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SHARED MOBILITY & MaaS

THE REGULATORY CHALLENGES OF URBAN MOBILITY

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Executive summary

Urban mobility is a daily challenge. People are increasingly faced with significant time and money costs to access their workplaces and other urban amenities (school, shopping, leisure activities, etc.). The external costs of road transport (i.e. accidents, congestion, noise, air pollution, and CO_2 emissions) are an important area of concern. The Paris Agreement (United Nations, 2015) commits all signatories to reducing CO_2 emissions with the aim of keeping the global temperature rise this century below 2°C above pre-industrial levels. Efforts are being made at national, state/provincial and local government levels. The road transport sector, which is responsible for 19% of total GHG emissions in Europe, will play an especially important role in this respect.

The external costs of road transport have been scrutinised and measured for decades, and the idea of encouraging car drivers to switch to public transport has also been embedded in local transport policies across countries for a long time. Although some progress has been made, the missing piece in the puzzle has typically been linked to the disutility of changing mode, foregoing the convenience that the private car brings, and the financial problems linked to public transport provision in areas of dispersed and low demand.

An answer to these problems may come via the concept of **Mobility as a Service (MaaS),** which today is gaining momentum in a number of countries.[1] MaaS is clearly a sub-product of digitalisation. The latter provides unprecedented opportunities for integrated ticketing and real time information regarding public transport timetables and connections, traffic conditions, incidents, disruptions and delays. It has also enabled the development of new mobility services provided by new entrants. The question is therefore whether digitalisation can help reduce the negative externalities produced by urban mobility by lowering the time, money and environmental costs of traditional modes of transport. MaaS has the potential to provide a platform that will allow users to combine traditional and new mobility services. In doing so, it can reduce the disutility users would face from simply switching from the private car to public and/or active transport (i.e. walking and cycling). A number of issues emerge in this respect, however. Those are linked to the role of data, platforms and apps, as well as to the regulation of traditional and new modes of transport. This report attempts to frame those questions and proposes a number of answers and policy recommendations.

Four models of shared mobility

The first part of this report presents the different types of shared mobility, with a focus on the four models of shared mobility that involve motorised transport. On the basis of a review of academic and other literature, it provides evidence on the impacts that these new shared mobility models have or can have on congestion, pollution and CO_2 emissions. The main findings are that, unless ridesharing replaces solo trips by car on a large scale, the impacts on congestion, pollution and CO_2 emissions are likely to be neutral at best; and that shared mobility providers may have an important role to play in complementing public transport by supplying first and last mile solutions, and by serving areas where public transport is not financially viable. In addition, in partnership with local authorities, shared mobility providers may have a role in providing services to the elderly, disabled, or those on low incomes. Shared bicycles and scooters can also provide first and last mile solutions and substitute for public transport, thus reducing pollution and CO_2 emissions, and in the case of bicycles, yielding additional health benefits.

[1] See UITP, Mobility as a Service, Report, April 2019, 26 pages, https://www.uitp.org/report-mobility-service-maas and also EMTA, Mobility as a service, a perspective on MaaS from Europe's Transport Authorities, June 2019, 16 pages, https://www.emta.com/spip.php?article1319&lang=en

The policy recommendations of Part 1 of the report can be summarised as follows:

- **Invest in public transport, walking and cycling**

  Enhance policies aimed at increasing the share of trips made by public transport, walking and cycling. Public transport needs to be a genuine, practical, fast, reliable, and affordable alternative.

- **Introduce policies to discourage trips by car**

  Trips by car, especially solo trips, need to be discouraged. Congestion charging offers a great opportunity for this.

- **Implement subsidies**

  When there are potential societal/social benefits, such as reaching areas poorly served by public transport or the elderly, disabled or poor, or providing first mile-last mile connections with public transport, there may be an argument for public subsidies, channelled through partnerships between shared mobility providers and public transport agencies.

- **Harness the opportunities offered by MaaS**

  Tap into the potential that MaaS offers, by providing the missing element that congestion charging and investment in public transport cannot deliver alone. Provided well-designed regulation guarantees that new mobility models complement and do not substitute for public transport, MaaS can enable the transition towards truly sustainable mobility.

Data, apps and platforms

Digital technology can contribute to implementing MaaS as a new deal for urban mobility, as it allows intermodality to become a reality across all modes of transport and all organisations providing mobility services. Digitalisation is a way for private actors to contribute to public policy in the area of urban mobility. The main benefit for commuters is the reduction of the transaction costs of mobility. A large number of apps are now available. They provide, for any given trip, information about the various modes of transport available, as well as about their costs, route choice, etc. In addition, EU legislation recommends the opening of sales channels. As a consequence, private actors can play an important role in helping commuters to change their routines by discovering the variety of mobility services available.

However, this reduction of transaction costs is not enough. Public stakeholders should enter into discussions with digital actors and new mobility providers to decide how they can each bring part of the solution to their common mobility challenges. MaaS is indeed a tool that should help abolish the barriers that exist between the various administrative layers of a given territory when it comes to organising mobility services. If implemented efficiently, it has the potential to foster public stakeholders' cooperation and to combine the mobility services organised or funded with public money.

Commuters' requirements and public policy goals need to be reconciled via new regulations, especially concerning the use of public space, which is a scarce resource though not a prime concern for most digital actors. This is necessary because public actors control or organise most mobility services with strong public funding constraints.

For efficient MaaS services to develop for daily mobility in urban areas, the key requirements are the following:

- **Mobility data must be gathered under the umbrella of Metropolitan Transport Authorities (MTAs)**, who are the only trusted party able to do so. Licensing to ensure compatibility with public policies is necessary and possible through the Intelligent Transport Systems (ITS) Directive.
- **Sales channels have to be opened for all mobility services and all tariffs**, with the prerequisite that reselling tariffs cannot be different from the MTAs tariffs, except if agreed by MTAs. This will strengthen cooperation between public entities (e.g. cities, regions, districts, MTAs) and also with private parties.
- **It is necessary to enlarge the spectrum of mobility offerings that will, in a financially sustainable way, ease user life and foster alternatives to solo car use.** This will require significantly enhanced cooperation between the various public stakeholders involved and also between the public and private sectors.

MaaS and regulatory issues

In the light of MaaS and shared mobility developments, the regulation of urban mobility needs to be transformed.

- The first required transformation lies in an **extension of the role of MTAs, stemming from the increasing role that the management of databases, platforms and applications will play in the coming years.** This is a relatively new field of activity for MTAs and they must invest by improving their skills in this area. MTAs must also value their own data as well as their brand name. They must not refrain from developing their own platform, even if, or more precisely because they will be facing the opening of sales channels. For the same reasons, they have to enlarge their spectrum of mobility services in order to improve the variety of options offered to inhabitants of urban areas. If the objective is to increase the number of users of the various urban mobility services, platforms, information services and ticketing are crucial, even if digitalisation cannot be considered a magic wand.
- In relation with the wider spectrum of mobility services, **MTAs must intensify their activities by way of a better integration of all the vectors of urban mobility**. To take into account the complex interactions between land-use and transport, as well as social conditions and the environmental challenges of sustainable development, the regulation of urban mobility must be unified and integrated. MTAs must, in one way or another, intervene in the use of roads and even sidewalks and pedestrian zones. It is the MTAs' role, and not that of commuters or mobility providers, to define the balance to be achieved between the different uses of roads. It is up to MTAs to take over the management of the main road networks. How to integrate road traffic management and public transport organisation will result from policy discussions. MTAs can certainly influence those discussions, but they will not decide the outcomes alone.

In sum, if the ambition is to reduce congestion and pollution thanks to the massive development of MaaS and shared mobility, the regulation of access to cities must change dramatically. Until now, the constraints on the use of cars remain low. Congestion charging is limited to a few examples. It therefore appears that, in order to assess the chances of success of shared mobility and of MaaS, it will be necessary to focus not only on vehicles (e.g. size, motorisation, ownership, etc.) but also on the different uses of public space that one wishes, or not, to develop.

The emphasis on individual needs is often misleading as it considers as a top priority the resource which for many people is the rarest, namely – **time**. However, an approach promising individual time savings does not make it possible to understand what is at stake from the point of view of the collective interest. The latter involves reasoning about what is the rarest resource for the community, namely **space**. The full development of MaaS and shared mobility will only become a reality if the rules for the use of roads are oriented towards incentives for ride sharing and disincentives for the use of individual cars. As long as the latter can move freely and on the same roads and use services in the same conditions as shared vehicles, it is unlikely that MaaS and shared mobility will be successful.

Introduction

Urban mobility is a daily challenge for both **commuters and public authorities**.

The main issue for **commuters** is accessing their workplaces and other urban amenities (e.g. school, shopping, leisure activities, etc.). Hence, the amount of time spent in transport and the monetary cost of mobility are the key variables for them. This is reflected in the European Commission's 2011 White Paper, *"Towards a competitive and resource efficient transport system",*[2] which promotes efficient transport systems, without 'curbing' mobility. As real incomes grow and the costs of mobility go down, the current trend is an increase in the number of daily trips to and within cities, especially in the peripheries. Between 30% and 50% of trips in dense areas, and 40% to 70% of trips in the peripheries are made by car (as shown in the Appendix).

For **public authorities**, an important area of concern is the external costs of transport (i.e. accidents, congestion, air pollution, and CO_2 emissions). More importantly, the Paris Agreement (United Nations, 2015), ratified by all European countries, commits them to curbing CO_2 emissions to stop the average global temperature from increasing beyond 2°C. The agreement requires all countries to put forward their emission reduction targets, or 'nationally determined contributions' (NDC) and to strengthen these efforts in the future. In addition, all countries must report regularly on their emissions and on their implementation efforts. The Paris Agreement was signed in December 2015, only three months after the Sustainable Development Goals were agreed upon by the United Nations General Assembly (United Nations, 2019). Three of the Sustainable Development Goals (SDGs) are especially relevant to urban mobility: SDG11, which aims at making cities inclusive, safe, resilient and sustainable; SDG13, which aims at combatting climate change; and SDG3, which aims at ensuring healthy lives and promoting well-being for all ages.

These thresholds set at the international level are in line with the objectives of the European Commission's 2011 White Paper:

> *"Halve the use of 'conventionally-fuelled' cars in urban transport by 2030; phase them out in cities by 2050; achieve essentially CO_2-free city logistics in major urban centres by 2030".*

But adopting such technical solutions only will not be enough to reach the goal of reducing negative externalities. Various other available ways to improve efficiency, limit oil dependence and reduce negative impacts have to be developed, while maintaining services of urban accessibility.

