologies that cause a big change in the industry's development. Nowadays there are some disruptive technologies that have the potential to change the way we understand the urban mobility creating new players and business opportunities.

The "Internet of Things" (IoT) is at the centre of *disruptive technology*, and it is characterized by three elements: an infrastructure of sensors, the connectivity to networks, and the ability to rapidly compute incoming data (McKinsey, 2015). IoT technologies have a number of applications in the transport sector, including intelligent transport systems (ITS).

One of the new ways to capture information from the streets and the roads are the sensors of autonomous/connected vehicles, which offer the challenge to gather updated information from any place where there is, at least, a car.

The connectivity to networks through the integration of systems that are part of mobility services is another key element to develop efficient ITS. The definition of standard protocols, the control of information, and the security of technological platforms need to be considered. On the other hand, 5G is positioning itself as the most suitable technology for the connectivity of these systems.

Finally, this huge quantity of gathered information needs to be processed in real-time, so Big Data technologies take an important role in the development and implementation of the ITS. Big Data technologies comprise the technology infrastructure (e.g., servers, data-warehouse, and processing units), the analysis software (e.g., R, and Phyton), the analysis models and their resolution methods (e.g., Machine Learning).

Figure 2 shows the elements to consider in the development of intelligent transport systems (ITS), highlighting the disruptive technologies. The aim of this section is to review these disruptive technologies in the transportation arena to show their main challenges.

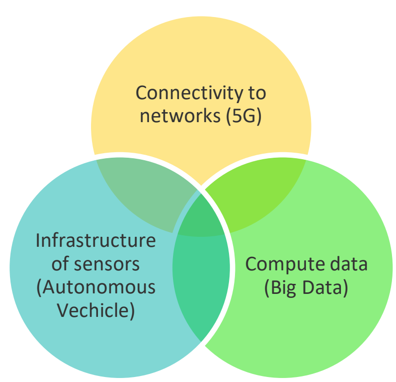

Figure 2 Characteristics of "Internet of Things"

5.1. Connectivity to networks

ITS is an integrated system of people, roads and vehicles, which provides transport solutions significantly contributes to improve road safety, efficiency and comfort, as well as environmental conservation through realization of smoother traffic by relieving traffic congestion (Andersen and Sutcliffe, 2000). MaaS is the cutting-edge ITS system.

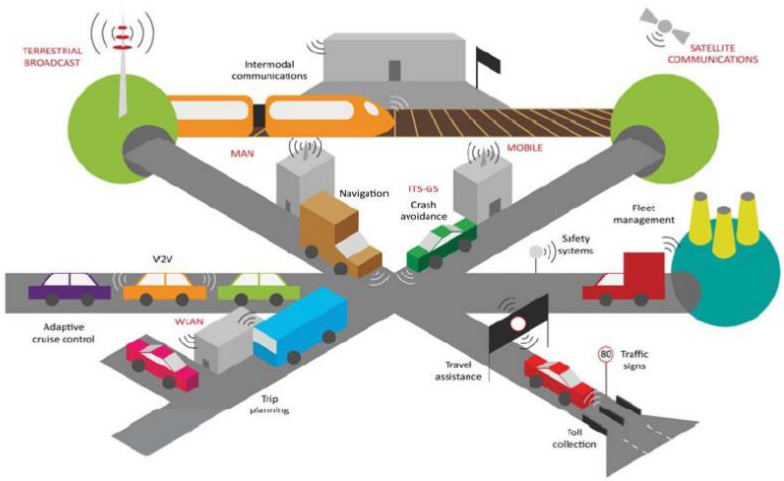

Figure 3 Systems interacting in an ITS (Coppola and Morisio, 2016, p. 6)

In ITS, we can identify (see **Figure 3**) several interactions among vehicles, and between vehicles and elements of the road infrastructure (e.g., traffic lights) (Coppola and Morisio, 2016). These interactions are falling into two categories: *Vehicle-to-Infrastructure* (V2I) and *Vehicle-to-Vehicle* (V2V) communications.

The V2V communication allows cars to know precisely where the rest of cars are on the road, which improves the safety of the roads, and helps in the traffic monitoring and control (the V2I communications also allow to manage the traffic monitoring and control). In a V2V communicating, vehicles form what is labelled as: *Vehicular ad hoc Network* (VANET) (see, Coppola and Morisio, 2016).

VANET are considered the biggest *ad hoc* network ever implemented, and issues of stability, reliability, and scalability are of real concern (Paul et al., 2017). Their unique form combined with high-speed nodes complicates the design of the network. Indeed, VANETs pose significant challenges since the network topology changes constantly and with a very fast pace. Moreover, the dynamic movements of nodes in the network, and the presence of obstacles, may create interruptions and disconnections in the data flow between vehicles. V2I and V2V communications are typically based on *Dedicated Short-Range Communications* (DSRC) and it is crucial to enable an efficient traffic management.

Several technologies are involved in VANETs, especially as enablers of ITS. Paul et al (2017) classified the communications technologies as ***Existing*** Vehicular Communication (WAVE, DSRC, CALM), and ***Possible*** vehicular communication technologies (Infrared, Bluetooth, Zigbee, VLC, 2G/3G, WLAN/WI-FI, LTE/4G, WiMAX, 5G/Millimetre WAVE). They also emphasize the importance of communication standards for ITS deployment. It should be noted that research projects funded by the European Union are major contributors to the standards committees.

From a completely different perspective, mobile phones, equipped with motion and location sensors also allow collecting data about mobility patterns to improve the mobility. In fact, infrastructure planners and public transport providers can use automatic recognition of public transport trips using mobile phone sensors to understand the requirements of the road and transport networks, and to predict the likely destinations in order to assist connecting passengers (Rinne et al, 2017).

In order to get an efficient connectivity to networks, it is necessary to keep working in the development and implementation of open standards. The *bIoTope* Project[2] aims to provide the necessary standardised Open APIs to enable interoperability between today's vertical IoT silos. However, further work is needed on security and privacy of the ITS in order to protect service providers and users from harmful and malicious attacks on their data while using the open ITS platforms services (Karpenko et al, 2018). As Constantini (2017) pointed out, "from a legal perspective, ITS raises several questions concerning the control of information, and specifically about the security of the technological platform where it is managed, the protection of personal data, the accuracy of data concerning roads, traffic and travel, and the transparency and accountability of all processes involved".

5.2. 5G Technology

As we said it, 5G is positioning itself as the most suitable technology for the connectivity of these ITS. More precisely, 5G is wireless broadband (WiBB) technology based on the IEEE 802.11ac standard (Camacho et al., 2017). The key requirement affecting the architecture is flexibility, as networks must support a heterogeneous set of uses cases efficiently. V2V and V2I communications offer great functionality and efficiency in the mobility, but require a fast communication among vehicles and between vehicles and traffic management systems. However, the current network latency offered by 4G networks doesn't allow these levels of fast communication. High bandwidth, pervasive availability, and low latency of 5G wireless is assuring smart and intelligent vehicular communications (Agiwal et al. 2016). In fact, 5G networks and automated vehicles are seen as facilitators of the MaaS growth and consolidation (Nikitas et al., 2017)

The European Commission recognise the importance of 5G for future mobility solutions and embrace the deployment of 5G technologies including both network and direct communication in transport as a European public policy priority. In 2019, a wide group of industry stakeholders that support the Connected and Automated Mobility (CAM) in Europe, establish the following principles that underpin their vision of the 5G Strategic Deployment Agenda (5G PPP, 2019, p. 7-8):

- The deployment of the 5G infrastructure for CAM should follow an evolutionary path in order to cope with future market developments and technological progress.

[2] For more information, please consult the following website: https://biotope-project.eu/overview

- 5G networks will initially co-exist, and where necessary be interoperable, with 4G (LTE) and other communication technologies to deliver a boundless, high-speed, reliable and secure broadband experiences for all.
- The infrastructure should aim at providing boundless connectivity with continuity of service across borders, across Mobile Network Operators, across vendors/OEMs, as well as across traffic managers, road operators and across service providers.
- The CAM infrastructure, including vehicles and road equipment, needs to have a very high level of cybersecurity.
- The 5G infrastructure for CAM will need to be a multi-service/multi-application platform using standardised specifications and/or data interfaces.
- The deployment of 5G infrastructure for CAM in Europe should be coordinated with public and private actors in charge of delivering V2X services in an extensive manner, starting along main pan-European cross-border corridors and expanding to cover all roads.
- Public administrations in charge of roads and mobile networks should collaborate to create synergies for connectivity deployment along CAM corridors.
- Need for flexibility within a cooperative planning model.
- Accelerate the digital transformation of industry verticals.

