Report for ART

on

Mobility as a Service (MaaS)

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1 Introduction

1. A complex set of global trends shapes our lives: rising urbanization, ageing population, climate change and digitalization, to name just a few relevant for the topic addressed in this report, all of which place significant challenges to sustainable development goals.

2. The world population is expected to increase, reaching 9.8 billion people in 2050 (United Nations Department of Economic and Social Affairs, 2017), together with a significant demographic shift taking place with different intensity across the world, that is: the ageing of population with increasing life expectancy and, in several countries, decreasing fertility. Together these trends challenge how the world is prepared to ensure good quality of life in this new reality.

3. Alongside population growth, there is an accelerated urbanization trend, expected to have repercussions in the total number of urban agglomerations with more than 10 million inhabitants; by 2030, 43 megacities worldwide (most of which in developing countries) are estimated to reach this level (Lajas, 2018).

4. In the European Union, 72,4% of the population lives in urban areas, and there is a growing trend of blurring boundaries between urban and rural areas. Increase of opportunities and improvement of living standards are the positive sides of this phenomenon, though some warn that "it carries risks in terms of rapidly growing burden of resource use and pollution" (European Environment Agency, 2015).

5. In parallel, the exponential development of ICT with computers, the internet and mobile phones created a new online world relying on flows of information being transferred at high speed in an invisible and often unaware way. To size this phenomenon, the International Telecommunications Union states that, in 2017, the number of mobile-cellular subscriptions exceeded 100 per 100 inhabitants (reaching 111.32 globally) (International Telecommunication Union, 2017). Comparing with UNICEF estimates that, in the same year, 2.3 billion people still "lacked a basic sanitation service" (UNICEF, 2017), it appears that in the information era more people have access to mobile phones than to sanitation[1].

6. Unstoppable, a new wave of ICT developments and a second digital revolution encompassing four key developments – the Internet of Things (IoT), cloud computing, big data analytics and artificial intelligence – is impacting society in numerous dimensions. The creation of "the cloud" means *"that data is theoretically accessible anywhere, and the proliferation of smartphones means that anybody can access the data"* (Bouton *et al.* 2015).

[1] https://www.unicef.org/wash/

7. As pointed out by Lajas (2018), data is known as the new "oil" of the 21st century. A huge amount of data is generated every day around the world and is expected to double every two years; consequently big-data analytics is determinant to extract descriptive, explanatory, and predictive insights from raw data.

8. Information which was previously considered an asset not to be shared is becoming virtually free and available in real-time. As indicated by Finger and Razaghi (2017), digitalization can have greater implications for cities than those entailed by the concept of "Smart Cities", *"namely first the implication for the management of urban infrastructure systems, second the implications for urban services, and third the implications for the governance of metropolitan areas more general"* [2].

9. From the consumer/citizen perspective, digitalization provides convenience and informed choices and enables information gathering. Digitalisation made the emergence of the digital economy possible, with traditional businesses going online, and the rise of the sharing economy. The so-called "collaborative consumption" is perceived as a social revolution that allows the sharing of resources across multiple platforms, challenging the traditional concepts of private ownership.

10. The Millennial and Gen Y generations (born between 1980 and 1995), often referred as "tech savvy consumers", are at the forefront of technologic advancement. As noted by Dewalska-Opitek (2017), research shows that this generation is "*less interested in buying, and more interested in availability*", that is using, with lower-cost options from within a collaborative consumption or *usership*, only possible with reciprocal trust among customers.

11. The last decade witnessed significant changes in our societies. The previous paragraphs provide a brief overview of the trends that affect urban mobility and of the challenge posed by the process of achieving the sustainable development goals. Against this background, a new agent arrived and changed the dynamics of the eco-system; it operates information and through it has the power to enhance the easiness to use of the whole mobility system. Not by chance in many cities it is common to refer to the mobile phone as the "new mode of transport". The underlying facilitator is organised information.

12. As already mentioned, information is now available and virtually free. Big questions such as how to use it, which rules apply, which rights and obligations arise, are key to assess the opportunity of introducing intelligent systems like MaaS. These questions address the functions of regulators and

[2] See European Commission, European innovation partnership on smart cities and communities. Strategic implementation plan, 2013: "*Smart cities should be regarded as systems of people interacting with and using flows of energy, materials, services and financing to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society*".

government, but also of service operators and infrastructure managers. All the agents of the eco-system are forced to look at urban mobility systems in a different way.

1.1 Role and impacts of transport

13. Transport has been determinant for the development of territories since ancient times. Apart from food and water availability, civilisations usually developed near riverbanks, ports, and trade routes. Major transport technological advances, that affected speed, range, price, affordability, and comfort, changed the way of living and had a major impact on the organisation of society and its quality of life.

14. The characteristics and robustness of a transport system today is one of the main drivers of the development of a country. Today the transport sector in many developed countries accounts for between 6% and 12% of the GDP and represents 10% to 15% of total household expenditures (Rodrigue, 2020). Transport networks and services allow the movement of people and goods, and provide access to opportunities (jobs, businesses, education, health, leisure, etc.) which is fundamental to support economic growth.

15. The impacts of transport in society are diverse. Impact on the environment, road safety and health are some of the most important effects. Concerning road safety, approximately 1.3 million people die each year because of road traffic accidents (93% in developing countries) and this type of injury is the leading cause of death for children and young adults aged 5 – 29 years (WHO, 2022). Accident costs have serious impact on national economies (human, medical, material and loss of production costs) and are estimated to represent 3% of their annual gross domestic product.

16. High levels of congestion in urban areas are one of the most visible causes of air pollution and have several impacts on economy, namely costs related with travel time delay; productivity; environmental costs and safety impacts. Although changes in urban settlements throughout the years with the increase of urban population led to urban sprawl, as Banister refers (2008), transport solutions to urban problems, the change in travel patterns and the longer distance of travel increased its costs and caused unsustainable travel and congestion.

17. Barthelemy (2016) studied and compared congestion in 300 cities and found out that the impact of congestion on GDP (based on travel delay - value of time and average income) represents between 1-2% to 4%. As an example, the extra travel time during peak hours for one hour trip in London is 39 minutes, which means significant losses in productivity.

18. The transport sector depends heavily on fossil fuels and is therefore an important source of greenhouse gas emissions contributing 25% of global Green House Gas emissions (UN, 2021). Air pollution is the most important source of local environmental externalities of transport, especially in cities, where the

main vehicle emissions like particulate matter (PM) and nitrogen dioxide (NO2) harm human health and the environment. Noise pollution is another major environmental health problem linked to transport, and road transport the most widespread source of noise.

19. Although being considered a derived demand – which refers to demand for one good or service in one sector occurring as a result of demand from another – and being perceived as a means and not an end in itself, transport can also be seen as a cause for inequities. This is the case when transport policy decisions aim to achieve a fairer distribution of benefits and costs, considering social justice equity regarding net income distribution for disadvantaged and unserved service; inclusivity (equity regarding need and ability); reduction of external costs that travellers impose on their communities (congestion, road safety and pollution) and follow a fair allocation of public resources.

1.2 Who is the stranger in the city?

20. MaaS combines public transport, such as buses, trains, and streetcars, with private and shared mobility options, such as car sharing, cab sharing and bike sharing. Users can plan, book, and pay for all their trips from a single platform, simplifying the travel process and making it easier to choose the most efficient transportation option for each trip.

21. MaaS is a new mobility concept that consists of the integration of multiple operators, services and modes of transport, both public and private, made available to the final traveller in an easy and unified way through digital services available to the traveller, accessible via smartphone or other digital tools, operated through 'intermediation platforms' (technological tools, procedures, rules) that include different functionalities - such as information, multimodal journey planning and booking, management of the journey itself, unified payment for services, post-trip operations - capable of responding in a customised way to all specific mobility needs and able to offer travellers all the freedom of movement they desire. The traveller, in the MaaS world, can turn to a 'MaaS service operator' of his choice for the preparation and management of his journey; the MaaS operator, in turn, will 'construct' the most convenient trip, selecting and assisting, in accordance with the traveller's preferences, for the various legs of the journey, the transport service operator among those available and agreeing with the latter on the conditions of transport and payment. The MaaS operator acts, therefore, as a service intermediary, realising both on booking and 'run-time' the harmonious and customised integration of existing transport services.

22. MaaS services, by their nature, involve a wide range of operators with possibly diverging interests: from scheduled passenger transport operators, to taxi and car hire-and-drive services, to shared services - car, bike and others, including, in the near future, services based on self-driving cars - to new

operators of digital intermediation services, to 'innovative start-ups' that, for instance, realise technological solutions or models and algorithms capable of adding intelligence to the selection and composition of elementary transport services, thus providing innovative tools to MaaS operators or acting as MaaS operators themselves.

23. MaaS is seen as a tool capable of contributing to a broad range of objectives, including: access to mobility and travellers' experience (perceived quality) qualification and valorisation of the public transport system; modal rebalancing, oriented towards reducing use of private cars; consolidating sharing habits consistent with the convergence of collective and individual interests; reducing energy consumption; lessening of climate-altering effects of mobility and contributing to decarbonisation; reducing consumption of urban space for mobility and parking; increasing digital intensity in the mobility domain; increasing passenger transport productivity (number of passengers transported per unit of service offered); enhancing social sustainability and cohesion (by reducing travel time, increasing accessibility, reducing social and territorial inequalities, supporting the inclusion of weak travellers-users).

24. Mobility as a Service (MaaS) is an emerging concept that seeks to integrate various transportation services into a single platform accessible through a digital interface (Figure 1). This interface can be a mobile application or a website. The goal of MaaS is to provide an attractive alternative to the use of personal vehicles that is as good or better in terms of cost, convenience, and efficiency. MaaS has the inherent objective of making the use of public transport easy and the whole mobility chain more effective.

25. .

Figure 1 – Exemplification of MaaS application *(source: authors composition)*

26. This system relies on digitalization and connectivity to integrate different modes of transportation. This can include the use of real-time data to provide up-to-date information on transportation options, as

well as integrated payment systems to facilitate transactions. It also enables the use of data analytics and machine learning algorithms to optimize travel routes and improve the efficiency of the transportation system. It has the potential to transform urban transportation by reducing reliance on personal vehicles, which could have significant benefits in terms of reducing traffic congestion, air pollution and greenhouse gas emissions. However, it also poses challenges in terms of transportation access equity, data privacy, and transportation regulation (Pydokke *et al.*, 2018, Hietanen, 2014, Wir-Konas *et al.*, 2021).

27. The global MaaS market has been developing rapidly and is expected to grow further in the coming years. The market has been segmented based on type of service, which includes e-hailing (whereby customers can request a ride from a driver of a private transportation service via a mobile app), carpooling and others, and by age of users, with dedicated service categories for users under 25 years old, 25 to 40 years old, and over 40 years old (Market Watch, 2023).

28. In addition, several key trends and developments are observed in the mobility sector that are affecting and shaping the MaaS market, such as the following:

- *Electric Vehicles and Improved Battery Technology*: increased demand for electric vehicles (EVs) has driven the development of more efficient and sustainable batteries. Significant investment is being made to develop batteries that are less expensive, lighter, have longer lifetimes, and can be charged more quickly.
- *Connected and Automated Mobility*: Connected and Automated Mobility (CAM) refers to autonomous and connected vehicles that are enabled by sensors, artificial intelligence, and maps. Autonomous vehicles generate large amounts of data that, when applied with AI, allow the vehicle to operate and make decisions as if it were the driver. Safety is a critical aspect in the development of CAM.
- *The Rise of Shared Mobility*: there is a shift from individually owned vehicles to interconnected shared mobility solutions, used as a service as needed. This shift is driven in part by higher vehicle costs and by the younger, tech-savvy generation seeking easy and affordable mobility (IEEE Standards Association, 2023).

29. There have been several scientific publications on the topic at hand, which have focused essentially on the issues of the nature of the market, users, data, technology and the impact on the transportation system as well as on developing and evaluating business models, mobility service packages and policy aspects. Most of this literature has considered urban settings including only surface transportation alternatives. Multilevel approaches have been established for the organization and cooperation of stakeholders, showing different levels of integration of public and private actors at regional and supra-regional levels. However, there are still outstanding challenges to the further development of MaaS, such as a low willingness to pay, requirements regarding the individualization of mobility services and the handling of sensitive mobility data (Aditjandra et al., 2021).

30. It is important to keep in mind that, although these trends are ongoing, we are still far from a full implementation of mobility as a service, and there are many challenges to overcome, including

technical, regulatory and user adoption issues. MaaS is therefore a rapidly growing and developing area of research. Although much work has been done in the field, there is still plenty of room for exploration and future research.

31. For a deeper knowledge of "What is MaaS" we need to address the questions *Why*? *How*? and *What*? Answering them is fundamental to structure the concept and to understand the central building blocks that shape and condition its existence. In other words, we need to understand the ecosystem lying behind the visible part of MaaS.

2 MaaS ecosystem[3]

2.1 What is MaaS?

32. A wide range of "MaaS" definitions are used in the literature in different areas; this is unlike multimodality and intermodality that are well-known concepts and frequently referred to as partial solutions to pursue the provision of a more efficient and sustainable transport system. With "Mobility as a Service" the focus is wider and encompasses not only the right to choose the most convenient mode of transport, but also the ability and the means necessary to make that choice possible, leading to seamless mobility and integrated management of all trip stages.

33. There are references on "MaaS" that date before 2014 (Smith *et al.*, 2017) and concern an experience in Sweden with an R&D project (Go:Smart project) and the launching of UbiGo pilot during 2013-2014 (the "flexible traveller" MaaS pilot), as well as the Movense Ltd. workshop on "MaaS" (December 2013). Heikkilä's thesis (2014) is also referred to as one of the first studies with a focus on "MaaS", that was commissioned by the city of Helsinki. In her study, Heikkilä (2014) argued that the current organization of public transport didn't support flexible multimodal mobility and her focus was on proposing an action roadmap for the city of Helsinki to change the paradigm of mobility. The author defined MaaS as: *"a scheme in which mobility services are provided as an individual and flexible service in a competing mobility operator market. (…) MaaS refers to circumstances, in which comprehensive supplies of mobility services are provided by mobility operators. Versatile services offered by the operators satisfy all mobility needs, thus decreasing the need to possess a car"* (Heikkilä, 2014).