Among the solutions proposed to improve the efficiency of urban transport systems, the 8th goal defined in the European Commission's White Paper is:

> *"By 2020, establish the framework for a European multimodal transport information, management and payment system".*

On this basis, the concept of **Mobility as a Service (MaaS)** is gaining momentum in a number of countries. MaaS is clearly a sub-product of digitalisation: the latter is currently the source of a new deal due to the development of new mobility services provided by new entrants. The question is therefore whether digitalisation can help reduce the negative externalities produced by urban mobility. It could do so by lowering the time, money and environmental costs of traditional modes of transport, and potentially by combining these with new mobility services. This would give

[2] WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system /* COM/2011/0144 final */ accessible at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN

commuters incentives to abandon their private vehicles and to turn to public and/or active transport (i.e. walking and cycling), and if and when necessary, to combine these with shared mobility options.

In the second quarter of 2019, two reports on the future development of MaaS were published by key stakeholders involved in the area of urban mobility: the International Association of Public Transport (UITP)[3] and the European Metropolitan Transport Authorities (EMTA).[4] Both reports underline that MaaS is a promising innovation, yet still in its infancy. In a lot of cities, MaaS remains a fuzzy concept, a tagline having, until now, no measurable effective impact on mobility patterns. We do not observe a large shift away from personally-owned vehicles, and towards shared mobility services provided by both traditional and new mobility providers.

In line with CERRE's activities, the aim of the research project whose analysis, findings and recommendations are being reported in this document, is to produce a forward looking examination of issues of regulatory competence and choice of regulatory instruments likely to arise in association with the development of MaaS. This project does not, however, aim to present a 'global solution for MaaS'. Instead, it focuses on the development of MaaS in four European metropolitan areas: Barcelona, Frankfurt Rhine-Main, Oslo and Île-de-France.[5] When possible, it draws conclusions and suggests policy recommendations that may be applied more generally.

To examine the regulatory challenges which the development of MaaS presents, this report is organised around three parts:

- The first part provides a critical review of shared mobility, seen as one component of MaaS. It assesses the potential that shared mobility has to help reduce road transport externalities in cities, and increase mobility and accessibility.
- The second part focuses on MaaS, its potential benefits and its limitations. The business model of MaaS is facing substantial challenges, related to the sharing of data among mobility providers, and to the development of mobility platforms and apps. The features of the necessary cooperation between private and public actors are also discussed.
- The third part addresses regulatory issues. If we consider that walking, cycling and public transport must be the backbone of urban mobility, what is the impact of MaaS on the regulation of urban mobility? The paradoxical result is that the entry of new mobility providers, associated with the growing role of data, leads to a necessary enrichment of the role of local mobility authorities.

[3] UITP, Mobility as a Service, Report, April 2019, 26 pages, https://www.uitp.org/report-mobility-service-maas
[4] EMTA, Mobility as a service, a perspective on MaaS from Europe's Transport Authorities, June 2019, 16 pages, https://www.emta.com/spip.php?article1319&lang=en
[5] Île-de-France is the metropolitan area comprising Paris and its surroundings.

01

SHARED MOBILITY

OPPORTUNITIES AND CHALLENGES

1. Shared mobility: opportunities and challenges

1.1. Definitions and key issues

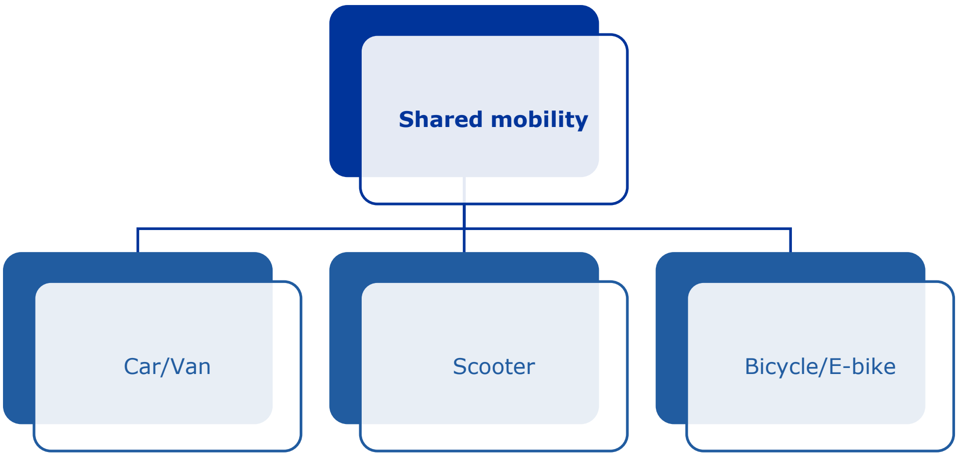
1.1.1. What is shared mobility

Shared mobility or 'mobility in the sharing economy' entails the sharing of an asset (i.e. a vehicle) that is not owned but accessed. Such access is typically facilitated through a digital platform. Shared mobility can include bicycles, electric bicycles (commonly known as 'e-bikes'), motorcycles and scooters, and cars and vans.[6]

There are examples of these throughout the world. Typically, shared motorcycles and scooters and shared bicycles and e-bikes are owned and/or operated by either private or public enterprises. Sometimes, the private enterprises involved are contracted out by local governments. Shared cars and vans are typically private enterprises or peer-to-peer businesses. There is no reason, however, why a public company could not run a shared car business, other than that most market economies see commercial enterprises as endeavours that should ideally be undertaken by the private sector. When public policy objectives can be achieved through guaranteeing the provision of certain services, the government will often, in most market economies, consider stepping in. This has been the case with a number of shared bicycle schemes, as shared bicycles help achieve sustainable mobility. Bicycles do not cause pollution, do not emit CO_2 and do not cause congestion. In addition, they provide health benefits to those who use them.

Figure 1 hereunder shows the three main types of shared mobility.

Figure 1 – The three main types of shared mobility



Although this report will briefly touch upon shared bicycles, e-bikes, scooters and motorcycles in Section 1.3.1., most of it focuses on shared cars and vans. Shared mobility involving cars and vans can be understood to mean different things, so we will briefly discuss the four main models, as identified by Santos (2018), in the section that follows. The feature common to all four models is

[6] Strictly speaking, the original taxi/cab-services and bus/train-services, which are in a narrower or broader sense shared mobility services *par excellence*, are shared mobility services but are not typically included in the definition of shared mobility in the sharing economy.

that vehicles are shared and that access to the vehicle, and typically payment for its use, are enabled a digital platform. Needless to say, car-pooling, car rental, and car clubs all existed before the Internet age. The Internet, however, along with smart phones and apps, has provided new opportunities to refresh these models. As a result, the latter have become more practical and more attractive, paving the way to new ideas.

1.1.2. The 4 models

Santos (2018) identifies the following four models of shared mobility involving cars and vans.

Model 1: Peer-to-peer car rental

Just like individuals may rent a room that is not in use in their house through Airbnb, they may also rent out their car when it is not in use. These are not companies but simply individuals lending their vehicles to other individuals. The peers meet through a digital platform, provided by a business which typically collects payment and takes a percentage.

Model 1 examples:

- Turo (https://turo.com/)
- easyCar Club (https://carclub.easycar.com/)
- hiyacar (https://www.hiyacar.co.uk/)
- Drivy by getaround (https://www.drivy.com/)

Model 2: Modern car club or modern car sharing

Alternatively, individuals may rent a car or van on a short-term basis in a modern car club. Here, the vehicles are managed and owned by a provider. The way in which modern car clubs are run can take one of three forms:

(a) vehicles are station-based and need to be collected from and returned to that one and only station, so essentially the trip is a round trip or a two-way trip;

(b) vehicles are station-based but there are two or more stations, and vehicles can be collected from a station and returned to a different station (Shaheen at al., 2015); and

(c) vehicles are strategically parked in a city or in certain areas of a city and can be collected from and returned anywhere within that area (Bieszczat and Schwieterman, 2012; Shaheen et al., 2015).

On top of the fee per hour or minute, some providers require the payment of an annual or monthly fee. Option (a) preceded the Internet Age with examples in the late 1980s and early 1990s in Switzerland, Germany, Austria, the Netherlands, the UK, Denmark, Italy, Sweden, Canada and the US (Shaheen et al, 1998; Enoch and Taylor, 2006). Today, all three options, (a), (b) and (c), rely on digital platforms.

Model 2 examples:

- Car2Go (https://www.car2go.com)
- Zipcar (https://www.zipcar.co.uk/)

Model 3: Ride-hailing, ride-sourcing, e-hailing, Uber-like service or Transportation Network Companies (TNC)

In this third model, the companies own no cars themselves. Instead, they sign up ordinary car owners as drivers.[7]. Driver and passenger(s) meet through a digital platform provided by a business, which typically collects payment and takes a percentage (Wallsten, 2015).

Model 3 examples:

- Uber (https://www.uber.com/en-GB/)
- Lyft (https://www.lyft.com/)

In San Francisco, Getaround (Model 1) has partnered with Uber (Model 3), so anyone can hire a Getaround car and serve as an Uber driver (registration with Uber is a pre-requisite to be allowed to hire the Getaround car as an Uber driver). This is an example of how Models 1 and 3 may be combined.

Model 4: Ride-sharing, ride-splitting, micro-transit and new public transport on demand

The distinguishing characteristic of Model 4 is that passengers share the ride. Operators range from those who set up to offer ride-sharing services from the beginning, and those who evolved from ride-hailing, offering passengers a variation of the service by which they can share rides in order to decrease financial costs (e.g. UberPool). Typically, passengers going in the same direction are matched with each other. Options include users specifying pick-up and drop-off locations and required departure and/or arrival times. Route, passengers and the driver are all allocated together by software that minimises travel time and other costs. A further variation of this model, used for inter-city travel, is that of drivers offering rides from one city to another, for passengers willing to carpool (e.g. BlaBlaCar). Some companies own a fleet of cars whereas other companies simply act as brokers for drivers driving their own cars.