However, research questions regarding the infrastructure of 5G networks, the enabling technologies, and application scenarios remain open (Barakabitze et al., 2020). One of the disruptive concepts that could provide answers to these questions and achieve the 5G vision is Network Slicing (NS), which will provide operators with capabilities to create different level of services for different enterprise verticals, enabling them to customize their operations. Barakabitze et al. (2020) remark that one of the significant questions is how to meet the requirements of different verticals over 5G networks.

In terms of security, 5G needs robust security architectures and solutions since it will share a great amount of data, including personal data, to communication networks. Ahmad et al. (2018) investigate and highlight the important security and privacy challenges in 5G, already remarked by the Next Generation Mobile Networks (NGMN, 2015). Table 1 shows a summary of the security challenges in 5G that will fulfil the design principles of 5G (mobile clouds, Software-Defined Networking (SDN) and Network Functions Virtualization (NFV) according to Ahmad et al. (2018).

Security Threat	Target point/network element	Effected Tech.			Links	Privacy
		SDN	NFV	Cloud		
DoS attack	Centralized control elements	x	x	x		
Hijacking attacks	SDN controller, hypervisor	x	x			
Signaling storms	5G core network elements			?	x	
Resource (slice) theft	Hypervisor, shared cloud resources		x	x		
Configuration attacks	SDN (virtual) switches, routers	x	x			
Saturation attacks	SDN controller and switches	x				
Penetration attacks	Virtual resources, clouds	x		x		
User identity theft	User information data base			x	x	x
TCP level attacks	SDN controller-switch communication	x			x	
Man-in-the-middle attacks	SDN controller communication	x			x	x
Reset and IP spoofing	Control channels				x	
Scanning attacks	Open air interfaces				x	x
Security keys exposure	Unencrypted channels				x	
Semantic information attacks	Subscriber location				x	x
Timing attacks	Subscriber location			x		x
Boundary attacks	Subscriber location					x
IMSI catching attacks	Base station, identity registers				x	x

Table 1 Security challenges in 5G technologies (Ahmad et al., 2018)

5.3. Big Data Analytics

The number of sensors from vehicles and traffic management systems generates a huge quantity (volume) of different types of data (variety) that needs to be processed in real-time (velocity). These three characteristics (i.e., volume, variety, and velocity) are the main features of Big Data, which makes it a core technology in ITS.

The advances in computing technologies in Big Data, such as artificial intelligent and machine learning, allow new ways to analyse data from cameras, GPS, mobile phones and sensors offering new opportunities to create better ITS. In fact, analysis of this data allows to optimise the use of infrastructure by improving the demand forecast, but also the asset maintenance and the real-time optimization of traffic control policies.

One of the challenges of Big Data in mobility is to interoperate transport systems to enhance the user experience and provide mobility services that be a real alternative to the use of private cars. To achieve it, we need data standards which allow the interoperable exchange of data between different travel information services and reduce the cost and complexity of data management. The deployment of these ITS will be a reality in the measure that the different companies from the mobility ecosystems, public and private, use these standards and share their data to build an integrate system.

Since ITS requires a large amount of data to offer personal mobility new kinds of legal concerns appear related to data protection and their processing. In this way, Constantini (2017) proposes, to overcome the remarks on the aspects strictly linked to General Data Protection Regulation (GDRP) that all operators draw a specific Code of Conduct concerning Data Protection (Article 40 GDPR) and propose a standard certification in this area (Article 42 GDPR). As an example, Finland approved a law integrating all modes of transport and enabling new, user-oriented transport services, which brings together transport market legislation and creates the preconditions for digitalisation of transport and new business models. The Finland experience shows that without a legislation framework the interoperability of different service providers could be difficult to guarantee.

5.4. Autonomous Vehicles

The connected and autonomous vehicles (AV) have introduced a large number of sensors in a decentralized way that could not have been taken otherwise. All this gathered information together with the autonomous systems of driving can help to reduce not only crashes, parking needs, and congestions, but also to change the way people travel.

According to the five levels of automatization model (L1: driver assistance; L2: partial automation; L3: conditional automation; L4: high Automation; L5: full automation) by Clarke and Butcher (2017), the L4 and L5, where an automated system conducts the driving without human interferences, are currently in development, and even some tests have been done. However, they still need to go through several stages to become a reality on our roads.

Martínez-Díaz and Soriguera (2018) describe the architecture of any AV in four parts: (a) the sensing system, which is responsible for the data collection from the environment, including other vehicles; (b) the client system, which consists of the hardware and operating system needed to process the data in real time to tell the vehicle how to proceed; (c) the action system, which consists of the mechanical parts of the vehicle; and, (d) the human-machine interface (HMI) basically oriented to provide information about the driving. Thus, AV needs to work in a cooperative environment exchanging information with involving V2I and V2V communications. According to Martínez-Díaz and Soriguera (2018), the establishment of a robust, powerful, safe and reliable communications network is still a main concern. Two tendencies are being followed all over the world: the use of evolutions of the wireless standard 802.11p, or of mobile networks, especially 5G.

AV implementation will require to consider, among other things, infrastructure adaptation. For instance, roads redesign will be required by adding lanes exclusively for AV. Also, marking for road signals and deployment of V2I communications to help routing the AV will be a must. Besides, Vehicle-to-Pedestrian (V2P) and Pedestrian-to-Vehicle (P2V) communication technologies for exchanging information will be necessary to improve road use and their safety (Olaverri-Monreal, 2016).

As we have seen, the AV technology, which includes new sensors, communication and guidance technology and software is still very expensive, which make the AV unaffordable for the majority of citizens. However, as any other technology on the market, it’s expected that the cost of self-driving systems drops significantly.

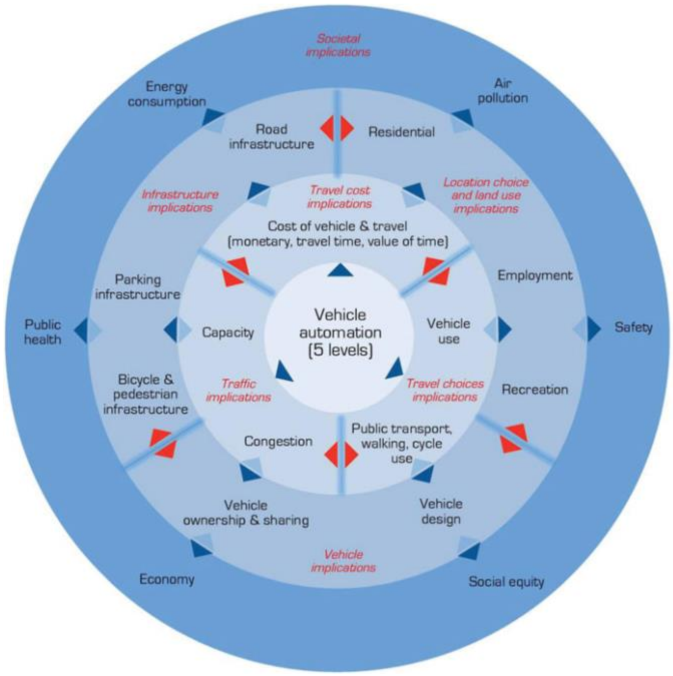

Figure 4 The ripple effect of automated driving (Milakis et al, 2017)

AVs represent a potentially disruptive and beneficial change to the ITS business model as these vehicles might bring several interrelated effects to mobility and society. This effect, called the ripple effect (Milakis et al, 2017), suggests that the driving automation is the source of several sequential effects in a three outer ripples (see Figure 4). The first ripple comprises the implications of automated driving on traffic, travel cost, and travel choices. The second ripple includes implications of automated driving with respect to vehicle ownership and sharing, location choices and land use, and transport infrastructure. The third ripple contains the wider societal implications of the introduction of automated vehicles.