34. According to Jittrapirom *et al.* (2017), the "MaaS" concept was first comprehensively coined in 2014,

[3] This section relies on research developed in the dissertation of Renata Lajas under the supervision of Prof Rosário Macário at Instituto Superior Técnico. The full study can be found under the title "Public Policy Framework Supporting "MaaS" Implementation", 2018.

during the 10th European ITS Congress that took place in Helsinki as follows: "*a mobility distribution model in which all of customer's major transportation needs are met from a single platform by a single service provider that orchestrates each individual transport service component to meet a customer's end-to-end service expectations*" (Ovaska, 2017).

35. The public-private partnership "MaaS Alliance" established in 2015[4], works as a focal point that promotes a common European approach to MaaS and contributes today to European policy making among other activities; it understands "MaaS" as: "*the integration of various forms of transport services into a single mobility service accessible on demand. (…) (implying) the use of a single application to provide access to mobility, with a single payment channel instead of multiple ticketing and payment operations*" (MaaS Alliance, 2017).

36. Each author's perspective culminates in a definition of "MaaS", and it is also widely acknowledged that there isn't yet a commonly accepted description by the scientific community (Smith *et al.*, 2017; Polis Network, 2017). Indeed, in some of the conceptualizations, goals and visions overlap with core features and detailed system features of MaaS. Apart from the ones already mentioned, other relevant definitions are presented in peer-reviewed papers in Transport and Information technologies (IT), conference papers, institutional reports among other sources. A selection follows in table 1 while a more comprehensive list is provided in Annex 1.

37. The focus of the present analysis will drift away from IT-related publications, and will concentrate on the fields of transport, urban and social sciences. Authors with an IT background tend to reduce the definition of MaaS to little more than the technological aspects of an ICT solution. For instance, "cloud computing" is evidenced in some literature as an inspiration for the concept of MaaS only concerning a small part of the ecosystem (e.g. *"(MaaS) applies the everything-as-a-service paradigm of Cloud Computing to transportation",* in Callegati *et al.*,2016)

38. As a result of previous MaaS definitions analysis, Jittrapirom *et al.* (2017) suggested that "MaaS" can be thought as a concept, a phenomenon or as a new transport solution. It is possible to acknowledge in this investigation that other authors emphasize its emerging and holistic character (Sochor *et al.*, 2016) to justify the existence of more than one transversal definition. Others rely more on an "ecosystem" approach (Matyas and Kamargianni, 2017) and almost all concur that "MaaS" is something "new": a "paradigm shift" (Kronsell *et al.*, 2016), a "systemic innovation" (Surakka *et al.*, 2017) or a "disruption in mobility" providing a new way of thinking *"in terms of how the delivery and consumption of*

4 The "Mobility as a Service (MaaS) Alliance" is a public-private partnership established with the aim of laying down the foundations for a common approach to MaaS, unlocking the economies of scale needed for successful implementation and take-up of MaaS in Europe and beyond. The main goal is to facilitate a single, open market and full deployment of MaaS services (http://maas-alliance.eu).

transport (or mobility) is managed" (König *et al.*, 2017).

39. Analysing the statements shown in table 1, it is possible to understand that there are three approaches to its characterization:

- (a) MaaS exists when a specific action occurs (and is defined by it);
- (b) MaaS is what happens when some conditions exist (no direct action needed for MaaS to exist);
- (c) MaaS is understood as a Mobility Distribution Model (a model that enables a set of conditions that allow afterwards the occurrence of specific actions within the mobility system).

Table 1 – Selected definitions of MaaS

Author (year)	MaaS Definition	Source
Hietanen (2014)	Mobility as a Service (MaaS) is a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider	Peer Reviewed (Eurotransport)
Leviäkangas (2016)	The concept of MaaS is relatively simple: bundling different transport means, public and private, into one easy-to-use package for the customer. The service is provided to the customer via mobile applications and payment is handled via a digital wallet	Peer-Reviewed (IT)
Y. Li and Voege (2017)	The concept of MaaS is to use a single app to access and pay for various transport modes within a city or beyond; and the app will give options to allow a traveller to select the most suitable transport mode	Peer-Reviewed (T)
Veerapanane *et al.* (2018)	MaaS combines transportation services from public and private providers through a unified gateway that handles individual door-to-door trips, managing all stages of their creation and implementation (planning, payment, real-time monitoring, etc.)	Peer-Reviewed (T)
Sprei (2018)	Is a bundling of services such as public transportation, car sharing, bike sharing and taxis. The idea is to offer a subscription or pay-per-use service that will cover different types of mobility needs and create a seamless intermodal travel	Peer-Reviewed (U&SSc)
Matyas and Kamargianni (2017)	Mobility as a Service is a user-centric, intelligent mobility distribution model in which all mobility service providers' offerings are aggregated by a sole mobility operator and supplied to users through a single digital platform	Conference Paper
Eckardt, Aapaoja and Sochor (2017)	The great vision in the MaaS concept is to connect all available transport and mobility services together in a one-stop-shop package and hence offer an agile sustainable and effective competitor to private cars, which can be tailored according to the needs of end users	Conference Paper
EPOMM (2017)	Mobility as a Service (MaaS) is such a concept, combining services from public and private transport providers through a unified gateway that creates and manages the trip, which users can pay for with a single account	Institutional Position Paper
Transport Systems Catapult (2016)	The Transport Systems Catapult has defined MaaS as using a digital interface to source and manage the provision of a transport related service(s) which meets the mobility requirements of a customer	Public-Private consultancy company
König *et al.* (2017)	Multimodal and sustainable mobility services addressing customers' transport needs by integrating planning and payment on a one-stop-shop principle	"MaaSiFiE" - EU Project
MaaS Global (https://maas.global/)	A way of combining options from different transport providers into a single mobile service, removing the hassle of planning and one-off payments	MaaS Provider

40. Circumscribing the existence of MaaS to the occurrence of specific actions, as under the first-mentioned approach, focuses on the access to mobility services through specific actions, whether related to the "purchasing ability" or the "means" of access (one interface, gateway, digital interface, app, etc). Some examples of this perspective are shown when the authors define MaaS as: *"(…) buying mobility services as packages"* (Kamargianni *et al.*, 2016); "*(…) using a digital interface to source*

and manage the provision of a transport related service(s)" (Transport Systems Catapult, 2016); *" (…) the ability to purchase access rights to an interoperable package of mobility services"* (Docherty *et al.*, 2017); or by the *"(…) use a single app to access and pay for various transport modes"* (Y. Li and Voege, 2017).

41. The second perspective portrays MaaS as something that "happens" when certain conditions exist; thereby, it provides further insights on features of the concept that are essential to its characterization. The "conditions" mentioned above can be understood as the necessary relations between systems (transport; information; payment; data infrastructure; etc) and stakeholders (public and private transport providers; authorities; data providers, etc.) to allow new mobility experiences. Most of these authors define MaaS as the "combination" or "connection" of different transport modes or providers (public, private, shared, etc) through a unified gateway or based on one-stop-shop principle (Veerapanane *et al.*, 2018; Eckardt *et al.*, 2017; EPOMM, 2017; Transport Systems Catapult, 2016). Most of them refer that this single interface allows the management of all stages of the trip (König *et al.*, 2017; EPOMM, 2017; Veerapanane *et al.*, 2018), although varying in the extent of the available functions. It is possible to underpin that seamless and door-to-door trips, alongside with the focus on customer needs are a distinctive feature associated with the existence of MaaS.

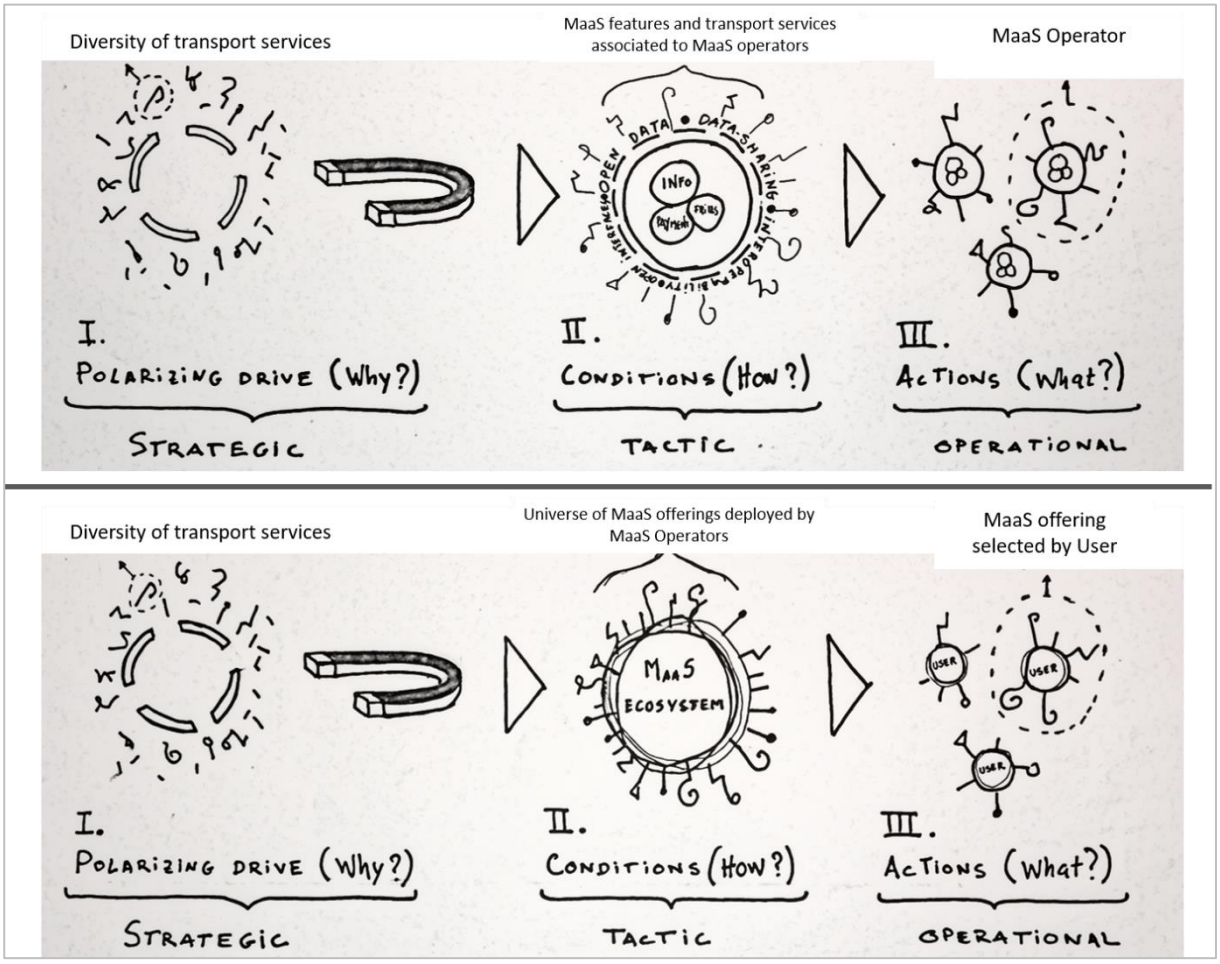
42. Finally, the understanding of MaaS as a "Mobility Distribution Model" encompasses the idea that MaaS exists when there is a coordinated scheme of relations, relying on several functions that enable the match of supply and demand of combined mobility services through one single interface (gateway), hence the distributional character of MaaS. This perspective encompasses the actions and their enabling conditions that can take place inside a MaaS ecosystem. Adding to this building blocks is the scheme of relations that need to exist at different levels of decision to enact the emergence of MaaS. This perspective comprises the fundamental concerns and represents a wider scope of MaaS conceptualization.

43. Schematically, two perspectives emerge when answering the *Why*, *How* and *What* questions: the planning side and the end-user perspective (Figure 2 and 3). The main difference between them rests in the way in which they address the *How* and *What* questions, since the first one focuses on the supply side whilst the latter on the journey of the customer. Concretely, on the planning side, the *How* question is answered by the conditions enabling the occurrence of a "MaaS System", whilst the *What* refers to the different configurations that characterize each "MaaS System" offering.

44. Considering the user perspective, the first level corresponds to the "polarizing drive" for the establishment of the necessary relations between Systems and Stakeholders to enable the emergence of MaaS (answering the *Why* question). The second level embodies the "conditions" or, in other words, the relations that emerge from the processes that enable the "Actions" (answering the *How* question).

And finally, the "action" level, where it is possible to acknowledge *What* actions can be performed within this system given pre-established conditions.