Model 4 examples:

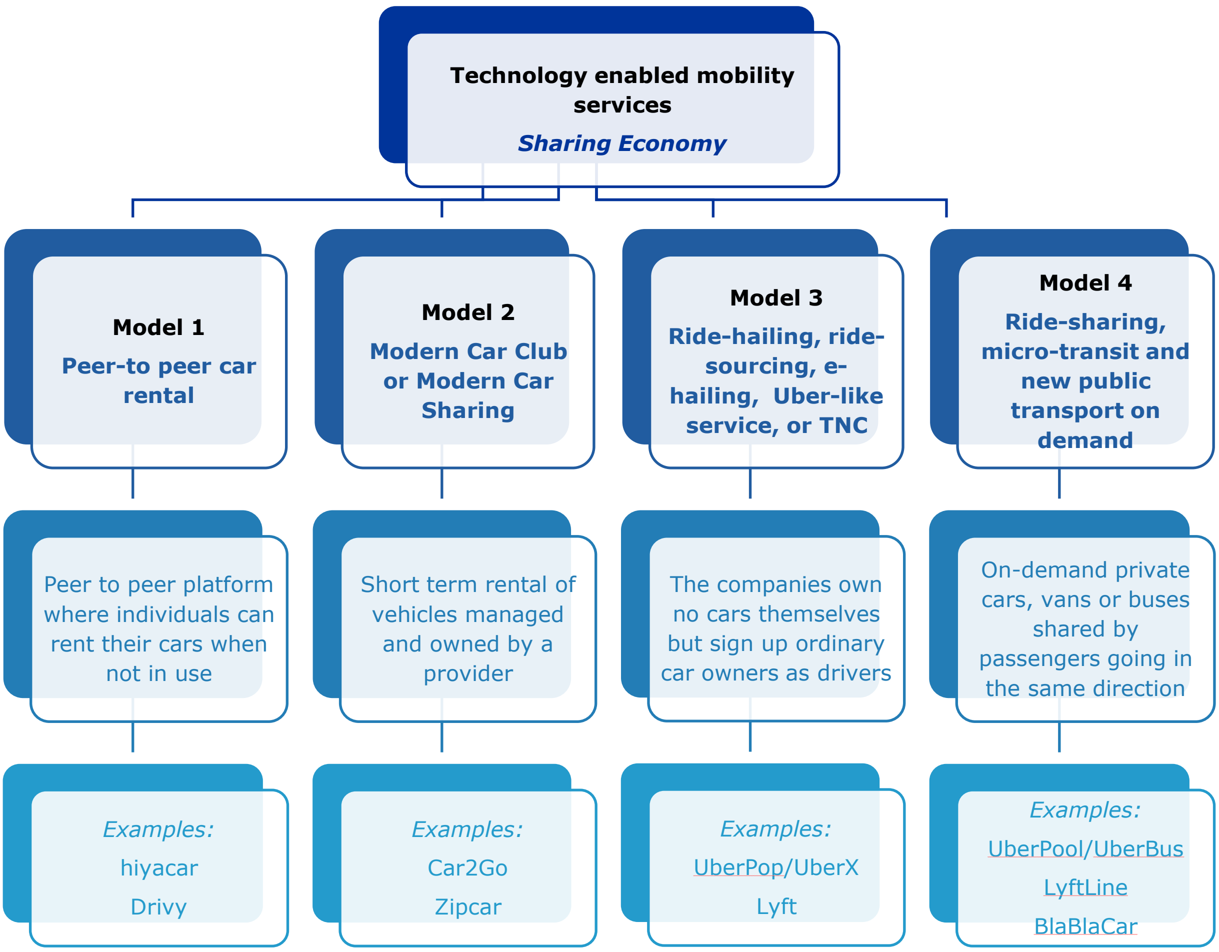
- Via (https://ridewithvia.com)
- Chariot (https://www.chariot.com/)
- UberPool (https://www.uber.com/en-GB/ride/uberpool/)
- LyftLine (https://www.lyft.com/line)
- BlaBlaCar (https://www.blablacar.co.uk), for inter-city travel

[7] Although in some areas of the world, for instance in Europe, these car owners have been required to apply for professional driver's licences.

BlaBlaCar has a particular business model: drivers on their platform can only charge for the cost of the journey (fuel, insurance, etc.). This is an important difference from all the other Model 4 companies, where drivers also make a profit. The way in which BlaBlaCar operates is different, because drivers are not 'earning money'. They are simply drivers who, before making a long-distance trip, say, from Paris to Brussels, offer empty seats in their car. Other people who need to make the same trip can pay to carpool with them.

Figure 2 hereunder summarises all four models.

Figure 2 – The four main models of shared mobility involving cars and vans



Source: adapted from Santos (2018)

1.1.3. Benefits for customers and growth of new mobility providers

As explained above, shared mobility providers are in general private companies, which are not controlled by the state, although they can be regulated. The nature of these shared mobility providers in a market economy means that, on an individual level, consumers are best served if companies are competing to provide the best services at the lowest possible prices.

The main piece of evidence showing that customers have benefited and continue to benefit from these relatively new shared mobility models is that all of them have grown considerably over recent years, thanks to a growth in demand. Although this is still a niche market, it is fast growing (ING Bank, 2018).

Peer-to-peer car rental (Model 1), is 'on the rise', as it offers decentralised fleets and 'customers have more variety in terms of brands and models' (Monitor Deloitte, 2017, p.5). In France, in particular, there is a boom of Model 1 shared mobility (Monitor Deloitte, 2017).

Modern Car Club or Modern Car Sharing (Model 2) is also growing. In Europe, for example, the number of Model 2 users increased from 2.2 million in 2014 to 4.4 million in 2016 (Shaheen et al, 2018), i.e. an increase of 98%.

The caveat with these numbers is that some of the Models 1 and 2 users may use car sharing regularly, whilst others may do so only occasionally, sometimes as little as once a year (ING Bank, 2018).

Ride-hailing (Model 3) has also grown substantially. The benefits of ride-hailing to customers are widely recognised and well-known: ride-hailing companies tend to provide fast, reliable and affordable services (Schaller, 2018). Uber, a company that only came into existence in 2009, is present in 63 countries and over 700 cities. 14 million trips are completed with Uber every day (Uber Newsroom, 2019). In the United States, Model 3 companies have more than doubled the size of the for-hire ride services sector since 2012. They served 2.6 billion customers in 2017, a 37% increase from 1.9 billion in 2016 (Schaller, 2018). In Europe, it is forecasted that they will serve 70.9 million passengers by 2023, up from 45.5 million in 2017 (Statista, 2019).

Ride-sharing, ride-splitting, micro-transit or new public transport on demand (Model 4) are also growing. In Europe, BlaBlaCar, which only started in 2006, has 70 million members in 22 countries and over 25 million travellers every quarter (BlaBlaCar, 2019).

If customers were not benefiting from these new shared mobility models, demand would not have grown. That growth has, however, been challenged by incumbents. Those are traditional providers offering very similar (and therefore, close substitute) services. In the US, for example, peer-to-peer car rental (Model 1) has been criticised by traditional rental car companies, especially by Enterprise Rent-a-Car and by the American Car Rental Association (Bliss, 2019). Furthermore, there are 34 states currently considering bills that would require companies like Turo and Getaround to pay the same taxes and follow the same safety requirements as incumbents (Bliss, 2019).

On similar lines, a major concern amongst taxi drivers throughout the world has been and continues to be that ride-hailing companies (Model 3), such as, for example, Uber, are 'stealing' their passengers (Adebayo, 2019). Some taxi companies have adapted to this new competition. Taxis in New York, for example, have retained their number of trips and market share by increasing their geographic coverage and serving customers outside of Manhattan, as customers in Manhattan have been partly grabbed by Uber. This wider coverage has obviously benefited customers (Kim et al, 2018).

Likewise, Rohan Silva, a tech entrepreneur, highlighted in an interview on BBC Radio 4 in December 2017 that Uber had made competitors up their game. This had, he said, brought benefits to customers, 'making it cheaper, easier and more convenient to get around the city' and it had also brought benefits to the 'incumbent London taxi cabs, which are now taking credit cards, which they resisted for years' (BBC News, 2017). Wallsten (2015) also finds that Uber's increasing popularity is associated with a decrease in consumer complaints about taxis in both New York and

Chicago. Faced with competition, taxi drivers seem to be providing better quality rides, for example by being more courteous to passengers (Wallsten, 2015).

It is important to note that competition of new entrants with fresh business models offering services which are very similar to those previously offered by traditional companies is not in itself a problem in a market economy. Competition encourages innovation, lowering of costs and improvement of the service in question. Customers are the main beneficiaries of this process. If taxi companies cannot compete with the likes of Uber, or traditional car-rental companies cannot compete with Turo or Getaround, then they may need to re-think their businesses or exit the industry.

The problem of these new shared mobility providers is, however, not simply one of competition, which is one of the very advantages of a free market economy. It is one of potentially *unfair* competition.

To guarantee fair competition, Uber, for example, had to adapt its services in line with the regulations that prevail in each region of the world where it operates. The original idea of ordinary car owners offering a ride to potential passengers was indeed short-lived in Europe, where all ride-hailing company drivers need to hold a professional driving licence, just like taxi drivers do.[8]

In Barcelona, there was a legal dispute between the Asociación Profesional Elite Taxi, a professional taxi drivers association, and Uber Systems Spain SL, a company related to Uber Technologies Inc. The Commercial Court No 3 of Barcelona decided to refer the following questions to the European Court of Justice: "[…]must the activity carried out for profit by [Uber Systems Spain] […] be considered to be merely a transport service or must it be considered to be an electronic intermediary service or an information society service[…]?" (Eur-Lex, 2017).

The European Court of Justice ruled the following:

> *"… the intermediation service provided by Uber is based on the selection of non-professional drivers using their own vehicle, to whom the company provides an application without which (i) those drivers would not be led to provide transport services and (ii) persons who wish to make an urban journey would not use the services provided by those drivers. In addition, Uber exercises decisive influence over the conditions under which that service is provided by those drivers. On the latter point, it appears, inter alia, that Uber determines at least the maximum fare by means of the eponymous application, that the company receives that amount from the client before paying part of it to the non-professional driver of the vehicle, and that it exercises a certain control over the quality of the vehicles, the drivers and their conduct, which can, in some circumstances, result in their exclusion.*
>
> *That intermediation service must thus be regarded as forming an integral part of an overall service whose main component is a transport service, and accordingly, must be classified not as 'an information society service'[…] but as 'a service in the field of transport'[…]"*
>
> *Source: Eur-Lex, 2017*

[8] UberPop is the version of Uber with non-professional drivers, UberX is the version with professional drivers, and UberBlack is the luxury version of UberX (i.e. a luxury sedan). In Europe, UberPop does not operate.