In consequence, AV technologies can speed up the change in the mobility ecosystem. On one hand, AV can be an alternative for first and last mile option. On the other hand, AV can substitute the drivers of the taxis or ride-hailing services. As a result, these services are expected to become cheaper, which eventually may discourage car ownership (Bagloee et al., 2016). In fact, households will need fewer vehicles on average due to the additional flexibility of a private AV vehicle (McKinsey, 2016). However, AVs (with different operating constraints) will have share road space with non-AVs, resulting in mixed traffic patterns (Bagloee et al., 2016). The policymakers will have to take into account in their regulations (Bagloee et al., 2016).

6. New mobility services

In the last years, the mobility sector has seen a growth in app-based on-demand shared transport initiatives. These new mobility services have changed the urban mobility sector from a limited transportation offer to a scenario full of new players. Hence, Gilibert and Ribas (2019) suggest a classification of different types of for-profit shared mobility business models (see Figure 5).

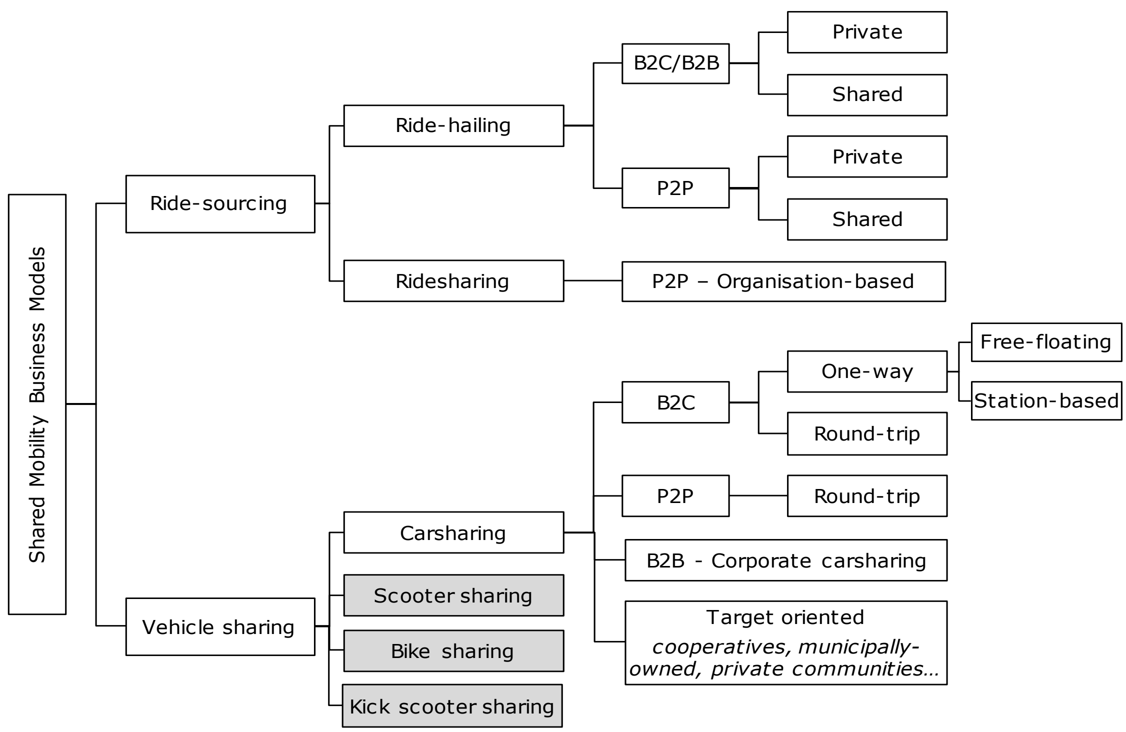

Figure 5 Classification of for-profit shared mobility services (Gilibert and Ribas, 2019)

According to the previous model, there are two types of Shared Mobility Business Models: (1) ride-sourcing, which includes all on-demand and pre-book services which offer a ride, and (2) vehicle sharing, which is based in renting vehicles for short periods of time and where different users can use them during the day.

Ride-sourcing refers to the services of ride-hailing and ride-sharing, since both activities offer private rides, i.e. driven transportation services. Ride-hailing operates like taxis, with the difference that this service is not authorised to pick up street hails and therefore, requires passengers to previously book their trips.

Ride-hailing is divided into singular B2C, chauffeur driven vehicles commonly called CTV services (Chauffeured Tourism Vehicle), singular P2P, where people seeking an economic return work as drivers using their cars to drive passengers to their destinations. In both modes we can find the shared version of the service, which are not so popular, since they are more complex and have recently emerged. They operate as shared taxis, which means that passengers are willing to share the ride with other passengers going to the same direction. This involves having, in addition to the user application and the booking platform, a routing software in order to group these users and guide the driver at all times, since in a single journey there could be many different pick-up and drop-off locations, which could implicate many short detours.

Conversely, ride-sharing is defined as a non-profit activity, where both driver and passenger/s share similar destinations and decide to share trips in order to share travel costs (Chan & Shaheen, 2012).

In the second branch of Figure 5, there are the vehicle sharing options, which are divided into four branches: carsharing, scooter-sharing, bike-sharing and kick-scooter sharing. Concerning carsharing, there can be classified into B2B, B2C and P2P models. In the case of B2B or corporate carsharing and P2P, they usually operate using the round-trip mode, where users are requested to return the vehicles provided to the pick-up location. Though, for instance, SocialCar, a P2P carsharing platform, offers the option of requesting and offering a home pick-up and delivery service (SocialCar, 2017). B2C carsharing services can be found either in the round trip and point-to-point modes. The point-to-point or one-way type allows users to return the vehicles near their destinations, in determinate points (station-based) or directly on the streets (free-floating or flexible).

Bike-sharing, scooter-sharing and kick-scooter-sharing are micro-mobility options mostly used as first and/or last mile options.

Bike-sharing systems have emerged as one of the fastest growing innovations in many cities around the world. They are intended to provide individuals with increased convenience and flexibility in access to bicycles without the cost and responsibility associated with bike ownership (Faghih-Imani & Eluru, 2016; Van Lierop, Grimsrud, & El-Geneidy, 2015).

Likewise, scooter sharing includes two types of services (Shaheen et al., 2019a, p.3):

- Standing electric scooter sharing: shared scooters with a standing design with a handlebar, deck and wheels that is propelled by an electric motor.
- Moped-style scooter sharing: shared scooters with a seated-design, electric or gas-powered, generally having a less stringent licensing requirement than motorcycles designed to travel on public roads (see Figure 6).

Figure 6: Example of a Moped-style electric Scooter:
Source: https://pixabay.com/es/photos/rodillo-scooter-el%C3%A9ctrico-4384701/

Although some studies found that scooter sharing is an alternative to motor vehicle travel, the truth is that the impacts of standing electric scooter sharing are limited. Thus, more research is needed to understand the impacts on travel behaviour, infrastructure, environment, and safety (see, Shaheen et al., 2019a, pp.6-7).

Finally, Kick scooter-sharing is a new form of mobility that "has solidified itself as a great way to make short distance trips easier and faster"[3]. It is a new type of shared EV, that is light (maximum weight of 25kg), has the potential to cover trips under 2 miles, and which is easy to use[4] (see figure 7). In short, Kick scoots are seen as a great way to make short distance trips easier and faster.

Figure 7: Example of a Kick Scooter.
Source: https://pixabay.com/es/photos/voi-e-scooter-vespa-rodillo-csd-4392378/

6.1. Analysis of car-related shared mobility business modes

Until now, the mobility services offer that could be found in any city was limited. Now, the situation changes and some cities are closer than others to this future full of local, global, public and private providers, among them offering many different services with the aim of covering people's mobility daily needs in the best possible way. Nowadays, many of these transport services are unprofitable, and for this reason end up closing down, moving to other cities or changing their business model (Gilibert and Ribas, 2019). Therefore, it is interesting to analyse the main characteristics of each business models in order to find out the main characteristics of each service, as well as their differences.