Figure 2 – Schematic representation of MaaS conceptualization from the perspective of the Planner and MaaS Operator (Top) and from the perspective of the User (Bottom)



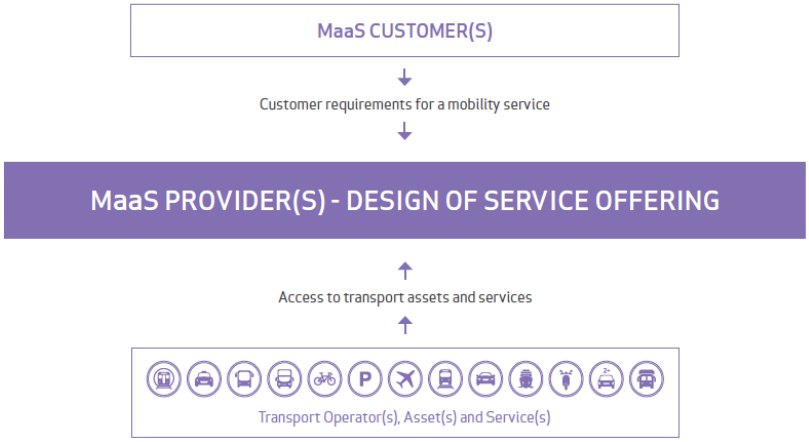
Source: Lajas, 2018

45. Considering the different approaches and definitions already analysed, it is possible to summarize the main characteristics of MaaS as follows:

- the existence of transport services information (the existence of transport options) allows seamless travel and door-to-door trips;
- the access to mobility services is made through one interface based on the one-stop-shop principle (or other designations, such as: gateway; digital interface; single app);
- this access encompasses integrated payment (single account) and the "purchasing ability" in a single interface;
- the interface enables the management of all the stages of the trip (planning, payment, etc.);
- it is a user-centric system, that matches supply and demand according to customers' needs (flexibility);
- depending on the existing payment conditions and ticketing options, it is possible to have tailor-made package bundles of mobility services, which highlights the "usership" concept associated with MaaS.

46. Surely, technology is an important enabler of MaaS, however co-operation and co-ordination between mobility agents, interoperability and integration of information are also three extremely important concepts when designing a MaaS ecosystem; the same can be said of the underlying relations between stakeholders, systems and infrastructure. The example of a reference architecture of a MaaS ecosystem can be considered to illustrate how it works in abstract terms (figure 3).

Figure 3 – Components/Stakeholders of a MaaS Ecosystem: reference architecture of the system



Source: Transport systems Catapult, 2016

2.2 Application models and implementation protocol

47. MaaS has been primarily a European concept, though it has been interpreted similarly in Australia (*Tripi Sydney*) and is being considered for applicability in India. In the United States, the MaaS concept is captured more by the growth of transportation network companies (*TNCs*), which often use apps to match passengers with vehicles providing Mobility-on-demand (*MoD*) mobility services such as *SHIFT*: an ambitious investment project (*Project 100*) in Las Vegas that planned to combine Uber and autonomous vehicles (it had placed an order for 100 Tesla vehicles) but closed considering the investment that still needed to be placed before the project could get off the ground.

48. To further understand the application of MaaS, it is useful to examine some different models and their respective implementation protocols. From the specific case of the UK, we can look at different approaches, in addition to discussing different payment and ticketing systems, potential markets, and privacy and security considerations related to MaaS (Wir-Konas, 2021, Cogitatio Press, House of Commons, 2019):

- *subscription-based MaaS*: users pay a monthly fee to access a variety of transportation services;
- *pay-per-use-based MaaS*: users pay for each trip or transportation service they use;
- *MaaS based on mobility credits*: users purchase mobility credits that they can use for different

transportation services.

49. For MaaS to work between users, public and private providers, agreed data protocols and data sharing are needed. Government plays an important role in shaping open data policies and frameworks and creating the right ecosystem and conditions to attract businesses and users to use and share data. Industry also has a key role to play, for example, in developing open standards with government and in promoting the value of the data that can be extracted by sharing it.

50. In terms of use cases, in developing cities we can find models such as: Kochi One in India, an example of how supply-side challenges are being addressed for MaaS implementation in emerging economies; *Jatri* in Bangladesh bus sharing services; Rwanda, as a leader in shared and electric mobility 'for hire' services in Africa; and Estonia's *X-Road system*

51. As a relevant example of the importance of data access, that an authority must receive on the use of services through open interface, and not linked to individual users or service providers, Figure 4 offers the schemes of the obligations that must be reflected in an "Act on Transport services": an act detailing the granting requirements of the different transport services as well as other types of obligation of different nature, such as to provide information to passengers and authorities and data on sales and tickets interfaces (open interface), as well as to verify and inform, especially as regards the activity of "Brokering and Dispatching Service Provider".

52. As discussed, the effective implementation and operation of MaaS requires careful consideration of numerous elements, from payment and ticketing systems to privacy and security issues:

- *payment and ticketing systems*: the idea of using electronic fare vouchers for public transport has been explored to develop a suitable revenue stream for MaaS;
- *potential markets*: an economic analysis of ride-sourcing markets has been conducted, and the impact of Uber-type solutions on the cab market has been examined;
- *privacy and security of systems*: the privacy and security of MaaS systems has been studied. For example, a case study of the regulatory approach around Uber and Lyft in San Francisco was presented;
- *vehicle-to-infrastructure interface*: very little has been written so far on the vehicle-to-infrastructure interface in MaaS, although there is a significant amount of information on the technological operation of vehicular *ad hoc* networks (VANETs) that allow vehicles to communicate with each other (V2V) as well as with roadside infrastructure units (V2I).

3 State of Practice

3.1 Cases

53. Some of the places where MaaS has been applied include London, UK (CityMapper Pass), Canada and France (Communauto), Hannover, Germany (Hannovermobil 2.0, swa Augsburg), Turku, Finland

(Foli), Berlin, Germany (Jelbi), Madrid, Spain (MaaS Madrid), Saint-Etienne, France (Moovizy 2), Italy (myCicero), Vienna, Austria (Smile) and Augsburg.

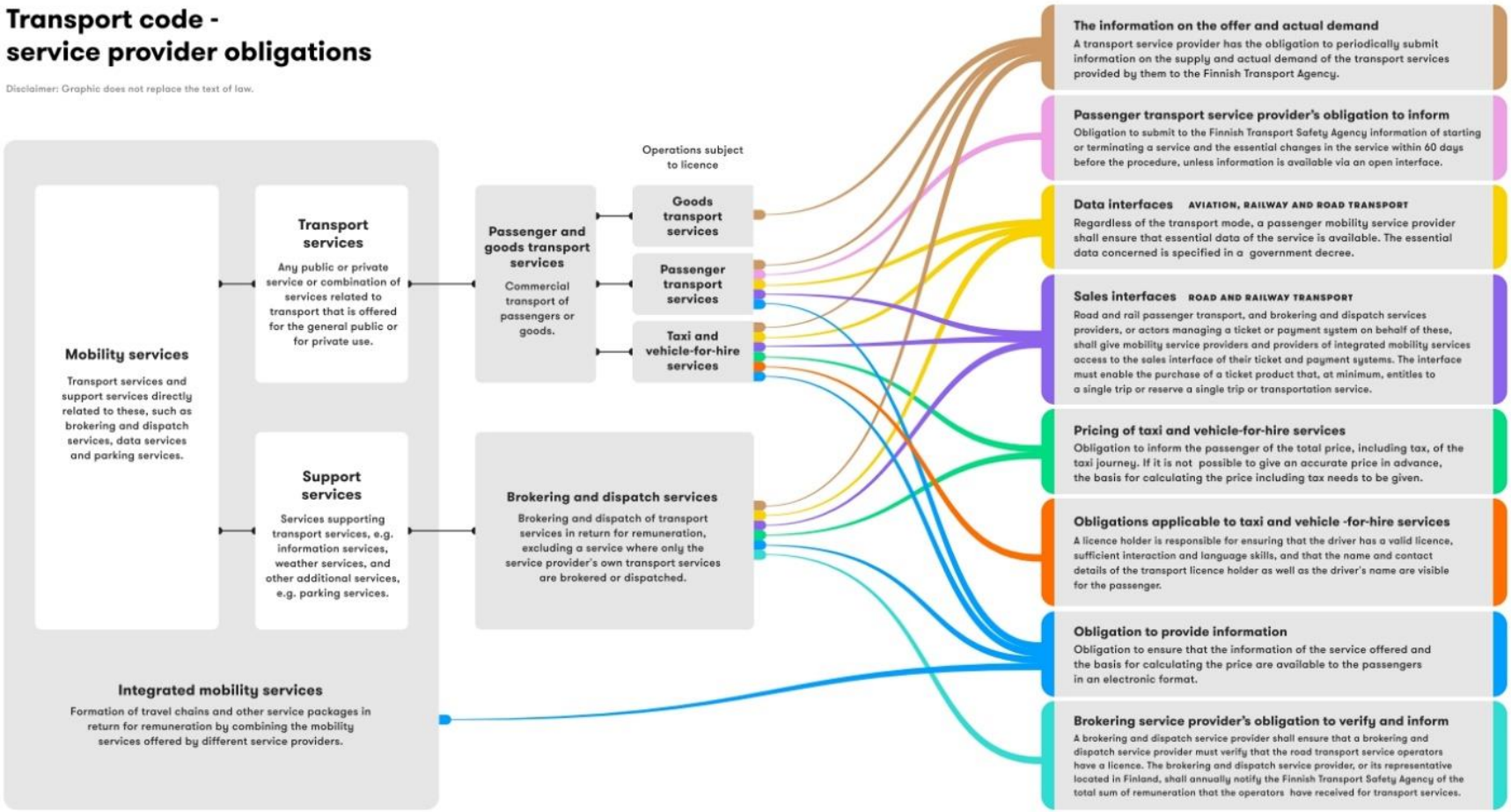
54. The most advanced is Whim: an app developed and operated by the Finnish startup MaaS Global, it was introduced in Helsinki in 2016 and has more than 45,000 users there. It calculates optimal routes across different modes of transport (including cabs, car rentals, trains, metro, streetcars, and local ferries) and allows customers to book combined end-to-end travel tickets for their preferred option. MaaS Global sells tickets to customers on behalf of transport operators through monthly subscription packages or on a pay-as-you-go basis. It is being trialed in partnership with Transport for the West Midlands (*TfWM*) and Viaqqio's NaviGoGo in Dundee and North Fife.

55. *EC2B* is a MaaS service that was launched in Gothenburg, Sweden, in 2019. It was implemented in an apartment complex called Viva, which consists of 132 apartments. The aim of this service is to demonstrate how the ecological footprint of housing and living can be reduced through novel approaches to mobility. *Mobil-flat*, Augsburg is a similar MaaS service in Germany. Also, in Germany we find *Moovel*: a partnership between Daimler AG and the BMW Group, that provides a combination of three applications: Carsharing, taxi-hailing and rail, along with a trip planning app. Its main objective is to promote the use of electric vehicles.

56. Other European apps are *Hannovermobil*, a crowdfunded app also supporting electric mobility, that relies on separate reservations, *UbiGo* in Stockholm, which is a very interesting option as it combines public transport with car-sharing, car rental services and cabs in an on-demand intermodal mobility service and is based on a flexible monthly subscription.

57. Denmark's national travel planner *Rejseplanen* aims to ensure seamless transportation throughout the country, both in metropolitan and rural areas. In the summer of 2018, the new multimodal application MaaS *MinRejseplan* was launched with the help of software specialist *HaCon*, a Siemens company. In addition to its regular public transport services, *MinRejseplan* integrates shared mobility services, on-demand transport, road traffic information, as well as bicycle, ferry, and pedestrian routes.

Figure 4 – Example of "Transport Services ACT" or "Transport Code"



Source: Finland, MTC (2017)

58. The coexistence of MaaS platforms from different geographic footprints is likely to become a reality. While many MaaS initiatives are being built at the local level, the "market reality" is evolving with the emergence of national and even global (or multi-local, but global) MaaS platforms. These global/multi-local players will primarily target infrequent customers but should not be underestimated because they still represent a large market segment.

3.2 Rules and regulations

59. Regulations and standards for MaaS services play a key role in the development and implementation of this innovative approach to mobility. These regulations seek to establish a legal and operational framework to foster the integration of transportation services, promote platform interoperability and ensure a seamless user experience. As it gains momentum in different countries, various laws and regulations have been introduced that address aspects such as open data, collaboration between transportation stakeholders and the promotion of sustainable solutions. Below is a list of countries (in alphabetical order) and the regulations and by-laws they have respectively adopted on MaaS (see more under Annex I):

- *Australia*: according to Kamargianni *et al.* (2016), the New South Wales state government launched a MaaS trial in Sydney in 2016. Although no specific law was introduced, government guidelines allow MaaS testing and experiments in a regulated environment;
- *Belgium*: Belgium has been experimenting with MaaS in Brussels and Antwerp through pilot projects and collaborations with technology companies. There is no specific regulation at the national level, but municipalities and regions have the authority to implement MaaS (Audenhove *et al.*, 2014);
- *Canada*: MaaS regulation in Canada varies from province to province. Some cities, such as Toronto, are exploring MaaS through pilot projects and collaborations with technology companies (Casello and Mahmoodi, 2020);
- *Finland*: with the passage of the Actors Transport Act in 2016, Finland became a pioneer in establishing legislation supporting MaaS. Hietanen (2014) notes that the law promoted the deregulation of the transport sector and mandated that transport companies make their Application programming interfaces (APIs) available to others for ticketing, which enabled interoperability and the emergence of MaaS platforms;
- *France*: the Mobility Orientation Law (LOM) enacted in 2019 highlighted the relevance of data for MaaS. According to Boutueil (2019), the law requires transport operators and mobility platforms to share data on their services and on the use of transport services;
- *Germany*: Sochor *et al.* (2016) mention that Germany does not have a specific MaaS regulation at the national level. However, several German cities have introduced MaaS services and have developed regulations at the local level to facilitate their implementation;
- *Japan*: Japan has been promoting MaaS with its vision of "Society 5.0", a super-smart society that integrates digitalization and physical infrastructure. Although there is no specific regulation, the government is encouraging MaaS adoption through pilot projects and subsidies (Ishida, 2019).
- *Singapore*: as part of its Smart Nation initiative, Singapore has been exploring MaaS through its Mobility Challenge. Ho *et al.* (2018) indicate that this challenge does not constitute a regulation per se but invites companies and organizations to develop innovative solutions to improve mobility;
- *The Netherlands*: the Netherlands has been active in the development of MaaS, with numerous pilot

projects underway in several cities. The Public Transport and Rail Authority (OVF) has established guidelines for these projects (Geurs *et al.*, 2020);

- *United Kingdom*: the 2019 Urban Future Mobility Strategy provided a perspective and outline for the future of mobility in British cities. Kamargianni *et al.* (2016) and Smith *et al.* (2018) highlight that this strategy recognizes the potential of MaaS in decreasing reliance on the private car and improving transport efficiency;
- *United States*: in the United States, MaaS regulation is varied and depends on each state and city, with no unified federal regulation. Cities such as Los Angeles are at the forefront with initiatives such as the "Mobility Strategy 2035" that seeks to improve transportation and mobility through integrated and multimodal solutions (Shaheen and Cohen, 2018)

4 Theoretical framework

60. A factor of success in the implementation of an effective MaaS ecosystem is to have a clear view of who does what. Table 2 provides an overview of decision levels and how they interact with the different MaaS components.