The implications of this ruling were further explained by the EU Commissioner for Transport, Violeta Bulc, as follows:

> *"The ruling of the Court of Justice of the European Union in Case C-434/15 Asociación Profesional Elite Taxi concerns a specific service called UberPOP (non professional drivers using their own vehicles), and not all services provided by Uber in general.*
>
> *The legislation applicable to private hire vehicles differs from one Member State to another. Thus, in certain Member States intermediaries, such as Uber, may provide their services consisting of connecting non-professional drivers with persons wishing to make an urban journey (e.g. UberPOP), while in others, they may only operate in collaboration with professional drivers. In some Member States, Uber as a platform is subject to authorisation to operate as an intermediary.*
>
> *Since there is today no specific EU legislation applicable to passenger transport by car, these services are regulated at national or local level.*
>
> *These rules should nevertheless be in line with Treaty principles, such as proportionality and non-discrimination (see also the general guidelines published by the Commission on the collaborative economy), as well as the freedom of establishment. Additionally, national rules could be necessary to achieve objectives of general public interest, including consumer protection."*
>
> *Source: European Parliament, 2018*

Fair competition is based on a level playing field, where providers compete in the quality of the service they provide and the price they charge. No provider should enjoy special treatment. Taxis and ride-hailing companies, however, are not subject to the same regulations and do not always enjoy the same privileges. For example, in London, black cabs, which incidentally are all wheelchair accessible, are exempt from paying the congestion charge, but private hire vehicles, including ride-hailing ones, are not, unless they are wheelchair accessible. Similarly, taxis are allowed to use bus lanes, but ride-hailing vehicles are not. Street-hailing is allowed for taxis but not for ride-hailing companies. In Germany and in Italy, private hire vehicles, including ride-hailing ones, must return to the business premises or the driver's house, whichever is the case, unless another ride has been booked before the driver's departure from the business premises or from his or her house, or during the journey (German Federal Ministry of Justice and Consumer Protection Passenger Transportation Act, point 4; Gazzetta Ufficiale della Republica Italiana, 2018). The sales tax paid by taxis in Germany is 7% instead of the standard 19% (German Federal Ministry of Justice and Consumer Protection Sales Tax Law, § 12 Tax rates, point 10). In addition to this, the issue of pricing is far from resolved. Taxi companies are heavily regulated in this respect. Taxis have a meter fitted within the vehicle, which calculates the fare for a journey. This fare also has a floor and a cap, and in some cities, an extra fee during rush hour or at night time. Ride-hailing companies, on the other hand, are free to charge low fares when demand is low and high fares when demand is high. There is no meter fitted in ride-hailing vehicles and so the customer may end up paying substantially less or substantially more than if they had used a taxi instead. This is actually one of the main differences between taxi and ride-hailing companies. Metering could perhaps be relaxed for taxis, or price regulations tightened for ride-hailing companies, or this could be left unchanged and highlighted as the main difference between these two substitute services. An argument for regulating taxi fares is that 'passengers are in a relatively weak position to compare offers and negotiate prices in the hail and rank (taxi) trade' (UK Competition & Markets Authority, 2017), unlike the private hire vehicle market.

1.2. Urban mobility

1.2.1. Overview of the 4 city-regions under study

The four regions under study in this report are Île-de-France (the Paris region), Frankfurt Rhine-Main, the Barcelona Metropolitan Region and the Oslo Metropolitan Region. All four regions have presence of shared mobility, as shown in Table 1 hereunder.

Table 1: Presence of shared mobility in the city-regions under study

	Île-de-France	Frankfurt Rhine-Main	Barcelona Metropolitan Region	Oslo Metropolitan Region
Model 1 **Peer-to-peer car rental**	Drivy	Drivy Turo Snappcar	Drivy Mambocar Amovens Socialcar	Hyre Nabobil Gomore Leieting
Model 2 **Modern Car Club or Modern Car Sharing**	Zipcar car2go	car2go Book-n-drive Stadmobil RheinMain Flinkster eMobil RheinMain	Ubeego Avancar Meccarsharing	Zipcar Greenmobility
Model 3 **Ride-hailing, ride-sourcing, e-hailing, Uber-like services or TNCs**	UberX Kapten Marcel Bolt	UberX	*None*	UberBlack
Model 4 **Ride-sharing, micro-transit and new public transport on demand**	BlaBlaCar UberPool Karos Klaxit	BlaBlaCar Ioki Clevershuttle	BlaBlaCar ViajamosJuntos Compartir Roadsharing	Sammevei Gomore
Shared bikes	Mobike Velib	e-Mobil-RheinMain Nextbike Call-a-bike Byke Lime Bike	Bicing (e-bikes also available) Donkey Bike Mobike Scoot (e-bikes available) Yes rent MouBikes	Oslobike Oslo bysykkel
Shared e-scooters[9]	Coop Citysccot Bolt Lime Wind Bird Voi Tier Flash Hive Jump	Lime Tier Circ	Scoot (motorbikes) Jet scoot Rent Electric Onwheel Yes Rent Rivera	Lime Voi Tier Circ (formerly Flash) Zvipp Ryde

Source: data provided by Autoritat del Transport Metropolità (ATM) Barcelona, Île-de-France Mobilités, Région Île-de-France, Rhein-Main-Verkehrsverbund (RMV), Ruter and Uber

[9] Note: some of those e-scooters sharing companies may have exited the market in a number of cities by the time this report is published.

1.2.2. Mobility challenges

Cities, where 85% of the EU's GDP is generated (European Commission, 2017a), are the engine of economic growth and employment in Europe. Most 'European cities face the challenge of needing to enhance mobility, ensure accessibility and create high quality and efficient transport systems while, at the same time, reducing congestion, pollution and accidents' (European Commission, 2017a, p. 5). Traffic congestion and emissions are mainly caused by cars. Although there is some limited evidence for the 'peak car' hypothesis, i.e. observed 'slower rates of growth, levelling off, or reduction, in various measures of car use […] in many […] developed countries' (Goodwin and Van Dender, 2013, p. 243), motorisation rates across Europe remain high. The average motorisation rate for the EU-28 in 2016 was 506 cars per 1,000 inhabitants, or just over one car for every two persons (Eurostat, 2019, p. 4).

The costs of congestion in Europe are high, estimated at around €130 billion per year, or just over 1% of the EU's GDP (European Commission, 2017b, p.7).

Emissions of nitrogen oxides (NOx) from road transport have not decreased enough to meet air-quality standards in many urban areas (European Commission, 2017b, p.10). The emission of air pollutants in cities is closely linked to traffic exhaust emissions. The transport sector is the largest contributor to NOx emissions, accounting for 46% of total (urban and non-urban) EU-28 emissions in 2014. Transport also contributed to 13% and 15% of total PM10[10] and PM2.5[11] emissions, respectively, in the EU-28 in 2014 (European Commission, 2017b, p.10).

In Europe, transport is the only sector in which greenhouse gases (GHG) emissions have grown since 1990 (Transport and the Environment, 2018). Road transport is responsible for 19% of total GHG emissions in Europe (European Environment Agency, 2018).

In line with the United Nations Sustainable Development Goals adopted in September 2015 (United Nations 2019) and with the Paris Agreement signed in December that same year (United Nations, 2015) and ratified by all European countries, CO_2 and air pollutant emissions from road transport need to be drastically reduced. Transport needs to be sustainable, in the sense that it needs to be 'safe, affordable, accessible, efficient, and resilient, while minimising carbon and other emissions and environmental impact' (United Nations Secretary-General's High-Level Advisory Group on Sustainable Transport, 2016, p. 10).

Within this context, mobility objectives in most cities and regions across Europe include reducing air pollution, CO_2 emissions and congestion, and achieving this through an increase in the share of active (i.e. walking and cycling) and public transport, and making efficient use of road networks.

Barcelona, for example, is in the process of preparing its new Mobility Plan for 2019-2024. Their objectives include promoting active mobility, reducing atmospheric pollution, facilitating a modal shift to more sustainable modes of transport, curbing transport-related energy consumption and reducing its contribution to climate change, amongst many others (Ajuntament de Barcelona, 2019). On similar lines, the city of Oslo also has set up a target of 16% of all weekday trips to be made by bicycle by 2020 and 25% by 2025 (Data provided by Ruter). In Île-de-France, the objective is to change travel behaviour towards more sustainable mobility over the 2010-2020 period, against a background of global travel growth of 7%. To achieve a 20% reduction in greenhouse gas emissions by 2020, the aim there is to increase the number of trips made by public

[10] PM10 includes particles that have aerodynamic diameters less than or equal to 10 micrometres. This approximately equals to one-seventh the diameter of human hair.
[11] PM2.5 is the subset of PM10 particles that have aerodynamic diameters less than or equal to 2.5 micrometres.

transport by 20%, increase the number of walking and cycling trips by 10% and decrease the number of trips made by car by 2% (Île-de-France Mobilités*, 2019*).

The four city-regions have planned a number of measures to help achieve those targets. All of them are extremely well-served by public transport, which runs mostly on schedule: 90% to 100% of all scheduled services are running within 5 minutes of their scheduled time. The four city-regions also have dedicated bus lanes, public transport integrated ticketing and some policies specifically targeted at air quality.[12] In Frankfurt, for example, there is a low-emission zone, where high polluting vehicles are not allowed to enter. In Barcelona, once nitrogen dioxide (NO_2) concentrations exceed a certain threshold, only low emission vehicles are allowed into the low emission area. This restriction will eventually become permanent. In Paris, on days when air pollution exceeds a threshold, restrictions are placed, and only cars with odd (or even) number plates are allowed to circulate. All four cities have streets which are closed to some or all motor-vehicles, just like so many towns and cities around the world.

It is clear that the four city regions are aware of the challenges they face and the interventions needed to reduce pollution, CO_2 emissions and congestion. The question that emerges, however, is whether Mobility as a Service, and shared mobility in particular, can accelerate or delay progress towards those objectives. Section 1.3 concentrates on that very question. Section 1.2.3 below first gathers some evidence regarding the impact that these new mobility services have on air pollution, CO_2 emissions and congestion.

1.2.3. Impact of new mobility services

One question that emerges is whether the new mobility services, encompassing Models 1 to 4, which can be a component of MaaS, have a positive, negative or neutral impact on congestion, pollution and CO_2 emissions. This is the point to which we now turn our attention.