This section analyses the business models of the most relevant ride-hailing and carsharing services in Amsterdam, Budapest, Barcelona and Madrid, in order to find out the main characteristics of each service, as well as their differences. The analysis of the business models follows the structure of the nine blocks suggested in the Business Model Canvas created by Ostarwalder and Pigneur (2013). Table 2 shows the full sample of companies analysed.

Notice that Amsterdam is the city which has more type of car related mobility services. It is also interesting to observe that even though Barcelona and Madrid are in the same country, the deployment of the

[3] See, https://invers.com/news/why-kick-scooters-are-not-just-a-fad/

[4] See, https://medium.com/@INVERSmobility/kick-scooter-sharing-is-the-gateway-to-shared-mobility-f4c0a39c29a5

carsharing, for instance, is not the same. This is due to the city regulations that allow, or not, the deployment of these services.

	Amsterdam	Budapest	Barcelona	Madrid
Carsharing	Snappcar Mobeazy Mywheels ConnectCar Greenwheels StudentCar Amber Fetch Car Sharing ShareNow	Greengo MOL Limo Drive now	Getaround Ubeqoo	Getaround SocialCar ShareNow Emov Wible Zity ShareNow Respiro WishLife Ubeqoo
Ride-hailing	Uber		Cabify	Uber, Cabify
Shared Ride-haling	Viavan			

Table 2 Sample of the car-related shared mobility companies

Block: Value Proposition

Although each mobility service has its particular value proposition, they all have the two main features in common: they are app-based and have been designed to provide a more convenient mobility service than the public transport or the private car. The greatest difference of these new transportation services in comparison to traditional ones is the use of the latest technology, which enables users to book, ride, drive or pay in a flexible, easy and convenient way.

Ride-hailing

Ride-hailing services offer private or shared pre-booked and on-demand rides, usually cheaper than the service provided by taxis. However, Uber could be more expensive when the user requests a luxury car or when there is more demand than supply. For example, Cabify doesn't apply dynamic pricing but also includes the possibility to choose among different cars, even electric vehicles and cars equipped with children seats, and offers premium facilities such as WiFi, a bottle of water and the possibility to choose the music and the temperature during the trip. When the service can be shared, such as in Viavan, the end-users can choose between shared ride or a private ride, in the App. Moreover, most of these kinds of services offer real-time information of the Estimated Time of Arrival (ETA) and cab position, information of the driver assigned (picture, name, rates, etc.), cashless payment or centralised invoicing for business, and some of them also offer sustainable rides (since they use electric cars). On the other hand, most of ride-hailing services offer flexible jobs as drivers, with or without car, depending on the service provider, and some of them also offer financial aids to buy a vehicle and discounts on fuelling and insurances. Table 3 shows the main characteristics of these services in several cities.

	City	Shared	Stops
Viavan	Amsterdam	X	virtual bus stops
Uber			door-to-door

Cabify	Madrid	door-to-door
		door-to-door
	Barcelona	door-to-door

Table 3 Features of the Value Proposition in the Ride-hailing

Carsharing

Carsharing offers a flexible, easy and digital access (via the subscription card or the app) to a variety of vehicles (depending on the service provider) in order to always cover citizens' requirements. This service can by point-to-point free-floating (the user can leave the car park in any point of service area) or station-based (the user has to park the car in determined stations) or round trip (the user has to leave the car at the same point where he picked it up). Although carsharing offer is usually much better within city centres, where B2C services are implemented, P2P carsharing enables the access to the service to the less populated areas. On the other hand, P2P carsharing offers car owners with underused vehicles to rent them per days, in exchange of an additional source of income. Table 4 shows the main characteristics of these services in several cities.

	City	Type of Service	Parking included	Fuel included	Insurance included	Toll included	Free-floating	Electric car	Station-based	Round-Tri
Snappcar	Amsterdam	P2P								
Getaround SocialCar	Barcelona Madrid				X					X
Getaround	Amsterdam	B2C			X					X
Mobeazy				X	X				X	
Mywheels				X						
ConnectCar Greenwheels StudentCar									X	
Amber								X	X	
Fetch Car Sharing							X	X		
ShareNow								X		
Greengo	Budapest		X			Pest	X	X		
MOL Limo			X	X			X	mix		
Drive now			X				X	mix		
ShareNow	Madrid							X		
Emov WiBLE Zity ShareNow Respiro WishiLife			X				X	X		
ubeeqo			X				X			
ubeeqo	Barcelona		X							

Table 4 Features of the Value Proposition in the carsharing

Block: Customer Segments

Emerging shared mobility services target, especially, city residents, but also other individual users Some of these services are also addressed to businesses communities. All of them, except from some carsharing services, require their users to hold a smartphone and a credit or debit card, or a PayPal account, in order to guarantee the reservations made and cashless payments. Besides that, some ride-hailing services include non-company drivers which are paid for trip made. Often, these drivers are requested to have, apart from a smartphone, the vehicle with which provide the service. Furthermore, in some countries such as Spain, ride-hailing drivers need to have either a taxi license or a CTV license.

Block: Communication Channels

Since the mobility services analysed are app-based, they mainly reach their customers through the own services' applications or through multimodal applications provided by the aggregator services including them. Another common and key channel of all these services is the website, since is where the customers usually inform themselves about the service and even sign up as users.

Block: Customer Relationships

Both the applications and websites of the mobility services explored provide a self-service interface for customers to help themselves, although all of them offer a customer support service. However, users also need personal assistance when signing up for a carsharing service or for a ride-hailing service as drivers, since some documentation needs to be checked. Besides, in order to retain customers, some services also offer loyalty programs. Moreover, the applications usually ask, after the use of the service, to rate the vehicle and/or the driver, and in case of drivers, to rate their passengers, feedback considered very important for the service provider in order to improve it.

Block: Revenue Streams

Emerging mobility services generally charge their customers per use; however, some services use a combination of a subscription fee and a usage fee, adapting the fee per use to the subscription chosen.

Ride-hailing

Ride-hailing services use the usage fee method, charging per ride made but with different combinations. Most of them apply a rate per kilometre and minute, like taxi meter fares. Fares applied are fixed (except in the case of Uber, which uses dynamic pricing to match the supply with the demand) and some services even estimate the total price of the trip when booking a ride, and therefore, they guarantee the price of it. Apart from that, in some occasions a flat rate per ride is also offered, as it happens when choosing the express option of Cabify, for example. On the other hand, Viavan establishes that all journeys within the Amsterdam ring road are always a maximum of 5 euros. Even outside the ring road the price is normally cheaper than to a normal taxi, TCA or Uber. The service offers also ViaPass options and bundle: Core zone Bundle (pay 39 euros in advance and receive 10 shared journeys within the core zone for a month), Bundle everywhere (pay 65 euros in advance and receive 10 shared journeys in the entire service zone for a month up to a maximum of 10 euros per trip), Core zone ViaPass (pay 149 euros in advance and receive 4 shared trips per day in the core zone for 4 weeks), Tourist Bundle (valid for 3 consecutive days, pay 35 euros to receive a maximum of 4 shared trips per day within the core, including a free ride from or to Amsterdam Schiphol Airport). Table 5 shows the main characteristics of the Revenue Stream in the Ride-hailing.

	City	Price	Bundles	Base rate	Booking fee
Viavan	Amsterdam	maximum price inside the city	several options		
Uber	Amsterdam			time/distance	X
Uber	Madrid			time/distance	X
Cabify	Madrid			time/distance	
Cabify	Barcelona			time/distance	

Table 5 Features of the Revenue Stream in the Ride-hailing

Car-sharing

Car-sharing services also use different pricing methods. Some of them have a fixed fare per minute, and/or per hour and/or per day established, but others, adapt theses rates depending on their different monthly subscription plans. This way, the cheapest plan offers the most expensive rates per rental and the most expensive plan offers the cheapest rates. Conversely, P2P car-sharing is slightly different, in this category the prices are not regulated leaving freedom to car owners to define the price for their vehicles. In this case, the car-sharing platform works as an agent, it collects the payments of each rental keeping a commission for all made deals. Table 6 shows the main characteristics of the Revenue Stream in the carsharing.