61. Due to the specificities of each country's organization and context (e.g., governance, administrative, bureaucratic, etc.), with clear consequences in the functions associated to each decision level, the stakeholders responsible for the implementation of the proposed policy instruments (table 3) are not specific; instead, indicative groups of stakeholders were identified.

Table 2 – Decision levels and MaaS features

			Decision Levels		
			Strategic	Tactic	Operational
General Features		Data-Sharing	●	●	●
		Interoperability	●	●	●
		User-Centric	●	●	●
		Integration of Information	●	◑	◑
		Coordination and Cooperation between mobility agents	◑	○	◑
Specific Features	C1 – Transport Services	C1.1 **'Self-service' transport** (only)	◑	◑	●
		C1.2 **'Non-self-service' transport** (collective or collective and individual);	◑	◑	●
		C1.3 **'Non-Self-Service'** (collective or collective and individual) **and 'Self-Service' collective** transport;	◑	◑	●
		C1.4 **'Non-Self-Service'** (collective or collective and individual) **and 'Self-Service'** (individual or collective and individual) transport.	◑	◑	●
	C2 - Information	C2.1 **Static Multimodal Journey Planner** ("Static" data)	●	●	●
		C2.2 **Dynamic Multimodal Journey Planner** ("Real-time" data)	●	●	●
		C2.3 **Assistant & Dynamic Journey Planner I** ("User preferences" data)	○	○	◑
		C2.4 **Assistant & Dynamic Journey Planner II** ("Crowd-sensed" data)	○	○	◑
		C2.5 **Assistant & Dynamic Journey Planner III** ("Predictive" data)	◑	◑	◑
		C2.6 **Intervenient, Assistant & Dynamic Journey Planner**	●	●	●
	C3 - Payment	C3.1 **Pay-as-you-go (PAYG)** (**physical** access only)	●	●	●
		C3.2 **Pay-as-you-go (PAYG)** (**electronic** possibility)	●	●	●
		C3.3 **PAYG and Single Subscription** (**physical** access only)	○	○	◑
		C3.4 **PAYG and Single Subscription** (**electronic** possibility)	○	○	◑
		C3.5 **PAYG and Fixed Subscription** (**electronic** possibility)	○	○	◑
		C3.6 **PAYG and Flexible Subscription** (**electronic** possibility)	○	○	◑

● Required ◑ Optional ○ Absent

Source: Lajas, 2018

Table 3 – Policy Instruments MaaS features

	Features	Policy Instruments (by governing resource and purpose of tool)		Levels of Decision and indicative group of Stakeholders	
				Strategic	Tactic
S ● T ●	• Data-Sharing • Interoperability • C2.1 Static Multimodal Journey Planner ("Static" data) • C2.2 Dynamic Multimodal Journey Planner ("Real-time" data) • C3.1 Pay-as-you-go (PAYG) (physical only) • C3.2 Pay-as-you-go (PAYG) (electronic)	Auth. (subst.)	**Direct Government Regulation [1]**: *Laws, independent regulatory commisions.*	Political autorities	Technical authorities and agencies; Regulating authorities
			Market Creation and Mantenance tools [2]: *establishing of limits and permits*	Political autorities	Technical authorities and agencies; Regulating authorities
			Visions and strategies: *Policy Vision, Strategic options and plans [6]*	Political Authorities	
		Org. (subst.)	**Direct Government [3]**: *Line departments, central support agencies*	Political autorities	Technical authorities and agencies
		Org. (proc.)	**Network management tools**: *Creating or reorganizing government agencies [4], Legislative and executive oversight agencies [5]*	Political Authorities	Technical authorities and agencies; Regulating authorities
S ● T ●	• User-Centric	Auth. (subst.)	**Visions and strategies**: *Policy Vision, Strategic options and plans [6]*	Political Authorities	
			Direct Government Regulation [1]: *Laws (consumer rights protection)*	Political autorities	Technical authorities and agencies
		Org. (proc.)	**Network management tools**: *Legislative and executive oversight agencies [5]*	Political Authorities	Regulating authorities
		Fin. (subst.)	**Tax- or royalty-based financial instruments [7]**	Political Authorities	Regulating authorities
			Cash or Tax-equivalent financial tools [8]: Favourable insurance and loan guarantees, Vouchers for public services	Political Authorities	Technical authorities and agencies; Regulating authorities
	• C2.6 Intervenient, Assistant & Dynamic Journey Planner	Auth. (subst.)	**Visions and strategies**: *Policy Vision, Strategic options and plans [6]*	Political Authorities	
		Org. (subst.)	**Direct Government [3]**: *Line departments*	Political Authorities	Technical authorities and agencies
		Org. (proc.)	**Network management tools:** *Creating or reorganizing government agencies [4]*	Political Authorities	Technical authorities and agencies
		Fin. (subst.)	**Tax- or royalty-based financial instruments [7]**	Political Authorities	Regulating authorities
S ● T ◑	• Integration of Information	Auth. (subst.)	**Visions and strategies**: *Policy Vision, Strategic options and plans [6]*	Political Authorities	
			Market Creation and Mantenance tools [2]		Technical authorities and agencies; Regulating authorities
		Auth. (proc.)	**Policy network activation and mobilization tools [9]**: *Public consultation, stakeholder and consensus conferences*		Technical authorities and agencies; Operators; Suppliers; Clients; Other interest parties
S ◑ T ◑	• C1.1 'Self-service' transport (only) • C1.2 'Non-self-service' transport (collective or collective • C1.3 'Non-Self-Service' (collective or collective and individual) and 'Self-Service' collective transport • C1.4 'Non-Self-Service' (collective or collective and individual) and 'Self-Service' (individual or collective	Auth. (subst.)	**Direct Government Regulation [1]**: *Laws (access standards to service provision)*	Political Authorities	Technical authorities and agencies; Regulating authorities
		Org. (subst.)	**Direct Government [3]**: *Line departments , central support agencies*	Political Authorities	Technical authorities and agencies
		Org. (proc.)	**Network management tools:** *Legislative and executive oversight agencies [5]*		Regulating authorities
			Quasi-governmental organizational forms [10]: *Partnerships and contracting out*	Political Authorities	Technical authorities and agencies; Operators, Suppliers
		Fin. (subst.)	**Cash or Tax-equivalent financial tools [8]**: Favourable insurance and loan guarantees, Vouchers for public services	Political Authorities	Technical authorities and agencies; Regulating authorities
			Cash-based financial tools [11]: Grants, subsidies and user fees	Political Authorities	Technical authorities and agencies; Regulating authorities
		Fin. (proc.)	**Policy network creation tools [12]**: *Interest group creation (support to start-ups)*	Political Authorities	Technical authorities and agencies; Operators, Suppliers
	• C2.5 Assistant & Dynamic Journey Planner III ("Predictive" data)	Org. (subst.)	**Direct Government [3]**: *Line departments*	Political Authorities	Technical authorities and agencies
		Org. (proc.)	**Network management tools:** *Legislative and executive oversight agencies [5]*	Political Authorities	Regulating authorities
S ◑ T ○	• Coordination and Cooperation between mobility agents	Auth. (subst.)	**Visions and strategies**: *Policy Vision, Strategic options and plans [6]*	Political Authorities	
		Auth. (proc.)	**Policy network activation and mobilization tools [9]**: *Public consultation, stakeholder and consensus conferences*		Technical authorities and agencies; Operators; Suppliers; Other interest parties

Governing Resources: Authoritative (Auth.) | Organizational (Org.) | Fianacial (Fin.) | Informational (Info.)
Purpose of tool: Substantive (subst.) / Procedural (proc.)
Decision Level: Strategic (S) | Tactic (T)
● Required ◑ Optional ○ Absent

Source: Lajas, 2018

4.1 Public Policy

62. Public policy can be understood as the science or art of governing what is public in a society ecosystem and defining a purpose of action in face of effective or potential problems. Public policy can be defined as a set of interrelated decisions taken by one or a group of public stakeholders with legitimate power (competence and capacity of decision conferred by law), about the goals and means to achieve them when facing a specific situation or problem. This definition is inspired by that of Jenkins-Smith (1978) cited by Deel and Hill (2009). Anything a government chooses to do or not to do is one of the most concise definitions of public policy (Dye, 2013), that entails two main ideas: first, the government is considered a determinant and necessary organizational vehicle for the enactment of policies and, secondly, governing implies "choice", and each choice is directly related to the promotion of the well-being of citizens and the protection of the public interest. A key part of that choice, which is profound in transportation, is establishing the distribution of burdens and benefits that will arise from the policy options that are chosen. We add that government must imply good quality of decision making.

63. Complementing this definition, Lasswell (1958) adds that besides government decisions, public policy is composed of two elements: *policy goals* and *policy means* (cited in Howlett, 2011). Following the logic of "principal components of public policies" (Howlett and Cashore, 2009), Howlett (2011) also emphasises that policies are based on policy goals and means ranging from strategic level (answering the *Why* question), to the tactic level (first level of operationalisation, answering the *How to* question), to the operational level (answering the *What* question or the *What has to be done for monitoring the implementation of "goals*" *and means" in terms of public policy* questions). The policy goals would be the "basic aims and expectations governments have in deciding to pursue (or not) some course of action", while the policy means are the techniques and processes used to attain the chosen goals. Howlett (2011) shows that policies are composed of goals and means that range from the most general level - that can be assumed to be the strategic one used throughout Howlett's text level to address the *Why* question - to the first level of operationalisation, the "tactical" level, that answers the *How to* question. Finally, following this logic of the "principal components of public policies" based on Howlett and Cashore (2009) in Howlett (2011), the last level would be the specific programme settings level that deals with "on-the-ground" measures and corresponds to the "operational" level (answering the *What* or the *What has to be done for the monitorisation of the implementation of "goals" and "means" in terms of public policy* questions).

4.2 Transport policy paradigms

4.2.1 *Predict and provide*

64. The first mainstream transport planning approach was named *Predict and provide*. Several authors refer to it as a paradigm according to which demand is projected (forecasted), equated with need, and met by infrastructure provision to the extent that funding can be made available (Owens, 1995). Traffic congestion was considered a major problem for private car use, and the solution envisaged for this problem was based on the prediction of growth trends and a provision of more road infrastructure (Noland, 2007). This approach of transport planning reflected a demand-led supply, a predictive and prescriptive planning process with a focus on mobility and speed, with particular emphasis on private cars.

65. *Predict and provide* justified a system planning approach. Manheim (1979) refers to the transportation system as a single multimodal system where three variables were identified: *(i) the transportation system and an (ii) activity system that equilibrate in (iii) traffic and transportation flows* (Zuidgeest, 2000).

66. Traffic growth prediction and the provision of more infrastructure was the basis of the "trip generation model" (or "four-step travel model") used traditionally in this planning approach. It was a straightforward travel forecast model that estimated traffic growth based on four modelling steps; here it can be considered as the policy formulation stage of the policy cycle. As a first step the focus was on travel demand forecast; trips were generated based on the transport system, mobility patterns (trips made by time, mode, route, destination, and purpose) and the land use activity system characteristics (step 1: *trip generation*). As a second step, forecasted trips were distributed by the possible origins and destinations of the study area (step 2: *trip distribution*), and attributed to the different modes of transport – mode choice analysis (step 3: *modal split*). Finally, these different trips by mode of transport were assigned to the transport network (step 4: *trip assignment*).

67. Significant critiques to the *predict and provide* approach appeared over time. The solution for transport problems was a strategy of combatting congestion that led to a repeated increase in the capacity of roads for the expected benefits to become a reality in the future, disregarding impacts on the environment or the future sustainability of territories. Poor representation of non-motorised modes, neglection of induced traffic, lack of strategic scenarios and policy development goals are examples of the shortcomings of the approach that, in addition, did not account for the whole spectrum of travel choices, equity, citizen's and national aspirations and vision.

68. As pointed out by Goulden (2014), despite the huge investment in roads, congestion was increasingly costly for businesses, vehicle emissions were growing, contributing to climate change and local air

pollution, and a mobility gap was widening between those with, and without cars, promoting high levels of inequity among transport users. In the UK, one of the key conclusions of Standing Advisory Committee on Trunk Road Appraisal (SACTRA) report, in 1996, was that demand forecasting and cost–benefit analysis methods did not adequately account for induced travel effects (Noland, 2007). The report mentioned specifically that "*new road capacity generated its own demand for the road, thus eroding or even eliminating any expected reductions in traffic congestion*".

69. In other words, the policy planning tool most widely used in the 20th century did not solve the transport problem that it was intended to address. Assessments made in the evaluation stage of the policy cycle showed that the 4-stage model was not working to solve problems like congestion, thus it lost legitimacy as a valid contributor to policy formulation.

4.2.2 *Aim and manage*: a paradigm shift

70. Goodwin (2017) outlines the ideal conditions for a paradigm shift stating that if supply could not be made to meet demand, then demand would have to be changed to meet supply, hence the need for demand management and the realisation that "*different policies will result in different forecasts"*.