From a local government and social welfare perspective, when a person travels by car, whether the vehicle is a private car, a taxi, a car rented from a peer (Model 1), a car from a car sharing scheme (Model 2) or from a ride-hailing service (Model 3) is not relevant. A car is a car. It takes the same amount of road space and produces the same level of air pollution and CO_2 emissions regardless of who the owner is and who drives it. Therefore, from an intuitive point of view, there is no reason to think that a 'shared mobility' car would cause more or less congestion, pollution or CO_2 emissions, as it is simply a question of 'substitution', as is indeed argued by Transport for London (2016, p.188). There are, however, three caveats, as follows:

a) Pollution and CO_2 emissions: sometimes, Model 2 (free-floating) cars are required to be hybrid or fitted with an electric battery. This is, for example, the case in France (Monitor Deloitte, 2017, p. 5). Potentially, the same could be required from Model 1, 3 and 4 vehicles. Under such circumstances, it could be argued that when trips made by any of these vehicles replace private car trips and the private car is a conventional vehicle, pollution and CO_2 emissions go down. However, regulators could potentially require all circulating vehicles to be hybrid or fitted with an electric battery, and in that case there would be no difference.[13] Having said that, cars in Models 1, 2, 3 and 4 tend to be relatively new, which is not necessarily always the case with privately owned cars. Again, if the cars are newer, they tend

[12] Data provided by Île-de-France Mobilités for the Île-de-France region, Rhein-Main-Verkehrsverbund for Frankfurt, Ruter for Oslo, and Autoritat del Transport Metropolita Área de Barcelona for Barcelona.
[13] A number of European countries have already banned the sale of conventional vehicles starting in 2025, 2030, 2040, etc., including France, the UK, Norway, Ireland and the Netherlands.

to be more efficient and less polluting, so there could be a reduction in pollution and CO_2 emissions, as compared to privately owned (older) cars.

b) Congestion: when the trip is completed with Model 3, there are extra miles on the way to pick-up, as compared to a trip made by private car. In cases like this, when Model 3 replaces private car trips, vehicle miles travelled (VMT) increase and congestion goes up (Schaller, 2018). Collecting and dropping passengers also causes congestion (Erhardt et al., 2019). As highlighted in Section 1.1, some countries require ride-hailing vehicles to return to the driver's house (or business premises) and in those cases, the return trip adds even more miles.

c) Behavioural change: although any given car trip may cause the same pollution, CO_2 emissions and congestion, there may be a reduction in emissions and congestion, not linked to that given trip but to a behavioural change linked to Models 1, 2, and 3. Nijland and van Meerkerk (2017), for example, argue that Models 1 and 2 are associated with lower car ownership and fewer miles travelled. Feigon and Murphy (2016, 2018) argue that Model 3 could also be associated with lower car ownership and more frequent use of public transport and non-motorised modes. Transport and the Environment (2017) argue that Models 2 and 3 encourage a behavioural shift towards multi-modal, sustainable transport.

Model 4, on the other hand, is different, and there is widespread agreement on the fact that it can indeed reduce congestion, air pollution and CO_2 emissions when replacing solo trips made by car (Viegas and Martinez, 2016, 2017; Furtado et al, 2017; Schaller, 2018).

The key issues can therefore be summarised as follows:

- Are Models 1, 2, 3 or 4 replacing private car trips *and* triggering a reduction in car ownership, which in turn, causes increases in the shares of public transport and active transport?
- Are Models 1, 2, 3 or 4 taking passengers away from public transport, walking or cycling?

There are only a handful of studies looking into these issues and their geographical coverage varies, which means that lessons are not transferable. There is currently no data on the number of trips, number of users or distances travelled by vehicles from Models 1, 2, 3 and 4 in the four regions under study, or on what mode of transport would have been used had Model 1, 2, 3 or 4 not been available. With this in mind, we can only review the studies that have been conducted for other cities in Europe and elsewhere, and highlight what may or may not apply to the four regions under study.

Models 1 and 2

No research seems to have been published specifically on Model 1. In relation to Model 2 (Modern Car Club or Modern Car Sharing), the global business consultancy Steer Davies Gleave (2017, pp. 20-31) surveyed over 1,100 users in London and found that:

- 47% of surveyed Model 2 club members who had joined six months prior to completing the survey owned at least one car before joining, but this share fell to 39% afterwards;
- 56% of surveyed Model 2 club members who had joined in the six months prior to completing the survey owned at least one car before joining, falling to 43% afterwards;
- 19% of surveyed Model 2 users reported that they had sold or disposed of their car in the 12 months prior to completing the survey and from those, one in four stated that joining the car club was the main factor, or a major factor, in this decision;

- 27% of surveyed Model 2 users stated that they would have bought a car if they had not joined a car club;
- 39% of surveyed Model 2 users stated that joining a car club had reduced the likelihood of them buying a car in the future, 40% stated that it had had no effect, 10% were more likely to buy a car, and 11% did not know.
- The average reduction in annual car mileage since joining a car club (for all cars in the household) reported by surveyed Model 2 club members was 239 miles, and that reported by surveyed Model 2 club members who had joined in the six months prior to completing the survey was 372 miles;
- Surveyed Model 2 users use sustainable travel modes more often than the average resident of the areas where Model 2 is available in London, as follows:
    - 30% travel by private car at least once a week, as compared to 36% of all residents in the same area (including Model 2 users);
    - 12% travel by car as passengers in a private car or in a Model 2 car at least once a week, as compared to 43% of all residents in the area (including Model 2 users);
    - 32% travel by bicycle at least once a week, as compared to 9% of residents;
    - 31% travel by train at least once a week, as compared to 16% of residents;
    - No differences in bus use were identified between surveyed Model 2 users and residents in the same areas.

Along the same lines, Feigon and Murphy (2016) surveyed 4,500 users of public transport, bicycle sharing and Models 1, 2, 3 and 4 in a number of US city-regions and found similar results. The city-regions they studied were Austin-Round Rock (TX), Boston-Cambridge-Newton (MA-NH), Chicago-Naperville-Elgin (IL-IN-WI), Los Angeles-Long Beach-Anaheim (CA), San Francisco-Oakland-Hayward (CA), Seattle-Tacoma-Bellevue (WA), Washington-Arlington-Alexandria (DCVA-MD-WV) and New York City (NY). Their findings can be summarised as follows:

- Car ownership was lower amongst respondents who were shared mobility (Models 1, 2, 3 and 4) and public transport users than among respondents who were public transport users but did not use shared mobility, with an average of 1.05 and 1.5 cars per household, respectively;
- 20% of respondents who were shared mobility and public transport users reported postponing a car purchase, 18% reported having decided not to purchase a car, 21% reported having sold a car without replacing it, and 8% reported having bought a car.

These results are all in line with those of Miramontes et al. (2017), Nijland and van Meerkerk (2017) and Schaefers et al. (2015). Steer Davies Gleave (2017, p.13) also conclude that car clubs allow people who *do not need a car for most journeys* to benefit from the flexibility of car travel when they need to.

The Ajuntament de Barcelona (2017) reviews a number of studies on shared mobility and finds that (a) car clubs are neither useful nor profitable for people who imperatively need a car or motorcycle daily or frequently, and (b) many Model 2 users did not own a vehicle to start with.

In other words, Model 2 cars are used when public transport, walking and cycling are less practical, such as for example, when luggage or bulky items need to be carried, or when the alternative would take too long (Steer Davies Gleave, 2017, p. 13).

Model 2 cars are 'not considered an attractive substitute for private-vehicle ownership, because they are rarely appropriate for a daily commute' (Bieszczat and Schwieterman, 2012, p. 105).

The majority of car owners are unlikely to switch to Model 2 cars, as the costs are only lower under restrictive circumstances and there is still some emotional attachment to the car, combined with the convenience it provides (ING Bank, 2018).

From the above, there does not seem to be any evidence of people replacing private cars with Models 1 or Model 2 cars, except when their cars were not used frequently.

Model 3

In relation to Model 3 (ride-hailing), there are a number of studies for American cities but almost none for Europe.

Smith (2016) ran a survey in 2015, and found that around 3% of Americans use Model 3 on a daily or weekly basis. From these, 64% own a car and 63% drive a car on a daily or weekly basis. This is less than the 85% of less frequent Model 3 users, and the 85% of non-users who regularly drive a car. Smith (2016) also found that Model 3 daily or weekly users were much more likely to cycle and use public transport than those who use Model 3 only occasionally or never.

These important correlations should be further investigated in order to establish causality. In addition, Model 3 users should be surveyed, and asked what mode of transport they would have used had ride-hailing not been available. Rayle et al. (2016) and Clewlow and Mishra (2017) do exactly that, but their findings are only relevant for the US case.

Rayle et al. (2016) survey Model 3 users in San Francisco. These authors find that, when asked what mode of transport Model 3 users would have used had ride-hailing not been available, 8% would have not made the trip (which is evidence of induced demand for travel), 39% would have used a taxi, 33% would have used public transport, and 6% would have driven their own car.

Clewlow and Mishra (2017) survey Model 3 users in Boston, Chicago, Los Angeles, New York, San Francisco/Bay Area, Seattle, and Washington, D.C. and find that 49% to 61% of ride-hailing trips would have not been made at all, or would have been done by walking, cycling, or public transport, had ride-hailing not been available. This points towards the idea that Model 3 may be partly responsible for a reduction in public transport patronage in some US cities. Interestingly, however, Higashide and Buchanan (2019) find that although Model 3, with companies like Uber and Lyft, is 'nibbling away' at some public transport trips (p. 2), the main reason why their survey respondents reduced public transport use is that they replaced public transport with the private car, and access to a private car amongst their respondents increased in the two years previous to the survey, which was conducted in 2018. Three of the cities Higashide and Buchanan (2019) surveyed are the same cities surveyed by Clewlow and Mishra (2017): Chicago, Los Angeles and New York. The other cities are different: Pittsburgh, Seattle, Denver, and New Orleans. The reason why Clewlow and Mishra (2017) and Higashide and Buchanan (2019) attend up with apparently different conclusions is that they ask different questions to samples selected in different ways. The sample in Clewlow and Mishra (2017) is made up of Model 3 users and the questions involved, amongst other things, understanding what mode of transport they would have used had ride-hailing not been available. In contrast, the sample in Higashide and Buchanan (2019) is made up of public transport users and the questions involved, amongst other things, understanding if they had reduced their use of public transport and if so, what mode of transport they were using instead. Different questions lead to different answers and the conclusions can be easily reconciled: Model 3 attracts passengers from public transport, as well as from walking and cycling (Clewlow and

Mishra, 2017) and many former public transport users who reduced their public transport use are using private cars instead (Higashide and Buchanan, 2019).

Clewlow and Mishra (2017) also find that 91% of Model 3 users who responded to their survey had not made any changes regarding whether to own a vehicle or not. This contrasts with Feigon and Murphy (2016), who found that Models 1, 2 and 4 reduce the need to own a car.