	City	Registration Fee	Starting Rate	Minutes for free	Maximum price per day	Price/hour	Price/min	Price/km	Price/day	Week Tariff	Weekend Tariff	Price/month	Minimum time	Plans
Snappcar	Amsterdam	X							X			X		
Getaround	Madrid Barcelona					X								
SocialCar	Madrid Barcelona								X					
Mobeazy	Amsterdam					X			X		X		X	
Mywheels	Amsterdam					X		X						
ConnectCar	Amsterdam	X				X		X						
Greenwheels	Amsterdam		X			X		X	X		X			
StudentCar	Amsterdam	X	X			X		X						
Amber	Amsterdam						X	X						X
Fetch Car S.	Amsterdam	X					X			X				
ShareNow	Amsterdam Madrid	X	X			X				X				
Greengo	Budapest	X		X	X		X							
MOL Limo	Budapest						X							
Drive now	Budapest					X	X							
Emov	Madrid	X					X		X					
WiBLE	Madrid						X		X					

Zity			X		X		
ShareNow				X			
Respiro		X		X	X		
WishiLife			X				
ubeeqo	Madrid Barcelona	X		X		X	X

Table 6 Features of the Revenue Stream in the car-sharing

Block: Key Resources

Key resources common to all of the services explored are the technological platform and the user application. Apart from these, there other key resources to consider according to each type of service.

Ride-hailing

Depending on the service provider and the place where the service is offered, they required to hold a taxi or a CTV license; the driver application (needed to receive users requests); vehicles, adapted to the features of each service (basic, premium, sustainable, etc.); algorithms to provide the routing, to match different users going to the same direction willing to share the ride, and to provide the surge pricing depending on the demand and supply of the moment; the insurance for the service provided; and investors, willing to acquire a fleet of vehicles, VTC licenses or invest money on the service provider concerned, among other options.

Car-sharing

One important resource are the vehicles (variety of cars and vans); the parking spaces to park the vehicles, which could be on-street, off-street or even in other places such as at the airport; the insurance for each car and user; and investment, in order to expand the service.

Block: Key Activities

Since all services explored required a technological platform as a key resource, they can be categorised as platform-related key activities, needing all of them to always optimise and manage their online platforms, and also promote them in order to continue acquiring customers. However, the different service categories have distinctive features, meaning that key activities can differ depending on the corresponding service, as described below

Ride-hailing

The most important actions required for ride-hailing services in order that they can operate properly are: the development and optimisation of the online platform that enables the service and, among other functions, connects drivers with passengers; the development and optimisation of both user and driver applications; the development and optimisation of the algorithms of routing, also the matching algorithms for ride-sharing services, and surge pricing algorithms for services like Uber and UberPOOL; obtaining and providing real-time information of the ETA and cab position to the customer; the management of the reservations, cancellations, payments and contracts; marketing in order to acquire drivers and passengers; and community management in order to retain them.

Carsharing

As mentioned, car-sharing key activities also include, among others, the development and optimisation of the technological platform that offers the booking system and real-time information of the availability of the vehicles and the development and optimisation of the user application or the website. But that is not all, car-sharing providers need, as well, to manage their fleets of vehicles and maintain them, in order words, keep them clean, fuelled or charged and repair them when it is needed; manage the reservations, cancellations, payments and contracts; conduct marketing campaigns and; in case of P2P car-sharing, provide the tools (on the online platform) so that car owners can post and update, quickly and easily, the information of their vehicles and their availability.

Block: Key Partnerships

All urban mobility services providers should have city councils as key partnerships since these strategic relationships could contribute to improve and expand their services. Apart from that, other key partnerships differ according to the characteristics of the service provided, as explained below.

Ride-hailing

As stated before, in order to carry out a ride-hailing service, drivers and vehicles are required. Therefore, either drivers provide their own cars or they should be supplied by rental car companies or automakers. For instance, in 2016 BMW provided twenty cars of its i3 model to Cabify, for its service in Madrid, and Tesla began to provide to Uber some of their Model S vehicles, also for its activities in Madrid (Navas, 2016). Besides, it is also possible that investors or collaborators provide the service with both, skilled/licensed drivers and a fleet of cars. Moreover, other key partnerships required, either as suppliers or strategic alliances, are map providers, to provide localisation and navigation, and insurance companies.

Car-sharing

Car-sharing providers also need vehicles, concretely, different type of cars and even vans, in order to be able to operate. Therefore, above all, they need a partnership with automakers. For instance, car2go only offers vehicles of Daimler, its parent company. In the case of P2P car-sharing, car-sharing providers obtain the vehicles to offer from particular car owners, which beforehand, have acquired their vehicles. Moreover, B2C and B2B car-sharing providers also need parking spaces to place their cars, and for that reason they need to have partnerships either with private parking operators or with local governments, providers of regulated on-street parking, as most of electric car-sharing has in Madrid. Besides, as other mobility services, car-sharing operators also need a relationship with map providers, in order to locate their vehicles; with insurance companies, in order to insure their vehicles and users; and with investors.

Block: Cost Structure

All three categories of the mobility services explored have similar costs, having all of them as fixed costs: the expenses related to IT development, maintenance and infrastructure; the salaries of employees; and the marketing expenditure and the corresponding taxes.

Moreover, in the case of B2C and B2B car-sharing, to the fixed expenditure it has to be added the costs of leasing or purchasing vehicles and the associated insurances, and also the cost of the parking spaces needed. Regarding variable costs, ride-hailing operators need to pay their drivers (in case of having the drivers as company employees, this cost becomes fixed and is considered as employees' salaries) and also the associated insurances (variable as long as the fleet is flexible), in accordance with the services carried out; and B2B and B2C car-sharing providers need to cover the expenses related to the maintenance of their vehicles, such as fuelling or charging, cleaning and repairs, expenses covered by car owners when car-sharing is P2P.

6.2. Analysis of micro-mobility business models

"Micromobility is the new term on the block" are the first words in a recent post[5] on Medium.com. Indeed, in the past few years, cities and shared mobility users have started to realize the potential of micro-mobility, which encompasses shared modes that are made on a vehicle less than 500 kg. In the last years, several bike-sharing, and scooter-sharing options has appeared in many cities. These services aim to complement the public transportation offering a door-to-door service to the users (first/last mile), and are generally restricted to urban areas.

Shared bikes are especially suitable for short distance trips (Zhao, Wang, & Deng, 2015). Several authors (e.g., Shaheen, Martin & Cohen, 2013, and WHO, 2016) state that bike-sharing systems contribute to reducing emissions and fuel usage, easing traffic congestion, and fulfilling recommended exercise requirements by integrating physical activity into daily life. The majority of bike-sharing systems are public. Many docked-systems are usually IT-based with credit card payments and have dynamic pricing schemes (Fishman, Washington, & Haworth, 2013; Shaheen, Guzman, & Zhang, 2010). The main barriers that prevent the uptake of station-based bike-sharing systems are the difficulty of accessing docking stations, the fact that the number of docks/stations is often restricted by space limitations in a city, and the municipal budget (Zheyan et al., 2019). In fact, the most recent generation of dockless bike-sharing systems, which combines cashless mobile payments and GPS (Global Positioning System) tracking, has the potential to overcome these barriers (see, Zheyan et al., 2019).

Scooter-sharing services, compared to bike-sharing, offer a faster option to move, allowing users to cover longer distances, and also is more attractive to reach some areas in non-flat cities (Kafyeke, 2017). There are several scooter sharing systems (both standing electric and moped- style scooters) across the globe (see, Shaheen et al., 2019b). Users access to scooters by joining an organization that maintain a fleet of scooters at various locations. In fact, users have to download the service company application onto their

[5] See, https://medium.com/@INVERSmobility/kick-scooter-sharing-is-the-gateway-to-shared-mobility-f4c0a39c29a5

smartphone, register and validate their driving license before being able to rent the vehicle for the first time. They typically provide gasoline or electric charge (for motorized scooters), maintenance, and may include parking too.

This section analyses the business models of the most relevant micro-mobility services in Amsterdam, Budapest, Barcelona and Madrid, in order to find out the main characteristics of each service, as well as their differences.

Table 7 shows the full sample of companies analysed.