71. A new philosophical approach of transport planning emerged in the 90s, that would overcome the former predictive planning and would be based on transport demand management and consider environmental concerns; accordingly, national transport strategic goals would guide future sustainable development scenarios.

72. The *Aim and manage* approach to transport planning is defined as a goal-oriented approach and a means to promote accessibility, improve the environment and the quality of life of citizens. This approach envisages a mix of policy measures spanning the whole spectrum of the mobility ecosystem; through its impact on travel behaviour it may also contribute to improving public transport and non-motorised transport modes (cycling and walking). Demand management was described by Goulden (2014) citing Myer (1999) as "*any action or set of actions aimed at influencing people's travel behaviour in such a way that alternative mobility options are presented and/or congestion is reduced*".

73. Thereby, a clear shift occurs from mobility planning towards accessibility, considering the whole ecosystem of transport rather than just private car, moving away from demand-led supply (based on forecasting) to demand and travel behaviour management to achieve long-term sustainable goals (based on backcasting). This new approach analyses transport problems with an integrated perspective, embedding environmental concerns and sustainable development at the core of its transport vision and strategy.

74. This new approach moves away from the identification of latent demand and prescriptive provision of

infrastructure – a transport manifestation of the neo-liberal growth paradigm (market-led decisions) (Noland, 2007), towards proactive demand management according to long-term planning goals, which in turn leads and steers the market instead of following it.

Table 4 – A comparison of the *Predict and provide* with the *Aim and manage* approaches

Predict and provide	Aim and manage
Demand-led	Demand management
Stable growth trends	Influence travel behaviour to manage growth
Predictive planning	Strategic planning
Forecasting	Back casting
Infrastructure supply	Focus on supply and demand
Mobility	Accessibility
Speed (quantity)	Quality of access
Car oriented	Entire transport ecosystem – Car, public transport and non-motorised transport modes
Inequity (favours car transport users)	Equity based – considers all transport users
Direct transport costs	Direct and indirect (external) transport costs
Market-led decisions (Cost-benefit supported decisions)	Goal-oriented decisions able to lead/steer the market

Source: Lajas and Macário, 2023

4.2.3 Decision levels and stakeholders

75. Mobility by itself can be seen as a process-oriented system that "*results from a sort of productive chain where several agents (authorities, operators, and users) intervene at different stages of the mobility chain (and also at different decision levels) to pursue the final objective that is to access a number of urban functions*" (Macário, 2011).

76. Understanding the nature of decisions which are intimately connected with policy making within the urban mobility system, is of extreme importance to have a coherent and effective policy framework, leading to a consistent policy process with the highest efficiency potential. Matching the nature of decisions (decision levels) with the stakeholders responsible for implementation according to their mission and role, is also of utmost importance. In fact, upon addressing the *Why* and *How* questions, only with this matchmaking practice it is possible to understand *Who* has the responsibility to do *What* and *When*, resulting in a clear roadmap to policy implementation and evaluation.

77. According to Macário (2011), the allocation of responsibilities within each decision level cannot be the object of generalisation because of its highly contextual dependency, especially at the political and

administrative levels; culture is a relevant factor, too. Among the principles of good practice necessary to establish a management model for urban mobility systems, the author refers to the need to "*ensure a clear distinction between the three levels of planning and control (strategic, tactical, and operational), or decision levels, with different organisational requirements and functional roles and a clear allocation of these roles to different institutions, whenever possible*" (citing Anthony, 1989; EC, 1997, ISOTOPE). A clear separation between these levels provides higher consistency to the distinct phases of policy-making and implementation, resulting in a "*network of institutions (i.e., authorities, operators, and third parties) linked by varying degrees and forms of interaction*" (Macário, 2011).

78. The levels of planning and control, or decision levels, adopted here are as follows:

1. Strategic: "*The main concerns relate with long-term decisions*" and it is "*where mobility policy and objectives (…) are defined*" (Macário, 2011). This level corresponds to the policy formulation phase, where the rationale for the policy is established by addressing the *Why* question;

2. Tactical: "*The main concerns are medium-term decisions*" and it is "*where the respective policies are defined translating the strategic goals into operational specifications, assuring the effectiveness, and coherence of the system*" (Macário, 2011). This level corresponds to the policy implementation phase, where strategies, goals and visions (the *why* question) are matched with the necessary package of policy tools (means) necessary to their operationalisation, answering the *how* question;

3. Operational – "*The main concerns are "short-term and related to management of services and resources*" and it is "*where transport services are produced and consumed*" (…) "*usually supported in well-defined rules*" (Macário, 2011). This is the level that relates to "*evaluation and monitoring*", when it is decided *what* to do to ensure compliance with the strategic goals (*why* question) and the correlated and enabling policy means (*how* question) for final consumption by the users. In other words, which type of monitoring and specific actions should be put in place to guarantee that the policy goals are being implemented correctly to achieve the desired and expected change. This level addresses the *what* question. It both corresponds to the policy implementation phase and opens the policy evaluation stage of the policy process.

79. Regarding stakeholders, which can be described as "*any group or individual who can affect or is affected by the achievement of the organisation's objectives*" (Freeman, 1984), their responsibilities when acting in mobility systems, too, depend on the politico-administrative context as well as on the whole ecosystem of agents.

80. Actually, in the design of policy, stakeholder identification and management are a matter of identifying determinant relations between agents. Referring to organisations, Fontaine (2005) argues that "*a very common way of differentiating the different kinds of stakeholders is to consider groups of people who have classifiable relationships with the organisation*".

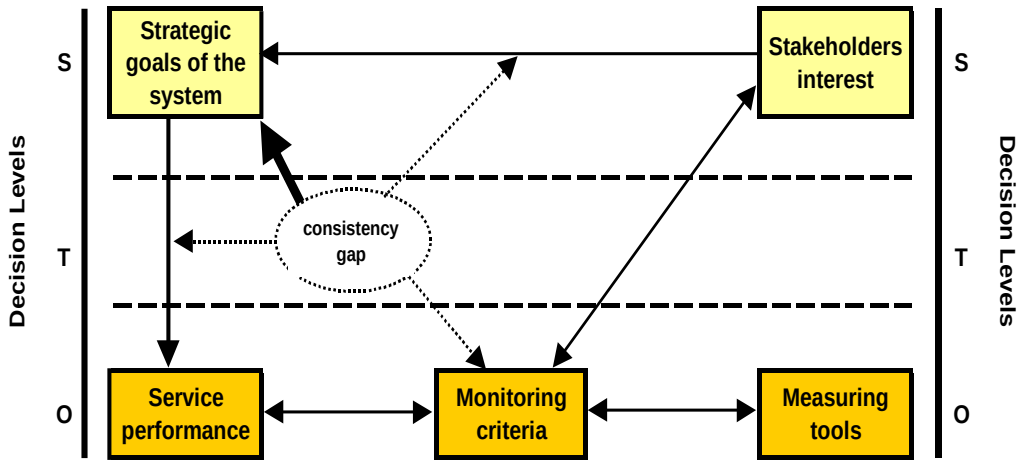
81. The nature of decisions (decision levels) pertaining to individual stakeholders varies. While some entities are bound to a specific level of decision due to their intrinsic characteristics (e.g., "transport system providers" from the point of view of the policy process are classified in the "operational decision level"), generalisations should be avoided to reflect the specific dependencies of the mobility system and accommodate individual countries' context and culture. By understanding, within the

universe of stakeholders, their roles, missions, contributions, expectations, power and strategy, a contextual management strategy can be implemented throughout the entire policy process.

82. Macário (2011) states that, by looking at "*all sorts of flows exchanged between institutions (and) decision-making agents (…) within the system*", one understands the nature and scope of interactions between institutions. The Author also highlights that, by defining their function in the mobility system, these entities "*have their departure point to move into a certain direction and to define purpose and values to guide their characteristic actions and reactions*", thereby establishing the "*patterns of their institutional behaviour*". Hence, disregarding specific policy processes and specific national contexts to focus on commonly referenced stakeholders in urban mobility systems, it is possible to identify *typical entities* that interact in the mobility system.

Stakeholder categories as referenced in Macário (2011) can be represented according to their nature and role, and include: i) political authorities; ii) regulatory authorities; iii) technical authorities and agencies; iv) operators; v) suppliers; vi) clients; vii) other interested parties (e.g. NGO; academia). These stakeholders can intervene in different stages of the policy cycle and can assume different configurations. However, it is important to understand the position of each stakeholder in relation to the different decision levels, and to what extent the influence or direct interference of one stakeholder in one decision level can impact on the other decision levels. That is, coherence between decision levels must be ensured while managing stakeholders impact, that is the meaning of the illustration in figure 5, if not attended a consistency gap will condition the performance of the system.

Figure 5 – Flow of impact of stakeholders in decision levels (Source: Macário, 2005)



5 Legal barriers to MaaS

83. From a legal perspective, what is crucial in MaaS is the multimodal character of the service and the existence of an intermediary between the mobility provider and the end-user (and ensuing issues related to the legal qualification, liability regime, etc. of such intermediate actor). The interactive process between the final user and the various providers of the system is relevant as illustrated in the following description:

> A passenger buys a tailored package of transportation services offered through a MaaS smartphone application. The package provides a predetermined number of monthly rides on the national rail, subway, and bus and a certain distance to be covered using various car and bike-sharing services offered by local providers. The application suggests a combination of transportation services to use on that day and identifies the intermediate locations where the passenger can switch from one to another. Once he/she accepts, the application makes the necessary bookings. Along the way, on all modes of transport, the passenger uses his MaaS smartcard and does not need to buy a single ticket. An interactive map signals the locations that he needs to reach, and the application informs him if conditions change along the way and proposes faster alternative options. Attempts to implement MaaS experience like the example above have succeeded in Helsinki, through the app Whim and in Berlin, with the development of Jelbi.

84. The disruptive but beneficial potential of MaaS can be described as the shift from modal-centric transportation to user-centric mobility[5]: if one of the existing transport providers, be it public or private, transforms into a MaaS operator by integrating publicly and privately provided transport across different modes, it becomes capable of offering outcome-based contracts that can package the services of multiple providers.

5.1 Definitions and Regulatory basis

85. MaaS is defined as a platform-based mobility management and distribution system that facilitates planning and payment for mobility services by connecting service providers and end users[6]. Currently the transport sector is mode-specifically regulated which does not always favour the implementation of MaaS (**barrier 1).**

86. In addition, there is no harmonized handling of the MaaS operator as a new actor in terms of transport regulation in different EU Member States, which may hinder the emergence of new (cross-border)

[5] S. Yianni, "Foreword", in P. Wockatz and P. Schartau (eds), *IM Traveller Needs and UK Capability Study: Supporting the realisation of Intelligent Mobility in the UK*, Transport Systems Catapult, 2015.
[6] Definitions of MaaS are provided by Kamargianni *et al*., id., A. Aapaoja *et al*., *Business models for MaaS*, 1st International Conference on Mobility as a Service (ICoMaaS), Tampere, Finland, 2017, and W. Goodall *et al*., "The rise of Mobility as a Service", *Deloitte Review*, 20, 2017, 112-129.

services. Development of the MaaS market will rely on the accessibility and openness of data, open APIs and more flexible transport and mobility regulations (**barrier 2**)[7].

87. *MaaS operators* operate through *intermediation platforms*, applying logics of aggregation and optimisation of the transport offer accessible through the DS&SRF from a traveller perspective. In their turn, for the DS&SRF, MaaS operators may represent a source of "complex" services that are exposed to the other intermediaries who have access to the platform in a B2B logic. *Transport operators*, on the other hand, may operate scheduled or non-scheduled services. Given the heterogeneity of services encompassed by MaaS, the DS&SRF characterises the operators according to a clearly defined and articulated taxonomy highlighting at least the type of service that it provides (e.g., rail, local public transport, maritime, air, metro, road, taxi, hire-and-drive, etc.). Key for the concrete operation of some DS&SRF services is the definition of the territorial scale" of the service (e.g.: local, urban or metropolitan service, regional or medium-distance service, national service, etc.) that will allow the selection of elementary travel components within complex chains, particularly in the composition of intercity trips.

88. It is therefore possible to understand the fundamental role of the tools for effective interaction between MaaS operators and transport operators. This interaction must be ensured in 3 different phases:

- in the phase of selection and composition of the elementary transport alternatives by the MaaS operator, aimed at offering customised services to travellers, it is necessary to make available sufficiently detailed data on the service offerings of the various transport and mobility operators;
- in the phase of defining the travel between transport operators and MaaS operators, and between the latter and the travellers, it is necessary that information - including payment information - is shared and stored in a secure and protected form, so that it can be retrieved both during the journey and at the end for possible disputes; the chain of responsibilities towards the travellers must therefore be traced and traceable;
- during the execution and at the end of the journey, data must be available in a protected and secure form only to those concerned and must be updatable by them.

89. With regard to the first point (availability of supply data), the availability of dynamic data on the supply of transport services in an open, secure, protected and non-discriminatory form, and (on equal terms for all operators who wish to be visible), is an essential condition for the development of MaaS services.

90. The most important governance concern standing in the way of a more energic policy engagement with MaaS in the EU has to do with sovereignty (**barrier 3)**. On the one hand, utilizing MaaS technology relies on platform replicability and scalability, which raises the issue of digital sovereignty, particularly regarding issues of taxation and data disclosure[8]. On the other hand, however, MaaS is inherently

[7] MaaS Alliance AISBL, *White paper on Maas*, 2017.

[8] The concept of digital sovereignty is generally understood to imply that users, citizens, and companies have control

territorial. While it can accommodate existing forms of transport governance at the territorial level, insofar it be developed for a wider spatial scale, it could equally submit them to its own logic. Hence, it is necessary to approach MaaS at a regulatory level with the competence to address each of the specific challenges involved.