Schaller (2018) argues that, in the US, Model 3 is not generally competitive with the private car on speed, convenience or comfort. Clewlow and Mishra (2017) conclude that Model 3 is mainly used when parking is expensive or difficult to find and to avoid drink-driving. Feigon and Murphy (2016, 2018) find that Model 3 is often used for social trips during the night, when public transport is infrequent or not available.

In a detailed study for San Francisco, Erhardt et al. (2019) find no changes in car ownership, despite the growth of ride-hailing in that city. They also find that the changes in travel time are worse than the background changes would predict, and that travel times get worse on roads with more ride-hailing activity than on roads with less ride-hailing activity. Those authors conclude that, in San Francisco, ride-hailing increases congestion, and this increase is bigger than the combined effects of population growth, employment growth and network changes. They also find that most ride-hailing trips are adding new cars to the roads, and that ride-hailing vehicles stopping at the curb to collect or drop customers off disrupt the traffic flow.

The evidence for the US therefore points towards Model 3 increasing congestion, and in so doing, also increasing pollution and CO_2 emissions. This is mainly because passengers replace public transport, cycling and walking with ride-hailing (Rayle et al., 2016; Clewlow and Mishra, 2017; Erhardt et al., 2019).

Although these results may be valid for US cities, they may not be transferable to Europe. The effects found for San Francisco, for example, may not apply to smaller cities, to less dense areas or to different populations and regulatory environments (Erhardt et al., 2019, p.10). In addition, in the US, public transport is in general perceived to be of poor quality, whereas this is not the case in Europe (Shrikantaditi, 2018; English, 2018). For this reason, public transport users in Europe may not be inclined to replace public transport trips with ride-hailing. One obvious recommendation from the present discussion is that surveys of Model 3 users should be carried out in European cities to understand, amongst other things, what mode of transport they would have used had ride-hailing not been available.

Another interesting area to explore is what mode of transport ride-hailing passengers would use if, once they start using ride-hailing, that option were taken away from them. Hampshire et al. (2017) were presented with this opportunity and they grabbed it. Following the suspension of services by Uber and Lyft in Austin, Texas, in 2016, they conducted a survey amongst 1,840 former Uber and Lyft users. They found that 41% had switched to other ride-hailing companies, 45% had switched back to their car and 3% to public transit, with the remaining ones having switched to other means. Among those switching to their car, 8.9% of respondents had bought a car in response to Uber and Lyft not operating in Austin any longer. This poses the question of whether they were former car-less public transport users who had switched to ride-hailing, or if they had decided to sell their cars after switching to ride-hailing. In addition, those who switched to private cars after the suspension of services by Uber and Lyft had a higher probability of increasing their trip frequency. Given the questions the authors asked, it is not possible to establish whether these former Uber and Lyft users had originally switched to Uber and Lyft from public transport, walking, cycling, private car or taxi.

Model 4

As for Model 4, Schwieterman and Michel (2016) compared the different performance characteristics of UberPool and public transport services between downtown Chicago and the city's north- and northwest-side neighbourhoods. Out of 50 trips that members of the research team took to and from the same location, starting at the same time, one by public transport and one by UberPool (Model 4), 39 were faster with Uber. The average price was $9.66 with Uber and $2.29 with public transport. Schwieterman and Michel (2016) also observed that four of five public transport users had seats, and eleven public transport trips involved walking at least two-thirds of a mile. They also noted that UberPool tends to perform poorly on trips to and from the central business district rush hour, when public transport is efficient. In sum, for those who are prepared to pay $7 more on average, UberPool appears to offer an excellent alternative to public transport, especially during off-peak hours when there is no surge pricing in UberPool and there is no congestion on roads.

In Europe, Model 4 simulations show that it offers important potential for reducing congestion, pollution and CO_2 emissions when replacing solo trips (Viegas and Martinez, 2016, 2017; Furtado et al., 2017). The key assumption in those studies is that Model 4 replaces a substantial percentage of solo trips. In line with previous surveys (Henao, 2017; Gehrke et al., 2017), Erhardt et al. (2019) assume that 13% to 20% of Model 3 trips in San Francisco are actually Model 4 trips.[14] They however find that this relatively small share is not enough to offset the increase of congestion due to Model 3.

It would thus be important to find what is the share of Model 4 in European cities either the Model 4 share in all transport modes, or the Model 4 share in Models 3 and 4 together. This would be especially interesting in the four city regions under study, taking into account all mobility providers offering Model 4 solutions and not just one or two. As long as Model 4 replaces solo trips and not public transport trips, the potential to reduce congestion, air pollution and CO_2 emissions should not be ignored.

Conclusion

Going back to the questions of whether Models 1 to 4 are replacing private car trips and triggering a reduction in car ownership, the limited evidence shows that they only replace private car trips occasionally. There is also a clear correlation between Models 2, 3 and 4 and lower car ownership, but this correlation does not equal causality. It may be that shared mobility does not trigger a reduction in car ownership but lower car ownership triggers demand for Models 1 to 4. In addition, the limited evidence shows that Model 2 replaces trips by public transport, walking and cycling and that, in the US, Model 3 does as well. This being said, public transport in Europe is perceived to be of better quality than in the US (Shrikantaditi, 2018; English, 2018). Europeans may thus not be replacing public transport trips with Model 3 trips.[15]

Finally, there is an urgent need for data collection, ideally by surveying Models 3 and 4 users in Europe, to understand what model of transport they would have used for their trips, had ride-hailing and ride-sharing not been available.

[14] As already mentioned above, 25% of Uber customers choose UberPool in New York (data provided by Uber, 2019) so the assumption of 13% to 20% for San Francisco, may not be unrealistic.

[15] It should be highlighted that public transport is central to sustainable mobility, as demonstrated by experience and the literature, and recently underlined by Verbavatz and Barthelemy (2019), who find that the percentage of people who commute by car decreases as the percentage of people who live within 1 km of a mass rapid transit station increases.

1.3. Can shared mobility help local authorities meet their targets and objectives?

In this section we discuss whether and how shared mobility can help local authorities meet their objectives.

1.3.1. Risks and opportunities

Section 1.2. above shows that, if current trends are maintained, shared mobility *per se* is unlikely to reduce congestion, pollution and CO_2 emissions. This is probably the result of not having enough disincentives for single car usage in place. There is even a possibility that shared mobility could actually increase those negative externalities. A reduction in congestion, pollution and CO_2 emissions is only shown by theoretical modelling efforts that assume a large switch from solo trips to ride-sharing (Model 4), something for which there is no empirical evidence anywhere as of 2019.

The potential benefits from replacing solo trips with Model 4 are, however, not trivial. They have recently been recognised by the French government. The *Loi d'Orientation sur les Mobilités (LOM)* was adopted by the French Senate on 3 April 2019 and by the National Assembly on 18 June 2019 (Le Monde, 2019a). No final agreement on specific amendments could however be found between the Members of Parliament and Senators, and the law will be discussed again this autumn. The LOM gives transport authorities a permanent legal framework to subsidise carpooling (Article 15). It creates a mobility package of up to 400 euros per year and per employee, allowing businesses and administrations to reimburse carpooling (Article 26).

Klaxit, a Model 4 mobility provider which specialises in car-to-work carpooling in France, has teamed up with local authorities in Toulouse, Clermont-Ferrand, Lannion and Lunéville. The local authorities will offer a subsidy that will cover approximately 50% of the cost of the trip for a carpool passenger. For example, for a daily round trip of 25 kilometres, the driver-owner will receive 5 euros while the passengers will pay between 0 and 2.5 euros each (Le Monde, 2019b). The idea behind this arrangement is that Model 4 reduces congestion, pollution and CO_2 emissions, as compared to solo trips by car.

However, when shared mobility substitutes for public transport, even in the case of ride-sharing (Model 4), the outcome can only be an increase in congestion (American Public Transportation Association, 2018; Erhardt et al., 2019), pollution and CO_2 emissions, and a reduction in public transport revenues (Santos, 2018). Furthermore, when shared mobility, especially Models 3 and 4, compete with public transport, cross-subsidies from profitable public transport services to non-profitable ones can be endangered (Finger et al., 2017). In a bleak, extreme scenario, public transport passengers could be attracted to Model 4, leaving public transport to struggle with lower revenues. This in turn would reduce service quality (coverage, frequency and reliability), thus causing a further decrease in patronage, and creating a vicious circle.

Whether, in Europe, Models 3 and 4 are more attractive than public transport for passengers is not clear and there is no evidence one way or other. Although this is the case in the US, the evidence may not be transferable because, as explained above, public transport in Europe is perceived to be of better quality than in the US.

What has been widely recognised, however, is that shared mobility can, in some cases, complement public transport. Although the overall effect for the US case is that it takes passengers away from public transport, there is a small positive effect on rail. Clewlow and Mishra (2017), for example, find that ride-hailing serves as a complementary mode for commuter rail services, with a 3% net increase in use on average in Boston, Chicago, Los Angeles, New York, San Francisco/Bay

Area, Seattle, and Washington, D.C. This is because ride-hailing is used to reach rail stations, and so it acts as a complementary service. Models 3 and 4 can thus induce passengers to switch from private cars to public transport ‘by providing better first- and last-mile connections’ to public transport stations (Erhardt et al., 2019, p. 1). In London, a night service running between 12:30am and 5:30am on weekends was introduced along the Central and Victoria underground lines in August 2016. During the first seven weekends, the number of Uber journeys starting within 200 metres of Night Tube stations (during the hours when the Night Tube was operating) increased by 22% (Rao, 2016).

Public transport agencies in the US and Canada are exploring ways in which they can partner with new mobility providers to provide first-mile/last-mile rides, reach areas not well-served by public transport, the elderly and the disabled (McMahon, 2018). For example, Uber is running an on-demand paratransit pilot scheme with the Massachusetts Bay Transit Authority (Uber, 2019) that rides from Innisfil, Ontario, a small town about an hour from Toronto, to key destinations such as the town hall and the employment centre (Schaller, 2018). The City of Arlington, Texas has also partnered with Via to provide on-demand trips in a certain zone within the city (Schaller, 2018).