	Amsterdam	Budapest	Barcelona	Madrid
Scooter-sharing	Felyx	Lime, Blinckee.city Ogre&Co	eCooltra, Acciona, Yego, Sccot	eCooltra, Acciona, Movo, Muving
Bike-sharing	Donkey republic, Hello Bike, OV-fiets, Urbee	MOL BUBI Donkey republic	Donkey republic, Bicing, Yego, scoot	BiciMAD

Table 7 Sample of the micromobility companies

Block: Value Proposition

In bike-sharing services, users access bicycles on an "as-needed" basis for one-way (point-to-point) or roundtrip travel using one of these bike-sharing models (Shaheen et al., 2020): station-based bike-sharing, dockless, or hybrid bike-sharing systems. All these systems operate with both traditional and electric bikes (e-bikes), and most bikesharing operators are responsible for bicycle maintenance, storage, and parking costs. Shaheen and Cohen (2019; p. 3) describe these systems as:

- In station-based bike-sharing systems, users access bicycles via unattended stations offering one-way station-based service (i.e., bicycles can be returned to any station).
- Dockless bike-sharing systems allow users to check out a bicycle and return it to any location within a predefined geographic region. Any location is valid.
- In hybrid bike-sharing systems, users can check out a bicycle from a station and end their trip either returning it to a station or a non-station location; or users can pick up any dockless bicycle and either return it to a station or any non-station location.

On the other hand, scooter sharing can be station-based, with a specified number of fixed rental locations, or free-floating in which the user can park the scooter in any point within a defined service area. Compared to bike-sharing, scooter-sharing is a faster option, allowing users to cover longer distances.

The value proposition among the various scooter-sharing companies analysed show no differences. They all offer the same services and the same characteristics: electric scooters, a free-floating, and two helmets. On the other hand, we found certain differences in the value proposition of bike-sharing companies, although most offer very similar services (see Table 8).

	City	Type of Service	Electric	Reservation	Station-based	Round-trip	Bonus
Donkey Republic	Amsterdam Budapest Barcelona	End-user			X		
Hello Bike	Amsterdam	Companies		X	X		
OV-fiets		End-user			X		
Urbee		End-user	X			X	
MOL BUBI	Budapest	End-user			X		
BiciMAD	Madrid	End-user	X		X		X
Bicing	Barcelona	End-user	mix		X		
Yego		End-user	X		X		
Scoot		End-user	X		X		

Table 8 Features of the Value Proposition in the bike-sharing

Block: Customer Segments

Most of bike-sharing users are commuters, which use this service to complete the door-to-door transportation, and tourists (if the bike-sharing service is not only for local residents). Despite the scooter-sharing services are also use for commuting, they are more and more used by young people for leisure trips or to go to city centres where it is difficult to park (Aguilera-García et al. 2020).

Kick scooter-sharing market is growing in importance. According to a recent report[6], in 2018, the kid's segment dominated the kick scooter market, although it is expected a rapid penetration of kick scooter among millennials. This report shows that various benefits for kids (e.g., the development of physical confidence, outdoor activity, and exercise, development of motor skills, and increase muscle power) explains the substantial growth of kick scooter among kids in the years to come. Moreover, it shows that rising kick scooter sharing services and technological advancement in the market will spur the adult segment growth, together with increased health consciousness among this segment.

Block: Communication Channels

As in the car-related business models analysed, they mainly reach their customers through the own services' applications or through multimodal applications provided by the aggregator services including them. They also use the website to give information to the users or to sign up them.

Block: Customer Relationships

Both the applications and websites of the micro-mobility services explored provide a self-service interface for customers to help themselves, although all of them offer a customer support service.

[6] See, https://www.credenceresearch.com/report/kick-scooter-market

Users of scooter-sharing services also need personal assistance when signing up for the service since some documentation needs to be checked. Besides, in order to retain customers, some services also offer loyalty programs.

Block: Revenue Streams

In the same way as the car-related shared mobility business models, scooter sharing companies charge their customers per use. Although all companies charge in minutes, some of them have two prices per minutes (e.g., Acciona and Muving): one when the scooter is in motion, and another when is not. On the other hand, some of these companies offer the option of prepaid packages with discounts, such as eCooltra, ACCIONA, Muving, Yego, and Ogre&Co. Besides, Blinckee.city has two prices, the standard and the student, which is more economic. It is worth noticing that companies in Budapest and Amsterdam charges a fee for the parking (price/minute) whereas the companies in Barcelona or Madrid do not, since the scooter can park on the road.

In the case of bike-sharing services, we identified more alternatives of revenue streams depending on the business model. Table 9 shows a summary of them for the companies of the sample. As we can see, the most common way for revenue is to charge per minutes of use.

	City	Subscription packages	maximum/day	price/ minutes	price/ hour	price/ month	price/ year	Pre-paid Packages
Donkey Republic	Amsterdam Budapest Barcelona	X	X	X	X			
Hello Bike	Amsterdam		X	X				
OV-fiets			X					
Urbee			X	X	X			
MOL BUBI	Budapest		X					X
BiciMAD	Madrid			X			X	
Bicing	Barcelona			X			X	
Yego				X				X
Scoot				X				X

Table 9 Features of the Revenue Streams in the bike-sharing

Block: Key Resources

Key resources to all micro-mobility services explored are the technological platform and the user application. Apart from these, it is required a fleet of vehicles and insurance. The station-based bike-sharing service also need the station or dock.

Block: Key Activities

One of the key activities of these services is the optimization and management of the technological platform, which includes the management of the reservation some minutes before, the lock and unlock of vehicles and the payment. Another key activity related to the customers is the marketing to promote the service in order to gain new customers as well as customer support. Finally, those activities related to the fleet management as the redistribution of vehicles, since during the day the most visited parts of the cities accumulate some vehicles whereas other parts, normally those that are the origin of the trips, require vehicles, and the maintenance of the vehicles, i.e. keep them charged in case of scooter sharing, and repair them when necessary.

Block: Key Partnerships

The city councils are key partnerships since they are the ones who decide if the service is allowed to run and expand in the city. Moreover, this service requires to have an insurance which is usually included in the price of the service. Some companies, are allowed to park their vehicles on the road by paying a fee to the city council, other use private parking to park them. In the last case, parking companies become key partnerships. Finally, banks, which lend money to the companies and manage the financial transactions (such as, the customer payments) are considered key partnerships.

Block: Cost Structure

The main fixed costs are the expenses related to IT development, maintenance and infrastructure; the salaries of employees; marketing and advertisement and the corresponding taxes. Additionally, it has to be added the costs of leasing or purchasing vehicles and the associated insurances, and also the cost of personal and the parking spaces needed or the fees to park on the road.

Regarding variable costs, the expenses related to the fleet management which include the maintenance, charging (scooter sharing), and redistribution of vehicles.

6.3. Analysis of Mobility as a Service Business Models

In the previous section the business models of different mobility services have been analysed but, from the user perspective, which one of these services is the more convenience (fast, cheaper, sustainable…) to go from one A to B at a certain time? Is it better to choose one service or to combine some of them? Journey planning apps helps the user to compare different modals options but MaaS goes a step further allowing the users to book and pay for the services selected, based on user preferences regarding time, comfort, cost, and/or convenience, as well as other transport related services such as parking. Hence, MaaS offers integrated planning, booking and payment, as well as, route information.

MaaS operators act as an intermediary between customers and service providers and hence it is crucial to understand the needs of both to create a sustainable business model. Grounding on an analysis of several MaaS business cases, Aapaoja et al. (2017) identified four business models for MaaS, depending on whether the operator is a private company, a public entity, a public-private partnership (PPP) or public-private-people-partnerships (PPPP).

According to Aapaoja et al. (2017), Commercial MaaS operator can act in two ways: as a reseller, combining and providing services from several transport service providers to end users via one interface; or as an integrator in which the ticketing and payment services are also added. On the other hand, when the MaaS operator is a public entity, the public transport operator focusses on enriching its services by integrating additional services as taxis, carpooling, city bikes and even digital services as mobile ticketing and payment and multimodal planning a routing. The PPP model integrates mobility services with local logistic service providers and other services (such as, school or statutory social service transportation). Finally, the PPPP model, extends the PPP model by adding shared resources as a part of public transport. These two models are considered a way for organizing future mobility and transport in primarily rural and sparsely populated areas and regions.