91. One of them concerns the institutional foundation of MaaS. Although Commission Delegated Regulation (EU) 2017/1926 addresses multimodal mobility regarding data sharing **(barrier 4)**, it leaves untouched the barriers between modes in transportation law that go beyond data sharing. The multimodality of MaaS implies that transport providers would provide predefined and harmonized benchmarks for the services they deliver, addressing issues such as payment and ticketing modes and data-sharing policies. This could potentially change if the EU attempted to supplement existing effort to facilitate multimodality in the domain of combined transport[9] with clauses that address multimodality issues specific to MaaS. One way for the European Commission to get involved in multimodal passenger mobility would be to consider it as a complement to combined transport in freight**.**

92. One of the most critical issues related to data sharing is the standardization of data **(barrier 5)**. In order for data to be shared, it must assume a single format. Technology used by the integrators can, in turn, be used to process this data in order to provide the MaaS service to users. Standardization involves multiple aspects, such as aggregation and anonymization, minimization, and encryption[10].

93. Public transport providers have sometimes refused to participate in ticket integration, assuming that they benefit more from offering individual ticket packages themselves **(barrier 6)**.

5.2 EU Regulatory perspective

94. The main factor attracting attention for urban mobility at the supra-national level is the rising concern for the environment. As transportation represents almost a quarter of greenhouse gas emissions and remains the primary cause of air pollution, arrangements like MaaS that are expected to address this problem, have been steadily gaining attention.

95. Several EU directives addressing environmental protection, taken as a whole, provide the background for a "new" urban mobility law. Since these legislative efforts refer to MaaS only as a tool for reducing

over their data. See, F. Gueham, *Digital Sovereignty-Steps Towards A New System Of Internet Governance*, 2017.

[9] Combined transport involves movement of goods in the same loading unit or road vehicle, using successively two or more modes of transport without handling the goods themselves in changing modes.

[10] Kamargianni et al., *supra* and MaaS Alliance, "Data makes MaaS happen", *Vision Paper Brussels*, 2018.

emissions, they are not included in the following multi-level governance analysis[11]:

96. There are also relevant soft law efforts, among which the *New European urban agenda*, and in particular Action No. 9 "*Setting up European framework for fostering urban air mobility innovation*". More recently, in the Commission Communication COM (2016) 501 of 20 July 2016, "*A European strategy for low-mission mobility"*, digital mobility solutions and the promotion of multimodality are identified by the European Commission as two of the key elements to make the transport system efficient. In the later Communication COM (2018) 773 of 28 November 2018, "*A clean planet for all. A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy"*, MaaS, combined with the transition to carbon-free transport technologies, is seen as a key element to reduce pollution and improve the quality of urban living.

97. In trying to contribute to this task, commentators analysed EU regulation and overlapping competencies at stake. Two main reasons determine the relevance of EU-level governance efforts in the context of MaaS: one is specific and the other general.

98. The specific reason is that, although MaaS is being developed for areas internal to individual member states, it has clear trans-national potential. It could connect locations and users that regularly move from one Member State to another. There may be benefits in using the same MaaS operator across States or, at the very least, fostering a significant level of collaboration among them; this is despite existing differences among transport providers and urban environments across the EU. As the EU institutions are generally capable of levelling the playing field across the Member States, they must adopt regulatory measures that would support a beneficial transnational spread of MaaS.

99. From a general perspective, moreover, the technology applied by MaaS can potentially be reused and adapted across regions and under the same rules and conditions, which would benefit both operators that set up MaaS in different locations and users who relocate and intend to use MaaS in a new location[12].

100. As is well known, the Treaty on the Functioning of the European Union (TFEU) states that when it

[11] See the string of regulations on emissions, among which Commission Regulation (EU) 2019/318 of 19 February 2019, amending Regulation (EU) 2017/2400 and Directive 2007/46/EC of the European Parliament and of the Council as regards the determination of the CO_2 emissions and fuel consumption of heavy-duty vehicles, and Commission Regulation (EU) 2018/1832, amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) 2017/1151 to improve the emission type approval tests and procedures for light passenger and commercial vehicles, including those for in-service conformity and real-driving emissions and introducing devices for monitoring the consumption of fuel and electric energy.

[12] Prominent examples of that development are MaaS Global, which originated with Helsinki MaaS experimentation; see https://whimapp.com.

comes to transport, competencies are shared between the European Union and the Member States[13]. Accordingly, the latter can legislate and adopt legally binding acts in transport to the extent that the EU has not exercised its competence in any given area[14]. The TFEU provides a sophisticated legal framework on transport that reflects the complexity of this sector. In this regard, the TFEU relevant provisions (Articles 90 to 100) emphasize that transport is as a catalyser for both developing other business areas and for creating a market. At the same time, MaaS depends on regulatory efforts that do not focus on transportation explicitly.

101. However, the regulatory landscape of MaaS at the EU level is dominated by Commission Delegated Regulation (EU) 2017/1926 of 31 May 2017 on the EU-wide multimodal travel information services provides that "*each Member State shall establish a national access point. The national access point shall constitute a single access point for users at least for static mobility and traffic data and historical traffic data related to different modes of transport modes, including updates of data, as referred to in the Annex, provided by transport authorities, transport operators, infrastructure managers or providers of on-demand transport services in the territory of a given member state"*.

102. The first attempts at addressing the challenges of MaaS in Europe date back to the end of the twenty-first century. In some cases, legislators have adopted measures directly addressing MaaS, typically within transportation law; in others, MaaS has been dealt with in related legal frameworks, for instance, on local transport or land use.

103. However, the latter is explicitly focused on data sharing, while there is a lack of regulatory measures explicitly addressing multimodal transport. For that reason, some of the important regulatory goals are less considered at the European level.

104. An opportunity to do that can be found in the existing TFEU provisions on Trans-European networks (TENs). Under Article 170 TFEU, the EU endeavours to establish and develop TENs to establish a related internal market and achieve economic, social, and territorial cohesion. More specifically, under Article 170 (2) TFEU, these efforts ultimately aim at promoting the interconnection and interoperability of national networks and link island, landlocked, and peripheral regions with the central regions of the Union. These provisions can be interpreted to imply that the barriers between different transport modes need to be broken down insofar as they complicate the role of transport in connecting diverse actors across regions.

105. An additional step in that direction can be found in the intention to develop the so called Trans-European transport network (TEN-T), a network aimed at underpinning the completion of the internal

[13] Article 4 (2) (g) TFEU.
[14] Article 2 (2) TFEU

market with actions that close gaps, remove bottlenecks and technical barriers and, here too, strengthen social, economic, and territorial cohesion. In this context, Regulation (EU) No. 1315/2013 of 11 December 2013, that sets guidelines for the development of the TEN-T, does not consider multimodality; however, unlike the policies mentioned above, it approaches transportation considering different modes together as parts of a whole.

106. In urban matters, the relevant framework for local authorities has begun to develop with the 2009 *Action plan on urban mobility*, contained in the Commission Communication COM (2009) 490 of 30 September 2009 and has been complemented by the Commission Communications COM (2011) 144 of 28 March 2011 laying down the *Transport white paper*. *Roadmap to a single European transport area towards a competitive and resource-efficient transport system*, and COM (2013) 913 of 18 December 2013, entitled *Together towards competitive and resource-efficient urban mobility* and adopted in the framework of the urban mobility package.

107. An important topic dealt with in this set of documents is the *Sustainable urban mobility plan*[15]. These plans have to be conceived based on strategic thinking regarding ways to connect the city centre with the commuter hinterland[16] and achieve significant social and environmental goals.

108. Since 2013, these plans explicitly consider inter-modality and intelligent transport systems. In the context of designing land-use rules that would ensure the right to equitable mobility across regions, Sustainable urban mobility plans implement a procedure that begins by aligning the aims of regional plans, municipal strategies, and urban development plans to coordinate mobility aspects of different user-specific plans[17].

109. As a result, sustainable urban mobility designers suggest changes to operational land use, zoning, and implementation plans[18]. Although integration and balanced development of transportation modes have been mentioned among priorities when defining zoning and land-use rules, until now, this did not refer to the specific form of integration that MaaS employs.

[15] https://transport.ec.europa.eu/transport-themes/urban-transport/sustainable-urban-mobility_en
[16] European platform on sustainable urban mobility plans, *Guidelines for developing and implementing a Sustainable urban mobility plan*, March 2019, https://www.eltis.org/sites/default/files/sump-guidelines-2019_mediumres.pdf.
[17] These include traffic plans, local public transport plan, noise action plan, clean air plan, energy action plan, and other sectoral plans.
[18] Recommendations for mobility master planning are in http://www.germansustainable-mobility.de/wp-content/uploads/2015/08/GPSM_Recommendations-for- Mobility-Master-Planning_english_final.pdf.

5.3 The Italian experience

110. In Italy, Maas has been subject to evaluation after the introduction of some investments plans under the PNRR.

111. In 2021, the Minister of Technological innovation and digital transition (MITD) with the support of the Digital transformation department (DTD) and the Ministry of Sustainable infrastructure and mobility (MIMS), launched sub-investment 1.4.6 denominated 'Mobility as a Service for Italy' within Mission 1, Component 1 of the national resilience and recovery plan (NRRP) funded by the European Union in the context of the Next Generation EU initiative.

112. *The Mission of the MaaS for Italy project*: the development of MaaS in Italy entails the creation of an inclusive ecosystem encompassing the implementation of the necessary reforms, the availability of pertinent regulatory and technical tools, the progressive digitalisation of the companies involved (an enabling condition which *per se* is necessary but not sufficient), the evolution of corporate culture and the possibility for citizens to benefit from MaaS.

113. In these new ecosystem, public administration's intervention is necessary. The public system has the role of establishing organisational, technical, and business rules in order to avoid market distortions, unfair commercial practices and dominant positions. Moreover, consistent with the public enablement of the MaaS ecosystem through an open platform (UITP, MaaS Model 2, 2019), a key objective of the MaaS project is to test and validate the Data Sharing and Service Repository Facility (DS&SRF, on which see more below) as a central element of the ecosystem itself. The ultimate goal is, therefore, to provide citizens and the economic system with platforms that enable the broad promotion of innovative services, while realising social and environmental objectives.

114. The objective of the project as a whole is to identify territories with different characteristics as laboratories for experimenting MaaS and test the applicability of the national conceptual architecture, the introduction of digital platforms, business models and interaction models between the subjects offering mobility services; this is done in order to best meet the mobility needs of the territories themselves, while understanding which models are best suited to the different contexts. In this perspective, the evaluation of interest and use by user-travellers, the validation of business models and the definition of guidelines for the drafting of possible regulatory measures at the end of the experiments are also central.

115. Three objectives of the project emerge from the above:

    1. to create and verify the enabling structures to facilitate the exchange of data and effective interaction between transport operators and intermediary platforms, to ensure greater participation and more effective interfacing with the national DS&SRF service;

2. to experiment the MaaS paradigm: to ensure the achievement of the objectives of MaaS experiments on the territory and the consequent evaluation of the economic, environmental, and socio-cultural impact in the reference context;
3. to increase the digitisation of collective transport using interoperable tools to increase the quality, safety and attractiveness of transport systems and enable the deployment of MaaS, by leveraging digital payment services, developing fleet monitoring and management systems, user information systems, services for creating packages and booking journeys in line with the MaaS model.

116. With these aims in mind, in 2021 work began to create the DS&SRF, aimed at guaranteeing effective interaction between MaaS operators and transport operators, for the implementation of all the actions necessary to create a national access point, reserved for accredited and registered operators, to the set of transport and mobility offer data available on the national territory for the MaaS, as well as a set of elementary functions to make this data usable in a regulated and easy manner (including the selection and composition of travel chains from elementary alternatives), and to facilitate booking and payment through appropriate access channels to the external platforms that provide these services. The DS&SRF[19] will be created in a progressive manner in accordance with, and based on, the needs of the pilot projects for MaaS to be implemented in the territories and in consultation with the sector's stakeholders. In this regard, the public administrations concerned have established a Partnership Table composed of more than 30 national associations and representative bodies relevant to MaaS, and begun a public consultation process, aimed at defining the 'user requirements' for the DS&SRF[20]. The public consultation aimed at receiving technical, informative, and cognitive input for the creation of the national DS&SRF platform, capable of implementing services useful to MaaS operators and transport operators, for an effective development of the pilot projects.

6 A data-driven ecosystem

117. For MaaS to become a dynamic embodiment of the mobility marketplace, cooperation between mobility providers and MaaS operators must be both facilitated and regulated. Mainly, this involves adopting an adequate framework of operation through data sharing to the extent that this creates a competitive environment. The new type of cooperation that MaaS brings crucially depends on data sharing. MaaS can involve the collection and sharing of a significant amount of different data: relevant information is related to routes, access locations, real-time asset/vehicle position, speed, transfer time,

[19] DS&SRF is a national enabling platform, capable of realising useful services for MaaS operators, transport operators and citizens. The main objective of the DS&SRF is to execute actions useful for the efficient operation of MaaS services at the service of authorised users and having regard to the different access rights.

[20] See, (n.d.) *Investment PNRR 1.4.6 "Mobility as a Service for Italy"*, *Discussion paper "Data Sharing and Service Repository Facilities" (DS&SRF)*, https://assets.innovazione.gov.it/1640338827-discussion-paper-data-sharing-and-service-repository-facilities-ds-srf.pdf.

battery status (of electric means of transportation), ticket pricing, asset usage, asset characteristics (e.g., disabled access, toilets, space for luggage, Wi-Fi), and environmental impact [21].

118. It involves data from different sources, such as transport providers and users and weather forecasts, parking services, etc. Finally, using the shared data, parties interact in different ways beyond the direct purpose of providing mobility service to the user. For example, based on information on the availability of seats and demand in a particular period, a car-sharing provider might engage with a parking provider to arrange for an exclusive discount on parking when this service is bundled with that particular car-sharing. Another example concerns the location or tracking of information collected by the MaaS app to facilitate situational user support regarding medical, law enforcement, or similar services. The diversity of the data-sharing process invites several regulatory considerations about interoperability.