Murphy et al. (2019) report the lessons from Pinellas County, Florida, which has the longest operating ride-sourcing partnership (with Uber) to provide subsidised first- and last-mile connections to public transport stops, known as PSTA Direct Connect. One of their conclusions is that, while successful at cutting costs overall, there were a number of other costs (such as per-ride reimbursements to service providers or transfer discounts provided to riders, amongst others) that are likely to ‘limit scalability beyond very low performing routes’ (p. 3). Furthermore, Reck and Axhausen (2019) analyse that same case study by using block-group level origin-destination commuting trip information. They construct public transport travel times, including access/egress walking times and intermediate wait times, and then construct first and last mile car trips from the origin to the first public transport station used, and from the last public transport station to the destination. They find that a first and last mile service leads to average travel time savings of 15.7 minutes. However, transfer penalties of 5, 10 and 15 minutes diminish travel time savings by 54%, 82% and 95% respectively. They conclude that these results may explain the low ridership of current first and last mile ride-sourcing services, and also why a significant and substantive positive relationship between ride-sourcing and public transport for urban areas has not been found yet (Reck and Axhausen, 2019).

In addition to potentially acting as complements to rail services by providing first and last mile solutions, Models 3 and 4 can also act as valuable extensions of public transport (Schaller, 2018, p. 23). This is in areas where public transport is not profitable or where demand is so sporadic that frequency can only be low. They can also provide services to the elderly and the disabled and, if the local authority pays for or subsidises the trips, to lower income groups without access to private or public transport. Laguna Beach, California, for example, has partnered with Uber to supplement public transport for the elderly and the disabled. Similarly, the public transport agency in Las Vegas, Nevada, has partnered with Lyft to provide on-demand paratransit services (Schaller, 2018).

Finally, shared bicycles and shared scooters, which take about 20% or less of the road space taken by a car and produce no pollution or CO_2 emissions, can also act as complements or even substitutes to public transport. Electric scooters are illegal in some countries/regions/cities, but legal and common in others. Although they do not cause congestion or emissions, they do not provide the additional health benefits that bicycles do. Shared bicycles offer ‘unique opportunities to promote physical activity on a large scale’ and they have the potential to achieve ‘long-term changes in commuting culture and physical activity around the world’ (Ding et al., 2018). The adoption of shared bicycles in Shanghai has been found to be inversely correlated with access to a public transport stop or station (Jia et al., 2019). This may not necessarily be the case in Europe, where some distances can be travelled by bike, especially on dedicated cycle lanes present in many cities (including the four city-regions under study here, although the coverage varies from one to another).

Shared bicycles substituting for public transport could cause public transport revenues to go down, but, in contrast with Models 3 and 4, they would yield benefits in terms of reduced congestion, reduced pollution and reduced CO_2 emissions. Traditional bicycles offer health benefits but are not suitable for very long trips. In a survey of over 10,000 e-bike users across seven European cities, Castro et al. (2019) find that, on average, the distance covered by e-bikers tends to be twice the distance covered by those riding traditional bicycles. This longer distance makes up for the lower physical activity. They conclude that physical activity levels are similar for those riding e-bikes and for those riding bicycles, since the trips are, on average, twice as long.

To summarise this section, the biggest risk posed by shared mobility, especially Models 3 and 4, is that public transport users could switch. Model 4, in particular, can be perceived as an improved, more convenient form of public transport. The biggest opportunity is that shared mobility can complement public transport very well, by providing first and last mile solutions, and by reaching areas where public transport is not profitable or where demand is so sporadic that frequency of service needs to be low. It can also provide services to the elderly, low income groups and the disabled. As for shared bicycles and scooters, they can also provide first and last mile solutions and, in some cases, substitute for public transport.

1.3.2. Regulatory challenges

Local authorities working towards a reduction in congestion, pollution and CO_2 emissions typically set targets related to increasing the share of trips made by public transport, cycling and walking. Discouraging trips by car is the other side of the coin, and this needs regulation that sends the right signals. Currently, the individual car remains a very attractive option in many cities, although high parking charges (or low parking supply) can help reduce this attractiveness to some extent (Verhoef et al., 1995). Congestion charging, on the other hand, is a policy favoured by most economists (Lindsey, 2006, p. 354) although it tends to be resisted by politicians. The idea is indeed not typically welcome by car drivers, and there have always been important equity concerns. This is the reason why so very few towns and cities have implemented congestion charging to date, with Singapore, London and Stockholm being the prime examples. Oslo has also had tolls in place since 1990, but these are not congestion charges strictly speaking. They are designed to collect revenue to fund road, bus and rail infrastructure. Having said that, a congestion charge component was added in 2017, with higher prices during rush hour, and different charges for electric, petrol, hybrid and diesel vehicles, and for Euro V or older, Euro IV and zero emissions vans (Fjellinjen, 2019).

Singapore does not exempt taxis from paying the congestion charge, and neither does Stockholm. In London, black cabs (licensed with London Taxis) are exempt but private hire vehicles, including all ride-hailing (Model 3) ones, need to pay. Most Model 4 cars also need to pay the congestion charge, except when the vehicles have nine or more seats (Transport for London, 2019). It is not clear why black cabs are exempt from the charge, given that they cause as much congestion as other cars.

In order for the London congestion charge to also contribute to reducing emissions, vehicles which satisfy Euro 6 standards, emit no more than 75g/km of CO_2 and have a minimum zero-emission capable range of 20 miles, are exempt (Transport for London, 2019). These restrictions will tighten in October 2021, when only pure electric vehicles will qualify for the exemption. The exemption will eventually be withdrawn in December 2025.

Congestion charging is a powerful and effective tool which can indeed reduce the share of trips made by car and increase the share of trips made by public and active transport, as demonstrated by the schemes in place in Singapore, London and Stockholm (Santos and Shaffer, 2004; Santos, 2005; Eliasson, 2014).

Investment in public transport (especially buses) was a key element in the success of the London Congestion Charging Scheme, which was introduced in February 2003. Many car drivers switched to the bus, and the number of bus passenger increased by 18 percent and 12 percent during the first and second years after charging started, respectively (Santos, 2008). In addition, bus fares were restructured, leading to a real decrease in the average fare paid per individual trip, bus service reliability improved on routes in and around the charging zone, and excess waiting time fell (Santos, 2008).

Public transport needs to be fast, frequent, reliable, convenient (with stops and stations within walking distance) and non-expensive by the time congestion charging is introduced, so that reliable alternatives to the car are available for drivers who are priced off the roads.

Softer alternatives to congestion charging include 'pedestrianisation' of certain areas or roads, where traffic is banned, or closing certain areas or roads to some vehicle types, such as low occupancy vehicles (Santos et al., 2010). These measures, however, do not guarantee efficiency, as socially valuable trips may not be made. Walking and cycling can also be encouraged with dedicated cycle lanes and wider pavements.

Overall, **an integrated and coherent policy package that simultaneously discourages the use of private cars and makes public transport, walking and cycling attractive alternatives, is much more likely to achieve substantial modal shifts than isolated interventions.**

This idea is not new, and indeed many local governments in Europe and elsewhere have attempted to offer those integrated transport policies for decades. Road pricing remains controversial, as explained above, but there are now new opportunities. What did change over the second decade of the 21st century, is that mobile phones have penetrated the market substantially. As a result, the new mobility providers which are the subject matter of this part of the report have the potential to complete the missing pieces of this complicated mobility jigsaw puzzle.

Regulation of these new mobility providers should also aim at reducing traffic congestion, air pollution, and CO_2 emissions. In other words, **regulation should be designed in a way that all new mobility services can co-exist with traditional services and can operate at scale by complementing (and not substituting for) public transport.**

The whole policy package can, with today's technology, materialise as MaaS. Transport users should no longer be expected to walk long distances to public transport stops and stations, or face infrequent public transport services. The elderly and the disabled should no longer be expected to struggle in crowded buses. Those on lower incomes should have access to the same transport options as those who can afford taxi or ride-hailing trips.

1.3.3. Policy recommendations

Part 1 of the present report has scrutinised the limited evidence there is regarding shared mobility and whether it can have a positive, negative or neutral impact on congestion, pollution and CO_2 emissions.

The main finding is that shared mobility is unlikely to help reduce congestion, pollution and CO_2 emissions, except when ridesharing (Model 4) replaces solo trips by car or when complementing public transport to offer an alternative to private car usage. Shared mobility can also complement public transport by providing first and last mile alternatives and reaching areas which are not well served by public transport, and people who are older, disabled or on low incomes, with the latter being an example of a group that justifies public subsidies. Shared bicycles and scooters can provide first and last mile solutions and substitute for public transport, thus reducing pollution and CO_2 emissions, and in the case of bicycles, yielding additional health benefits.

The policy recommendations of this part of the report are therefore as follows:

Invest in public transport, walking and cycling

The first policy recommendation is to continue and enhance policies aimed at increasing the share of trips made by public transport, walking and cycling. For this, public transport needs to become a genuine, practical, fast, reliable, and affordable alternative. Walking and cycling friendly urban environments are also key in this respect.

Introduce policies to discourage trips by car

The second policy recommendation is to concentrate efforts on reducing traffic, especially solo trips, by implementing policies that discourage the use of private cars. Congestion charging, in particular, offers a unique opportunity. The concept has been favoured by economists for decades but opposed by policy makers due to fear of public backlash and equity concerns. The time, however, is now ripe for this intervention, thanks to the potential of technology-enabled MaaS, which can offer convenient alternatives to the car.

Implement subsidies

When there are potential societal/social benefits, such as reaching areas poorly served by public transport or the elderly, disabled or poor, or providing first mile-last mile connections with public transport, there may be an argument for public subsidies, channelled through partnerships between mobility providers and public transport agencies.

Harness the opportunities offered by MaaS

The fourth policy recommendation is to tap on the potential that MaaS offers, by providing the missing element that congestion charging and investment in public transport cannot deliver alone. One of the constraints of combining congestion charging and public transport improvements has always been the first and last mile, and the financial unviability of public transport provision in disperse areas of low demand. Provided well-designed regulation guarantees that new mobility models complement and not substitute for public transport, MaaS can fill this gap, and enable the transition towards truly sustainable mobility.

02

MaaS, PLATFORMS AND DATA

TOWARDS A NEW ERA FOR MOBILITY?

2. MaaS, platforms and data: towards a new era for mobility?

Mobility issues are increasingly concentrated in and around agglomerations: 98% of trips are less than 80 kilometres long. As a result, supporting the development of our cities to ensure accessibility in a sustainable way has become a top priority for users, for inhabitants of urban areas, and for society and the environment at large.