On the other hand, UITP (2019) identify three main MaaS business models: (a) Commercial Integrator, which is a marketplace with agreements between MaaS provider and transport operators; (b) Open Back-End Platform, which is set up by a public entity with rules determined by the public authority in which all mobility services have to open up their API's, and (c) Transport as the Integrator, in which MaaS is run by public transport with selected mobility services.

Polydoropoulou et al. (2020), from the analysis of the literature and qualitative data collected from stakeholders in three European areas (Budapest, Greater Manchester and Luxembourg city) via workshops and interviews, proposed a prototype business model for MaaS. According to these authors some aspects of the Maas business model has to be adapted regarding to the particularities of each city/region. So context is important to consider when defining a business model for MaaS.

This section analyses the business models of the MaaS operators in Amsterdam, Barcelona and Madrid (see table 10). All these MaaS applications are classified as Commercial Integrators. To the best of our knowledge, at the moment of the writing, Budapest has none MaaS operator in the city.

	Amsterdam	Budapest	Barcelona	Madrid
Aggregators	Amaze Radiuz		CityTrips URBI Free2Move Chipi	CityTrips, URBI, Free2Move, Chipi, MaaSMadrid

Table 10 Sample of the MaaS companies

Block: Value Proposition

The main value offered by aggregators is the integration of different travel services in a single application, from which the user can plan, book and pay not only the most suitable mobility service for every occasion (including public transport and ride-hailing and car-sharing services) but also plan multimodal trips. There are several pilots running or planned to start soon in The Netherlands by the Consortium, in particular Amaze, in Amsterdam, whereas in Barcelona and Madrid there are some MaaS application which allow the user to plan the trip, book and pay the mobility service by acceding directly to its application. The main difference between them is the type of mobility services and companies aggregated. Table 11 shows the set of services that the selected aggregators include in their services.

Polydoropoulou, et al. (2020) also highlight the gathered data related to travel as another revenue stream. MaaS operator having access to traffic data can provide travel demand management services and forecast travel demand, traffic flow and travel times which could benefit the MaaS operator as well as the mobility service providers.

	City	Type of Service	Plan	Book	Pay	Services									
						Public Transport	Car-sharing	Bike-Sharing	Ride-hailing	Taxis	Car rental	Scooter-Sharing	Kick-Scooter Sharing	Parking	Car-Wash
Amaze	Amsterdam	B2C	X	X	X	X	X	X		X					
Radiuz		B2B B2C	X	X	X	X	X	X	X					X	X
MAAS Madrid	Madrid	B2C	X	X			X	X				X	X		
CityTrips	Madrid - Barcelona	B2C	X	X	X	X	X		X	X		X	X		
URBI	Madrid - Barcelona	B2C B2B	X			X	X	X				X	X		
Free2Move	Madrid - Barcelona	B2C B2B	X	X	X	X	X	X				X	X	X*	
Chipi	Madrid - Barcelona	B2C	X	X		X	X	X	X	X		X		X*	

Table 11 Features of the Value Proposition in the Aggregators

Block: Customer Segments

MaaS aims to provide the most convenient transportation option to the users in order to reduce the car ownership. Hence, the customer segments are different groups of private users from commuters to families and students. It is worth noting that there are three special target groups: (a) car owners, which can find a good alternative to the use of their car; (b) young people, which are less interested in car ownership and are more likely to adopt MaaS; and, (c) business, which are looking to reduce their car fleet and travel expenses (Polydoropoulou, et al. (2020). Radiuz[7], for instance, one of the MaaS application in Netherlands, is focused on business commuters.

[7] https://www.radiuz.nl/wat-we-doen/

Block: Customer Relationships

Customers/users can communicate through the MaaS website or application. A loyalty program can also be established to build customer relationships and retain customers (Magatef and Tomalieh, 2015). Radiuz have a call centre to help the users whereas CityTrips[8] uses the email.

Block: Revenue Streams

Some of the applications analysed charges for the use of each one of their services, keeping a commission for each sale or rental made done from the app. Most of them sell dashboards with relevant available data from mobility in a city to transport operators and public administrations.

Block: Key Resources

MaaS operators need to commit technological resources, such as, the physical platform, the website, the mobility application, and the information system where all the information is integrated. Likewise, people involved in running the business (from the management team to the helpdesk staff) are key players.

Block: Key Activities

The development and optimisation of the technological platform, is the most important activity of aggregator providers. Several reasons can be given for such a statement. The main ones are that the technological platform: *(i)* enables the user to plan their trips from a single application, *(ii)* give them real-time data of public transport and availability of private transportation services, *(iiI)* offer them the bests combinations for their trips, *(iv)* and even allows to schedule and book them. Another important activitiy is related to customer service and to gather and analyse customer information for knowing customers' requirements and improve the service (Polydoropoulou et al. 2020). Finally, they also require properly managing reservations, cancellations and payments, and conducting marketing actions.

Block: Key Partnerships

First of all, aggregators need services to be unified in a single application, therefore their main partners are both public and private transport operators. Public transport operators include bus, train, tram and metro operators, whereas private transport operators include share mobility operators, taxi and car rental companies. Moreover, some of them also offer multimodal services, such as trip planning and the combination of different mobility services in a single booking. For that reason, they also need to establish a key relationship with map providers. Finally, parking companies can be also considered key partners since if car-sharing or scooter-sharing are included in the Maas scheme.

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[8] https://www.racc.es/aplicacion-CityTrips

Block: Cost Structure

The cost of MaaS includes the development of the technological platform, as well as the cost of manage and maintain the system (operational cost). Polydoropoulou et al. (2019) highlight that operational costs include fixed costs (e.g., amortization of the investment cost, marketing and advertising cost, maintenance cost for the website, the mobile application and the information system, the legal-related costs and the data security and privacy related costs), and variable costs, which comprise customer service and support costs, personnel costs and insurance costs.

7. Regulations for MaaS

In the creation of MaaS systems, governments should also address more prosaic issues around vehicle driving, service provision, consumer protection, data protection, liability, and equal access. Government entities can use their power to foster equity in transportation provision, ensuring geographic coverage and accessibility, as well as serving low-income and underserved populations.

7.1. Introduction

The regulations regarding MaaS appear at diverse structures, levels of detail, and at different public institutions. For example, depending on the country, regulations are at the national level (e.g., Finland); in others, they are at the city level (e.g., Amsterdam). The topics in these regulations, their details, and the way to manage them also are varied.

Based on the review of the literature and several regulations, we identify three main blocks of content:

- Regulations about the functioning of MaaS
- Regulations about access to the mobility market
- Regulations about promoting the MaaS

7.2. Regulation Approach

The regulation approach for each block can differ among countries and cities, as well among them in a specific country, region, or city. We can define four approaches, which are not exclusive of each other within the same regulation: Strategic Tactical, Operational, and Reflexive (Smith and Hensher, 2020).

The strategic approach focuses on the desired long-term results and their corresponding investments. This approach can serve as a starting point for the development of other, more specific regulations. It is a way of establishing a framework for MaaS in a country, region or city.

The tactical approach focuses on the short- and mid-term results and their corresponding investments. This approach establishes the play-rules of MaaS, and the obligations and rights of the actors: government, public sector, private companies, and, in some cases, the universities (see the example of Amsterdam). In this approach, we can find the principles to follow when we start to implement the MaaS (e.g., principles of transparency of data).

The operational approach focuses on how to carry out several activities related to the implementation of the MaaS. For example, the specific protocols to share data and to interconnect systems. This approach gives detailed instructions about how to implement and manage the MaaS.

The reflexive approach focuses on to make all actors aware of the need for MaaS. This approach also tries to explain the fit of the regulations with the current situation of the country, region or city.

7.3. Regulations about the functioning of MaaS

The MaaS is the core of these regulations and contains different aspect to take into account. The first aspect refers to the data concerning mobility services. For example, which data the Maas needs, how to share this data, where to hold this data, who is in charge of this data, and when to share this data. Depending on the approach, the regulation can contain principles to share data (delegating to the market to decide the best option), or the specific protocol to share the data by private companies.