119. Data sharing should typically occur through APIs. APIs involve a set of procedures and tools for building software applications that interact with the features or data of another application or operating system. The APIs allow MaaS operators to communicate with the back-office systems of transport providers giving access to their data and systems. An example is given by a commentator who discusses a situation in which access to the booking API of transport providers allows MaaS operators to use that transport availability data and booking systems in their application. The API is itself subject to intellectual property law, as it can be potentially beneficial for creating a wide variety of intellectual goods. Due to the importance of facilitating sharing, MaaS, unlike other IP regulation spheres, necessitates a high degree of openness as a baseline.

120. According to commentators, MaaS implementation would benefit from sharing APIs among MaaS operators and from making these APIs open, that is freely available for anyone to use, alter, and distribute[22].

121. Regulators consider data sharing a competence in the field of geospatial interoperability by integrating transportation data collected at the national and local levels.

122. The centrality of data for the development of multimodal transportation has been recognized since the 2011 White paper on transport (see above). The suggestions made in the White paper have been successively codified in Commission Delegated Regulation (EU) 2017/1926 which was supposed to be the first in a series of acts, as a discussion on the matter was to be continued in non-formal channels.

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[21] M. Kamargianni and R. Goulding, "*The Mobility as a Service maturity index: preparing the cities for the Mobility as a Service era*", in *Proceeding of 7th Transport Research Arena,* Vol. 7, 2018.

[22] APIs can either be private, if developed and used within a firm, or open, when they are not designed for a specific firm. Regarding MaaS, Kamargianni *et al.*, *supra* note **X**, argue in favour of open APIs (see also Z. Deng *et al.*, "*Vetting private API abuse in IOS applications*", *Proceedings of the 22nd ACM SIGSAC Conference on Computer and Communications Security*, 44-56, ACM, 2015.

123. Commission Delegated Regulation (EU) 2017/1926 primarily focused on setting up the technical elements necessary for standardized, accessible, exchangeable, and updated travel and traffic data to be shared with the least potential impediments and harmful consequences. It builds on the already existing transport data-sharing regulation on the reuse of public sector information[23], free access to road safety information[24] and EU-wide real-time traffic information services[25]. Besides these regulatory efforts, EU institutions have supported the development of the technological infrastructure for transport data sharing.

124. A more articulated legal framework could provide a material basis for the operation of MaaS. It would include:

- INSPIRE, the infrastructure for spatial information in Europe, which facilitates information sharing on road infrastructure[26];
- TAP-TSI, the technical specification for interoperability for telematics applications for passenger services, which facilitates information sharing on long-distance railways[27];
- DATEX II, the data format that facilitates information sharing on road traffic information)[28];
- IATA, the international air transport initiatives on facilitating information sharing on road traffic information on air transport, and
- NETEX, the exchange protocol for public transportation schedule information[29].

125. Based on existing open API technology, Commission Delegated Regulation (EU) 2017/1926 recommends full accessibility of APIs in the area of multimodal transport. In terms of intellectual property rights, multimodal transport should follow the path of the Intelligent Transport Systems Public Transport Open API for distributed journey planning[30]. Although that of the Commission is only a recommendation, it represents a significant step towards removing the barriers to data sharing on the side of APIs.

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[23] Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the re-use of public sector information.
[24] Commission Delegated Regulation (EU) No. 886/2013 of 15 May 2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to data and procedures for the provision, where possible, of road safety-related minimum universal traffic information free of charge to users.
[25] Commission Delegated Regulation (EU) 2015/962 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide real-time traffic information services.
[26] INSPIRE originates from Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). More at https://inspire.ec.europa.eu/.
[27] The TAP-TSI standards have been introduced by Commission Regulation (EU) No. 454/2011 of 5 May 2011 on the technical specification for interoperability relating to the subsystem telematics applications for passenger services of the trans-European rail system.
[28] The DATEX II format stems from the Commission Delegated Regulation (EU) No. 885/2013 of 15 May 2013 supplementing ITS Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of information services for safe and secure parking places for trucks and commercial vehicles.
[29] Available at https://netex-cen.eu/
[30] Available at http://www.normes-donnees-tc.org/wpcontent/uploads/2017/01/TC_278_WI_00278420_E-RS-170118-final3.pdf.

126. The principal outcomes of the Delegated Regulation (EU) 2017/1926 are the rules governing the data access points for multimodal transport. These access points involve a digital interface where data, sources, and metadata are made accessible for reuse to multimodal transport providers such as MaaS[31]. Member States can cooperate to set up common access points and define the party responsible for providing travel and traffic data. Access points are to be developed in phases, the main governing rule being that unnecessary duplication of data should be avoided.

127. The main policy choice made in Commission Delegated Regulation (EU) 2017/1926 addresses the type of data made available for reuse. Namely, the regulation obliges transport providers to share static data without discrimination; the obligation, however, does not extend to dynamic data.

128. Static data either does not change at all or it does not change often, at least not regularly. It includes information regarding the location of points of interest, stations, road networks, and the timetables and estimated travel times. Additionally, it includes supporting information on where and how to buy tickets for both scheduled and demand-responsive transportation modes and car parking.

129. In contrast, dynamic data covers information that often and/or regularly changes. It includes the space-time information related to the estimated departure and arrival times of services, current travel times, as well as the information on the availability of publicly accessible charging stations for electric vehicles and refuelling stations, and on the availability of different types of mobility services. In this way, Commission Delegated Regulation (EU) 2017/1926 makes available the data needed for planning purposes during the pre-trip phase.

130. In the context of public sector data, dynamic data is addressed in the recently adopted directive (EU) 2019/1024 of 20 June 2019 on open data and the re-use of public sector information[32]. The directive acknowledges that the importance of open data and public sector information is primarily related to the creation of digital products and services[33]. The Open data directive also includes dynamic data, which must be made available for reuse immediately after collection via suitable APIs[34].

131. However, the directive indicates a very narrow scope for application to mobility. Recital 66 identifies the relevant datasets as being related to road signs and inland waterways. This creates ambiguity as to how much of the dynamic data of public transport providers will have to be shared[35]. For this reason,

[31] The overview of the Member States' efforts to establish data access point showcases that significant progress has been made throughout the Union: https://www.itsplatform.eu/filedepot_download/1971/6320.
[32] Article 1 refers to these document as existing documents held by public sector bodies of the Member States, existing documents held by public undertakings (the latter as defined by EU legislation), and research data.
[33] It will become an even more important content resource with the development of advanced digital technologies", Recital 13, Directive 2019/1024.
[34] Article 5(5), Directive 2019/1024.
[35] At the same time, Recital 66 only provides for a non-exhaustive list of types of data. The EC now has the

although the recognition of the importance of open data and reuse of public sector information signals that the EU legislator is aware of the dynamic relationship between public and private actors in the domain of data sharing, important transport-related dynamic data is still only marginally considered.

132. Turning to the user-governance framework and, in particular, to the issue of protecting the privacy of users, which is a shared competence between the EU and national levels,k it can be noted that Commission Delegated Regulation (EU) 2017/1926 is in accordance with Opinion No 3/2017 on *Processing personal data in the context of Cooperative Intelligent Transport Systems* (C-ITS) by the Data Protection Working Party of the EU and the current draft of Commission Delegated Regulation that will supplement Directive 2010/40/EU concerning the deployment and operational use of C-ITSs[36].

133. Together with the general frame provided by General Data Protection Regulation (DGPR)[37], Delegated Regulation (EU) 2017/1926[38] addresses the need to protect the privacy of users while allowing for more data sharing. Once an assessment of the necessity, proportionality, and impact of its provisions is made, the Delegated Regulation (EU) 2017/1926 makes it necessary to include built-in data protection that minimizes and pseudonymizes information relating to an identified or identifiable user, so that the identification of the individual is avoided whenever possible.

134. When it comes to MaaS, privacy is a crucial issue since most data involved is personal. The debate around data and privacy is already well-developed. In the context of MaaS, it is important to point out that general principles enshrined in the GDPR are to be respected by all the parties that make up the MaaS ecosystem. From this perspective, the concept of *privacy by design*[39] and *privacy by default* must be taken into account in all the design stages of the MaaS network.

135. At this stage, it is not clear what will be the exact GDPR relationships between the MaaS operator and the transport provider with regard to data, whether data will be shared in a more or less processed form

competence to adopt an implementing regulation which opens the possibility of changing the approach to a significant degree. For example, the EC even has the competence to enlarge the list of thematic categories of Annex I.

[36] The opinion is available at http://ec.europa.eu/newsroom/just/document.cfm?doc_id=47888, and the draft of the new Delegated Regulation on C-ITS is available at https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32010L0040.

[37] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC.

[38] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32017R1926

[39] On the use of the concept of *privacy by design* in the regulatory frameworks of the EU, see the Opinion No 5/2018 of the European data protection supervisor, at https://edps.europa.eu/sites/edp/files/publication/18-05-31_preliminary_opinion_on_privacy_by_design_en_0.pdf.

and who will be the data processor and the data controller.

136. There are, however, ways of enforcing privacy rules that have not been considered in Commission Delegated Regulation (EU) 2017/1926. Namely, the risk of a data breach faced by transport providers can be overcome effectively if transport information is aggregated within a single pool that is shared by the transport providers instead of being aggregated separately by the providers and then pooled together by a MaaS operator[40].

137. MaaS would include real-time updates across mobility providers, closely following change in actual transport conditions. These different itineraries are usually identified as belonging to a different mobility service type, such as municipal transportation or long-distance travel.

138. For this reason, MaaS operators are forced to choose a specific and often arbitrary type of transport activity under which they can operate. This prevents providing users with the all-encompassing mobility support it is intended to deliver. This problem gains further relevance when considering that MaaS could integrate provisioning of endpoint activities. For example, a MaaS operator might also offer to acquire event tickets or order groceries for the user. As these activities fall outside the domain of transport altogether, regulatory attempts to fix and separate domains stand in the way of this type of integration.

139. The issue invites consideration of how to govern the reach of MaaS in space and over time. This becomes particularly significant when we consider the risks of the potentially harmful effects brought about by MaaS, such as advantageous treatment of some competing transportation providers over others. Different forms of accreditation and licensing have been proposed to address this.

140. The main challenge originates from the risk that the operator could engage in preferential treatment of a particular transport provider at the expense of others. The operator could use its discretionary power to offer what are supposedly the best options in order to support some transport providers over others. The operator could also engage in rent-seeking, leading to increased journeys, contrary to the alleged optimization benefit of MaaS.

141. Private providers, too, can be reluctant to cooperate within any arrangement that does not enable them to control and supervise the platform, as they fear it would treat the often-dominant public providers preferentially. One way to address this problem would be to create a new entity to operate the MaaS platform, instead of relying on transforming existing transport providers that may be inclined to treat their services preferentially.

[40] Such as the breach faced by Uber; see https://www.nytimes.com/2017/11/21/technology/uber-hack.html.

142. Another way to address the potential distrust felt among mobility providers involves the financial facilitation of their local cooperation. In many cases, transport service procurement and other forms of transport-related public expenditure already comprise a significant part of central and local government budgets. As significant cost savings can be achieved by integrating services, establishing a cooperative relationship between the public and private side could help minimize government expenditure.

143. A third way to overcome trust problems among different participants is to base the future MaaS ecosystem on open-data principles[41]. This approach implies making all the data available to any potential operator. In this way, it would be possible to let competition among operators single out those that can realize integration in a manner that is both fair towards different providers and accessible to the largest number of users possible.

144. Using the tools of competition law and other forms of regulation, appropriate measures would support the winner by ensuring that transport providers on the ground are open to negotiating fair terms of integration of their service in MaaS. On the other hand, in less stable situations, introducing a form of subsidy in favour of the more successful MaaS operators could leave the complete process in private hands.

7 Passengers rights

145. MaaS users are different from traditional transportation users. They share personal information needed for MaaS to operate, and the MaaS operator significantly influences their choices and movement. This invites substantial policy adaptation. This novel type of user necessitates dedicated consumer protection rules[42].

146. Despite MaaS's novel practices, the passenger rights framework doesn't seem to diverge significantly from the existing standards. EU and international passenger rights regulations are not harmonised. The lack of harmonisation concerns refund schemes for cancelled services and arrangements similar to the so-called delay-repay scheme[43].

147. The EU framework, in particular, is composed of several different regulations: Regulation (EC)

[41] According to the 2015 Open data charter, agreed upon by some 170 governments and organisations, data needs to be open by default, timely and comprehensive, accessible and usable, comparable and interoperable, usable for improved governance and citizen engagement and for inclusive development and innovation. See https://opendatacharter.net/principles/.

[42] From a different standpoint it could be argued that move from consumers to users necessitates both novel forms of consumer protection and rules that address fundamental rights. For example, fundamental rights to privacy and data protection issues emerge when we consider user-generated payment data.

[43] These schemes involve compensation for any delay or cancellation causing the user to arrive behind schedule for longer than a defined amount of time.

261/2004 of 11 February 2004 on the compensation and assistance of passengers in the event of boarding denial and cancellation or long delay of flights; Regulation (EC) 1107/2006 of 5 July 2006 on the rights of persons with reduced mobility when traveling by air; Regulation (EC) 2027/97 of 9 October 1997 on air carrier liability in the event of accidents; Regulation (EC) 1177/2010 on the rights of passengers traveling by sea and inland waterway; Regulation (EC) 181/2011 on passengers travelling by bus and coach transport, and Regulation (EU) 2021/782 of 29 April 2001 on rail passengers' rights and obligations.

148. If a consumer acquires a MaaS package that includes different transport services, the overlap between the liability rules implied in these regulations will emerge. The consumer may face difficulties in being compensated for unfulfilled contractual obligations, dealing with different reimbursement types that may apply, and similar issues.