The first regulatory effort establishing preconditions for MaaS services and the standards for data exchange take place in Finland, in April 2017, where the Act of Transport Services was adopted. This regulation obliges passenger transport service providers to give access to essential data related to mobility services (Mass-Alliance, 2017).

In The Netherlands, the Ministry of Infrastructure and Water Management has recently launched 7 regional MaaS pilots with different policy objectives, from accessibility and social inclusion to sustainability, cross-border transport and traffic jams. In the framework agreement dossier there is a part dedicate to the open standards to ensure the full interoperability between transport operators.

The second one refers to the interfaces. As MaaS aggregates different services in just one place, it is necessary to define some prevalent criteria related to support services, terms and conditions of use, software, and licenses. These interfaces need to offer on fair, reasonable and non-discriminatory terms.

The third one refers to the interoperability of tickets—one ticket for several services from different providers. Taking into account this complexity, some regulations about the procurement and the criteria to satisfy everyone and simplify the work of customer is needed. This aspect of the regulation has to define how to update and change the current system of tickets of the country, region or city.

In this way, the Act of Transport Services of Finland contains provisions on the interoperability of ticketing and payment systems.

The fourth one focuses on the interoperability of services defining the play-rules among the service companies, and the interfaces. The process of interconnecting these services and the criteria for selection are elements to consider in this part.

The fifth and last one refers to the payment systems, where the regulation suggests (or forces) the use of a set of systems.

7.4. Regulations about access to the mobility market

The transport market legislation affects directly to the design, implementation, and use of MaaS systems. In the last years, new business models have appeared in the transport market, such as the sharing vehicles. And the forecast in short- and medium-term is that new business models and new actors/players will appear in the transport market.

These new mobility services unrest amongst traditional providers offering very similar services. For instance, Ride-hailing companies are competing with taxis but in most of the European cities they are not subject to the same regulations. On one hand, taxi drivers need a license to operate, on the other hand, the fares that taxi companies apply are regulated, instead ride-hailing companies are free to change low fares when demand is low and high fares when demand is high. However, in some cities, taxi companies have some privilege such as the use of bus lanes and street-hailing.

In some European countries the launch of ride-hailing has met a huge opposition from taxi associations because they consider them unfair competition. In Spain taxi drivers, protested since ride-hailing are not paying enough taxes and have a cheaper cost of VTC licenses compared to that of taxis. This fact led the regulators to find formula to distinguish both services. Moreover, in Barcelona, the local government impose a waiting time of at least 15 minutes between a booking being made and a passenger being picked up, which made ride-hailing services to leave the city, although Cabify returned one month later reinterpreting this limitation. In Hungary, regulators expelled Uber from the country. Conversely, Finland opted to deregulated taxis to secure a fair competition between both services.

Another example that shows how regulation can affect the deployment of mobility services can be found in the car sharing service. Lagadic et al (2019) indicate three key points to enable car sharing services: provide financial support, for instance with the development of the charging infrastructure as in Paris, Copenhagen or Amsterdam contrary to Madrid in which each service provider has to install its own charging point, which has impeded the expansion of services beyond the central ring; give service providers access to public space as in Madrid where full electric vehicles can park everywhere free of charge and without time limit, contrary what happen in Copenhagen where free-floating operators must pay the same parking fee as a private user (e.g. Car2Go left for this very reason); and, finally, to integrate the development of car-sharing in the planning policy for instance limiting the parking to private cars as in Madrid or facilitating the parking as in Amsterdam where Car2Go vehicles occupy parking spots equipped with a charging pole one third of the time.

As it has been noticed, these new mobility services lead to new regulations, both for each of the business models (e.g. UBER) and the general transport regulation that affects all business models, both public and private, in the same way.

These regulations must allow the coexistence of current and future business models related to the transport market, as well as their role in the MaaS. To achieve this goal, these regulations should facilitate market access, dismantle competitive barriers and reduce operators' administrative burdens, deregulating most of the requirements for transport services.

According to Cerre (2019) a well-designed regulation has to guarantee that new mobility models complement and not substitute public transport. In that way, MaaS can enable the transition towards truly sustainable mobility.

7.5. Regulations about promoting the MaaS

The regulation can also contain the strategy, tactics, practices and actions to promote the awareness and the use of Maas. Depending on the intensity and the national culture, there are several elements to consider. The use of taxes, grants, restrictions, indicators, good and ethical practices, and recommendations are some of the methods to carry out.

7.6. Structure of the content of the regulations

According to Smith and Hensher (2020), the structure to regulate the design, implementation and use of MaaS should contain the following parts:

- Terminology - Establishing a shared language on MaaS
- Objectives - Crafting inspiring visions and targets for MaaS
- Rules - Lowering institutional barriers and steering the trajectory towards contributing to policy objectives
- Technologies - Developing front-end, back-end and support systems for MaaS
- Business models - Assisting the development of viable and sustainable business models for MaaS
- Modes - Pushing the diffusion and availability of mobility services, to include in MaaS
- Alternatives - Supporting the relative attractiveness of MaaS, compared to alternative options
- Partnerships - Assisting inter-organizational collaboration, experimentation and mutual learning
- Diffusion - Accelerating the adoption and use of MaaS

To finish this section, a summary of the approaches to the MAAS regulation is shown in Table .

	Regulations about…		
	The functioning of MaaS	The access to the mobility market	The promotion of the MaaS
Strategic approach	Framework of MaaS	Framework of the access to the mobility market	Framework of the promotion of the MaaS
Tactical approach	Regulations about the functioning of MaaS	Regulations about the access to the mobility market	Regulations about the promotion of the MaaS

Operational approach	Activities for the implementation of MaaS	Activities for carry out the access to the mobility market	Activities for the promotion of the MaaS
Reflexive approach	-	Make all actors aware of the need for new mobility services	Make all actors aware of the need for MaaS

Table 12. Approaches about the MAAS regulations

8. Conclusions and Lessons learnt

Mobility as a Service (MaaS) is seen as the solution to improve intermodal access to public and private mobility services while aligning with the sustainable cities approach. However, the implementation of this innovative solution requires the development of some disruptive technologies, the sustainability of new mobility services business models, and an adequate regulatory framework.

The analysis of the business models of the new mobility services shows little differences among them. The value proposition and the revenue stream are very similar, which does not distinguish any sustainable advantage among them. The most important significant difference is the market target that they address: most of them focus on citizens, and only a few of them on employees in large companies. On the other hand, existing regulations could block innovations to protect existing services and business models. Disruptors will argue that they are not subject to the existing regulatory framework, while incumbents will require regulators to ensure that innovators meet the same standards as the incumbents as a matter of regulatory fairness (OECD Secretariat, 2015). This has been the case of the ride-hailing services which has been expulsed from some cities because they were considered as an unfair competence to taxis.

On the other hand, the new technologies are evolving very fast but some issues remain to be solved such as the standardization of communication protocols, configuration of the network communication between vehicle to vehicle or vehicle to infrastructure, the development of the infrastructure of sensors or the deployment of the 5G network. The deployment of MaaS will be a reality in the measure that the different companies from the mobility ecosystems, public and private, use these standards and share their data to build an integrate system. Besides, since MaaS requires a large amount of data to offer personal mobility, new kinds of legal concerns appear related to data protection and their processing. Last but not least, we cannot forget that the success of MaaS is ultimately dependent upon a shift in citizens' behaviour towards using this intermodal mobility proposition.

In short, the success of the operationalization and deployment of Maas depends on:

- The large quantity of real-time data from the sensors of transport infrastructure and autonomous/connected vehicles.
- The integration of more and more different systems, such as the sensors systems of transport infrastructure and autonomous/connected vehicles.
- The wireless communication technology (such as 5G) that can interconnect the previous systems without delay.
- The ability to process and analyse all this data in real-time by Big Data Analytics (using predictive and prescriptive models).
- Flexible Business Models which fit with the needs of citizens and MaaS regulations.
- Public and Private operators' collaboration.
- Specific regulations for the deployment of MaaS.
- Regulations for access to the mobility market in line with the MaaS regulations.
- Regulations and policies for promoting the use of MaaS in line with the MaaS regulations.
- A coherence among all related regulations at the national, regional and city level

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