149. Even more complex issues arise when we try to hold both transport providers and MaaS operators contractually accountable. These issues create significant ambiguity regarding liability because end users often lack knowledge about the specific service contract that applies. This can lead to difficulties for the MaaS operator. It may be liable for the entire trip if the prevailing rule implies that liabilities result from the aggregation of transport services providers.

150. As reported by one of the commentators, in cases where one part of an itinerary is cancelled, and others booked through the MaaS platform depend on its realization, the party that is deemed to cause the problem is liable both to the user and to other providers. In order to solve the problem of the user, the MaaS operator and user can adopt an end-to-end journey service level agreement for a higher price. The problem related to other providers could lead to costly litigation between the providers and the MaaS operator. One way to overcome this issue would be to adopt a rule according to which each transport service provider will need to maintain an individual liability insurance. Instead of the standard arrangement based on a single ticket from MaaS operators who would thus be generally liable, another way to address this problem would be to rely on combined ticket arrangements that split the liability between the operator and the providers in a stipulated manner.

8 Recommendations for ART

151. In all the successful cases to date, MaaS has emerged as a local phenomenon. Municipal authorities have collaborated with public transportation providers and startups to design and implement an institutional arrangement that harnesses the power of data and mobility integration to address congestion and make mobility services more efficient and equitable. In this work, we have not addressed the regulatory efforts to be made at the municipal level; instead, we have focused on the EU and Member State levels of the multi-level governance hierarchy and the division of competences

between them. Although municipal authorities can make significant contributions towards a MaaS set-up, without EU and Member State rules, their efforts will be highly dependent on the state of the local transportation environment and the nature of local transport providers. Furthermore, rules present at both the EU and domestic levels will inhibit their development at the local level.

152. Suitable EU and Member State rules related to the institutional foundation and governance of users and providers can make a difference. They can help overcome the barriers to entry that dominant transport providers may set up against MaaS and help create an environment of trust where transport providers will be empowered to collaborate. Beyond supporting local initiatives as they arise, rules established at higher regulatory levels can help in two additional ways. Firstly, they can help the local parties identify the approach that best suits the specific transportation environment in which they intend to operate regarding relevant factors that are usually disconnected.

153. Secondly, MaaS could significantly disrupt how transportation works. It could integrate transport systems across cities and states with mobility-supportive services (such as fuel providers or parking and highway operators) and other service providers (such as Wi-Fi providers or movies and games providers). The process would create various databases that could help improve urban planning and infrastructure in general.

154. One of the preconditions for the successful implementation of MaaS is the availability of an optimal legal environment to enable cooperation and sharing. Legislation designed for conventional transport systems in which transport modes are provided and consumed separately can unintentionally work against multimodal service provision and MaaS. In addition, while clear environmental policy targets may be beneficial to MaaS, regulatory measures to facilitate openness and exchange of data are necessary. The design of related policies, such as taxation and public procurement, may have a significant impact, too.

155. The competitiveness and attractiveness of MaaS services relies heavily on the availability of high-quality data. The first step towards a digital transport system is the harmonization of data, supported by appropriate regulation and standards.

156. Barriers identified are diverse:

- Regulation is mode specific, MaaS is a multi-mode platform (#85)
- MaaS market will rely on the accessibility and openness of data (#86)
- MaaS raises the issue of digital sovereignty, particularly regarding issues of taxation and data disclosure (#90)
- Current EC regulation leaves untouched the barriers between modes in transportation law that go beyond data sharing (#91)
- Standardization involves multiple aspects, such as aggregation and anonymization, minimization,

and encryption. This is a critical issue for data sharing (#92)

- Public Transport Operators are not favourable to ticket integration (#93)

157. Services, in any case, require new skills in digital technologies and new market approaches. It is therefore important to facilitate access to these skills and their use, by fostering and regulating the emergence and integration of open environments of regulated, and, where necessary, protected, data interchange (with the relevant elementary functionalities of use). It is also noteworthy that an evolved and accomplished application of the MaaS paradigm envisages a multi-territorial approach, capable of ensuring the continuity of the travel experience in the city and intercity chain, allowing continuity and enjoyment between different cities and territories. The multi-territorial dimension also corresponds to a vision of harmonisation and territorial cohesion, aimed at facilitating and making citizens' access to MaaS services homogeneous throughout the country

158. Existing barriers must be object of deep analysis and transparent discussions with stakeholders. An open dialogue would highlight the potential of MaaS as an important partner for investors interested in making public transport an easy and pleasant experience of added value to the user.

9 Annex 1 – Triggers of Change

Focus n. 1 - Triggers that from a regulatory standpoint may stimulate the adoption of MaaS

As emerged MaaS) represents a holistic concept that encompasses various facets of transportation, and regulatory initiatives play a pivotal role in stimulating and promoting its adoption. At the institutional level, collaboration between government bodies, agencies, and local authorities can serve as a powerful trigger. Regulatory frameworks that support interoperability, data sharing, and standardized ticketing systems encourage the integration of diverse transportation modes into a seamless MaaS ecosystem. Additionally, open dialogue and cooperation between stakeholders, including public transport providers, private companies, technology developers, and consumer advocacy groups, are essential. Such collaborative efforts can lead to the development of transparent and fair regulatory frameworks that facilitate the growth of MaaS, while ensuring the protection of user data, affordability, and accessibility. Ultimately, regulatory triggers that promote MaaS can transform the way people navigate their cities and regions, making transportation more efficient, sustainable, and user-friendly.

Delving further into regulatory triggers that can stimulate and promote MaaS, from a regulatory perspective it is possible to highlight:

1. Interoperability and Standardization: regulatory authorities can mandate or incentivize the standardization of data formats, interfaces, and payment systems among different transportation service providers. This enables seamless integration and cooperation between various modes of transportation, including public transit, ridesharing, bike-sharing, and car rentals. Standardized systems make it easier for MaaS platforms to aggregate and present diverse transportation options to users.

2. Data Sharing and Open APIs: regulators can require transportation service providers to open up their data through Application Programming Interfaces (APIs). This allows MaaS operators to access real-time information on routes, schedules, availability, and pricing, ensuring that users have access to the most up-to-date and comprehensive transportation options.

3. Licensing and Permits: regulatory bodies can streamline the process for granting permits and licenses to transportation service providers, making it easier for new entrants and innovative start-ups to enter the market. This fosters healthy competition and innovation within the MaaS ecosystem.

4. Pricing and Fair Competition: Regulators can establish rules to ensure fair competition and prevent monopolistic practices within the MaaS sector. This may involve setting price caps, requiring transparency in pricing, and preventing anti-competitive behaviour, ensuring that MaaS remains accessible and affordable for users.

5. User Data Protection: in an age of digital transformation, regulators need to address data privacy and security concerns. MaaS platforms collect and process large amounts of user data. Regulations that protect user privacy and security while allowing for the legitimate use of data for service improvement are crucial to building trust in MaaS systems.

6. Public-Private Partnerships: governments can encourage partnerships between public transportation agencies and private MaaS providers. This can lead to more comprehensive and efficient transportation networks, with MaaS platforms seamlessly integrating public transit options with other services.

7. Public Awareness and Education: regulators can support public awareness campaigns and education initiatives to inform citizens about the benefits of MaaS, how to use it, and its role in reducing traffic congestion, emissions, and overall transportation costs.

8. Performance Monitoring and Evaluation: regulatory bodies should monitor the performance and impact of MaaS implementation. Regular assessments can ensure that the regulatory framework is achieving its intended goals, such as reduced congestion, improved environmental sustainability, and enhanced user experience.

These regulatory triggers, when implemented effectively, can pave the way for a thriving MaaS ecosystem that benefits both users and the broader transportation industry, fostering innovation, efficiency, and sustainability in urban mobility.

Focus n. 2 – Actors that can most effectively pioneer MaaS

MaaS services implies the cooperation among different actors (e.g. national and local authorities setting up the guidelines for implementation of the MaaS, the platform operators selling the services and the transport operators performing the services) whose interests can be sometimes divergent or at least different. Also, in light of the regulatory triggers that can boost the efficient implementation of MaaS services as described above, it is possible to least the actors whose responsibilities may at institutional and practical level effectively enhance the implementation of the services:

1. Municipalities and Local Governments: municipalities play a critical role in driving MaaS initiatives, as they have authority over local transportation networks and urban planning. They can lead by implementing policies and regulations that support MaaS, promoting public-private partnerships, and integrating public transit into MaaS platforms. They can also create incentives for private operators to provide services that align with the city's transportation goals.

2. Private Companies and Start-ups: private companies, especially technology-driven start-ups, are at the forefront of developing MaaS platforms and services. They often bring innovation and digital solutions to the table, creating user-friendly apps and interfaces that aggregate transportation options. Private actors

can pioneer MaaS by offering diverse and convenient services while cooperating with municipalities to ensure regulatory compliance.

3. Transportation Service Providers: existing transportation service providers, such as public transit agencies, ride-sharing companies, bike-sharing operators, and car rental services, can be pioneers by actively participating in MaaS ecosystems. They can make their services accessible through MaaS platforms and collaborate with other providers to offer seamless connections.

4. Public-Private Partnerships: a cooperative approach between public and private entities can be highly efficient in pioneering MaaS. Public-private partnerships allow for the integration of public transit with private services, ensuring a comprehensive and interconnected transportation network. These partnerships can leverage public resources and private innovation to create robust MaaS solutions.

5. Transportation Associations and Advocacy Groups: organizations and associations focused on transportation can champion MaaS adoption by advocating for supportive policies and promoting best practices. They can help create a favourable regulatory environment and encourage collaboration among stakeholders.

6. Research and Academia: universities and research institutions can contribute by conducting studies and research on the impacts and benefits of MaaS. They can offer insights into best practices and help refine MaaS models for different urban environments.

7. User Communities and Consumer Advocacy Groups: user communities and advocacy groups can play a pivotal role in pioneering MaaS by raising awareness, representing the needs of the end-users, and advocating for equitable and accessible transportation options. Their input can guide MaaS development and ensure it meets the requirements of the people it serves.

In light of the above, efficient MaaS pioneers typically involve a combination of public and private actors working together to create a coordinated, user-centric, and sustainable transportation system. The specific mix of these actors can vary depending on the local context and the particular challenges and opportunities present in a given region.

Focus n. 3 Is there an ideal territorial dimension for the operation of MaaS services? If so, which is it? May the density of population be factored in any relevant model? If so, how?

There is no single "ideal size", but there are territorial considerations that may influence:

- Densely populated urban areas:
  - Advantages: Areas with high population density tend to have a steady demand for transportation services and an already established public transportation infrastructure.
  - Challenges: Congestion and competition between different modes of transportation may be greater, requiring careful coordination and planning.
- Suburban and Peri-urban Areas:
  - Advantages: These areas may lack efficient public transportation options, so MaaS can fill an important gap, offering solutions such as on-demand bus services or vehicle sharing systems.
  - Challenges: Lower population density may make some services not economically viable without subsidies or incentives.
- Rural Areas:
  - Benefits: Essential mobility solutions in areas where transportation options are limited, such as ridesharing services or on-demand bus systems (Ydersbond et al 2020).

  - Challenges: Low population density and long distances can present challenges in terms of cost and logistics.
  - Population density is a crucial factor in any MaaS model: In high-density areas, MaaS can focus on integrating and optimizing multiple modes of transportation, reducing congestion, and promoting sustainable mobility options. In low-density areas, MaaS can focus on providing essential mobility solutions, connecting rural areas to urban centers, and ensuring that all residents have access to multiple transportation options.
- To take into account the population density in this system:
  - Data Analytics: Use demographic and mobility data to understand transportation needs and patterns in different areas.
  - Flexibility: Offering flexible solutions that adapt to the needs of different areas, such as on-demand services in low-density areas.
  - Incentives and Subsidies: Consider incentives or subsidies in areas where economic viability is a challenge due to low population density.
  - Collaboration: Working with local stakeholders, such as municipal governments and transportation providers, to develop solutions adapted to the territorial and demographic characteristics of each area.

Focus n. 4 The path to set in operation MaaS services may be a long one. Are there intermediate steps that may be taken/medium to short terms of objectives that may be pursued/given services which are better apt to be considered? Which are they?

These steps and objectives can play a role in the development of a robust ecosystem:

- Digital Infrastructure Development:
  - In the short term: Establish basic digital infrastructure, such as high-speed networks and data platforms [9].
  - In the medium term: Develop more sophisticated applications and platforms that integrate different modes of transportation and allow for trip planning and payment.
- Payment Systems Integration:
  - In the short term: Integrate existing payment systems, such as public transportation cards, into a digital platform.
  - In the medium term: Develop unified payment systems that allow users to pay for different modes of transportation with a single solution, such as a mobile application.
- Collaboration and Partnerships:
  - In the short term: Establish dialogues and collaborations between key stakeholders, such as transport authorities, service providers and technology developers (Halvorsen, T., 2005).
  - In the medium term: Formalize partnerships and agreements to facilitate data integration and sharing among different stakeholders.
- Pilot Tests and Demonstration Programs:
  - Short-term: Launch small pilot programs or tests in specific areas or with specific services to assess feasibility and gather feedback.
  - Medium term: Scale up and expand these programs based on initial learnings and test results.
- Education and Awareness:
  - In the short term: Launch awareness campaigns to inform the public about benefits and characteristics of the project.
  - Medium term: Implement broader educational programs and train users on how to use such platforms and services.
- Policy and Regulatory Development:
  - Short-term: Review and adapt existing regulations to facilitate their implementation (Sorensen et al., 2011).

    - In the medium term: Develop specific policies and regulations that promote integration, fair competition and the protection of data and users' rights.
- MaaS Initial Services:
    - In the short term: Implement simpler and more direct services, such as bike-sharing systems or on-demand transportation services.
    - In the medium term: Integrate these services with other modes of transport and expand the range of services offered.

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