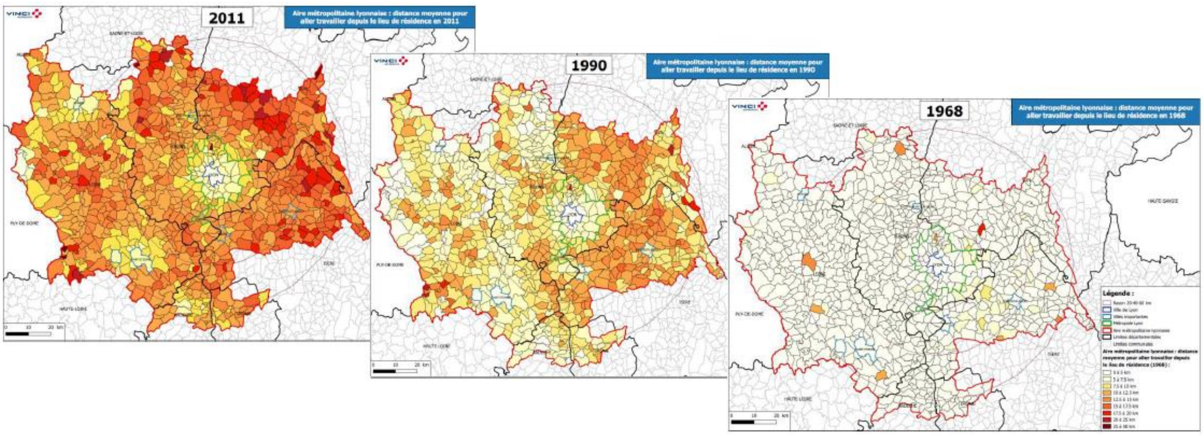
The cost of car usage has been reduced by a factor of 5 in the last 50 years, and it is foreseen that the rollout of electric vehicles will halve this cost again.

Still, it is striking that alternatives to the private use of cars (public transport, or shared mobility, as exposed in Part 1 of this report) are less and less easy to find as one moves away from the centre of agglomerations. The latter indeed concentrates jobs and alternatives to the individual car. In addition, housing prices in major urban centres have exploded over the past 20 years, pushing many social groups to move away from the heart of cities, leading to a significant increase in commuting distances.

In the near future, urban areas will continue to expand and distances from home to work will most probably also continue to increase. It is the lack of alternatives to the individually used car that generates flows of vehicles saturating road networks, leading to increased traffic congestion and CO_2 emissions.

It has thus become urgent to develop efficient and sustainable alternatives to solo car use for long distance travels from peripheries to cities. For now, private cars are still largely used. In some cities (as shown with the example of Lyon in Figure 3 below), these travels account for around 60% of daily travellers per km.

Figure 3 – Urban expansion and home-to-work travel distances, Lyon area (1968-2011)



Note: the colour indicates the average distance travelled by inhabitants of a given municipality to reach their work place. White = 0-5 km; Dark red = 50km.

Source: INSEE, AIPCR/ASFA, A Broto, October 2017

Against this background, the European Union has defined very ambitious objectives to decarbonise transport by 2050, with a reduction of greenhouse gases (GHG) emissions by 80% to 95% as compared to 1990s levels, and by at least 60% compared to 2010. In a similar vein, one of the targets included the United Nations Sustainable Development Goals (UNSDGs) set forth in 2015 is to *"By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all"*.[16]

One of the main challenges in meeting those ambitious goals is building mass alternatives to private car usage. This would require efficient public transport, connecting peripheral areas to each other and to city centres, using an inter-modality approach with feeder services. For now, public transport offers are still very focused on intra-ring road areas. Therefore, not least in view of the environmental impact of that situation, there is an urgent need for more sustainable solutions.

In this context, Mobility as a service (MaaS), including active management of mobility data, can constitute one of those solutions, by enhancing access to cities while limiting car use.

The concept of MaaS emerged in Finland. It is based on the idea of accessing a variety of mobility services, including integrated public transport, bike services and car sharing or carpooling services, via a single (smartphone) app. MaaS has however many different meanings and variants. Since the territorial contexts vary from one city and country to another, it would be risky to favour one over the other. It must however be assumed that, in the near future, information will be fully multimodal and access to services will become increasingly coordinated or even integrated between various mobility service providers .

Still, from theory to reality, the gap is immense. In this section of the report, we describe the overall context in which MaaS is deploying, and then analyse its possible business models. We will see that digital actors are facing significant difficulties to identify a sustainable business model: their clients, as well as the mobility flows they address, are still marginal in numbers, and their impact on urban mobility is still negligible.

How can these difficulties be overcome so that European citizens finally enjoy the full potential benefits of MaaS? We try to address this through the following three strategic questions:

1 – How to combine the public and private sectors' activities, so as to provide high benefits to commuters, public authorities and mobility services providers?

2 – How to manage data to ensure that it has a real, positive impact on urban mobility?

3 – How to make MaaS a reality and what is needed for MaaS to significantly impact current mobility patterns?

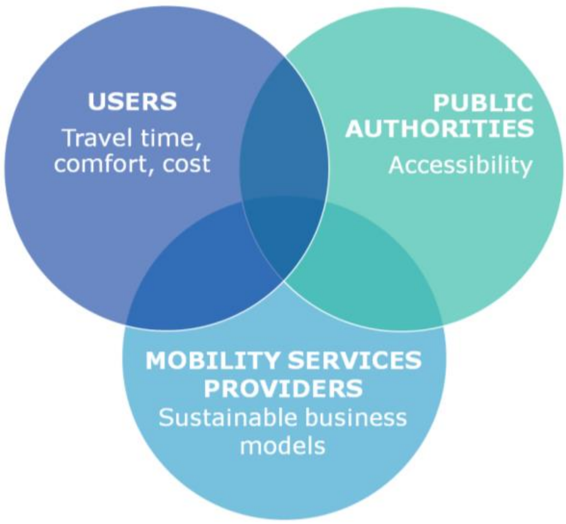
2.1. Mobility as a Service: what is at stake?

2.1.1. General considerations

As shown in Figure 4 hereunder, the merger of traveller information tools and multimodal ticketing (far beyond public transportation only) makes it possible to publicise the whole – both public and private – mobility offer of a given city or region. It also offers a unified, and thus much simpler, access to these mobility services.

[16] See Goal 11 ('Make cities inclusive, safe, resilient and sustainable'), Target 11.2, https://www.un.org/sustainabledevelopment/cities/

Figure 4 – MaaS: merging multimodal information and multimodal ticketing



Possible visions:

- **A user centric vision :** ease users' life, combine different modes;
- **A vision centred on new mobility service providers :** attract more users, lower commercial costs;
- **A vison centred on public authorities:** as mobility providers (public transit) but also as public mobility regulators.

A number of MaaS projects or experiments (public or private) have already been carried out in a number of countries: MaaS Global in Helsinki and Birmingham, Moovel in Stuttgart), and Mooveasy in Saint Etienne, among others. Those are mainly based in cities. Various services intend to launch long distance MaaS, but it is not the focus of this report.

The four cities-regions under study here (i.e. Barcelona, Frankfurt, Oslo and Paris) have also already implemented an integrated pricing system between their urban and periurban/interurban public transport systems. This includes the deployment of private mobility services, particularly in the city centres and for short distance. In addition, the Paris and Barcelona regions plan to deploy MaaS as a mobile application. So far, neither Oslo, nor Frankfurt[17] have their own MaaS application (except for an integrated traveller information service, as seen above), but the Frankfurt/Rhine-Main region is working on it.

2.1.2. The stakeholders involved and their respective objectives

Before going any further, it is important to clearly identify the various stakeholders involved in MaaS and their objectives. The above diagram in Figure 4 presents the three main stakeholders, whose respective objectives we will now discuss.

Public authorities

From a **public authority** perspective, the first objective is to ensure accessibility to cities and to the economic or leisure areas within those cities. As mentioned in Part 1 of this report, this must be achieved while simultaneously (a) limiting the impact of cars on the scarce public space and (2) using public funds wisely.

[17] PSA's Free2move application is deployed in Frankfurt, but on a limited number of services only.

Users

For **users**, travel time and cost constitute the key priorities, although other goals such as comfort, reliability and safety are also of importance.

Mobility services providers

There are many public and private **mobility services providers** (i.e. public transport and regional train operators, car parks, bike sharing, carpooling and car sharing companies, just to name a few) in city centres, but much less so outside those centres. The main goals of those mobility services providers are to attract new customers and achieve financial benefits, hence enabling further investment and therefore innovation.

2.1.3. What objectives for Maas?

The objectives of the three groups of stakeholders are not necessarily convergent. The general interest is not the sum of individual interests, as daily road congestion shows. Drivers indeed tend to minimise their marginal contribution to traffic, and in the end, congestion is always someone else's fault.

In addition, the objectives and constraints of public policies may vary greatly from one city to another, depending on the specific characteristics of territories. A car-free city can be a simplistic vision of mobility and of our lifestyles, as it does not take into account a major structural trend: the increased attractiveness of city-centres for peripheries. Plus, digital technology alone will not wipe out with a magic wand the functioning of our cities and the town planning errors of the 1960s and 70s (e.g. zoning, structurally inducing mobility needs).

We should also bear in mind that digital stakeholders primarily address individual needs, without taking into account the constraints of life in society. For instance, in case of congestion, Waze[18] may divert traffic towards areas which should normally be safeguarded (e.g. school and residential areas). We will come back to this later in the context of an open data policy.[19]

MaaS will be a 'smart' solution for 'smart cities' only if it manages to reconcile the needs of both the individuals and public policy priorities. This requires a number of key conditions, which are presented and discussed hereunder.

2.1.4. What package of services to be integrated in Maas?

MaaS: where and for who?

If we want to move towards a more rational use of cars, MaaS cannot focus on urban centres only, where public transport, car-sharing and taxis abound. Such a limited focus, which would in fact target a well-off but very small user-base, would have a very limited impact on mobility.

MaaS must, on the contrary, be aimed at all users. It must provide services to peripheral areas around cities, i.e. in a number of cities, those areas beyond the 1st and 2nd ring roads, where there are fewer public transport services. Therefore, services for all zones around city centres must first be set up.

[18] GPS navigation software app.
[19] For this part, we will rely on the work of the Urban ITS expert group of the European Commission/DG MOVE of 2014.

The need for a comprehensive MaaS package

MaaS should ideally integrate public transport, feeder services (car parks and on-street parking), and of course carpooling, in addition to bike sharing and the other shared mobility services presented in Part 1 of this report. In addition to conducing price incentives and incorporating all available mobility services, such integration will give full meaning to the concept of Maas as a tool addressing the needs of all social categories.

How to achieve MaaS while ensuring sustainable and efficient mobility?

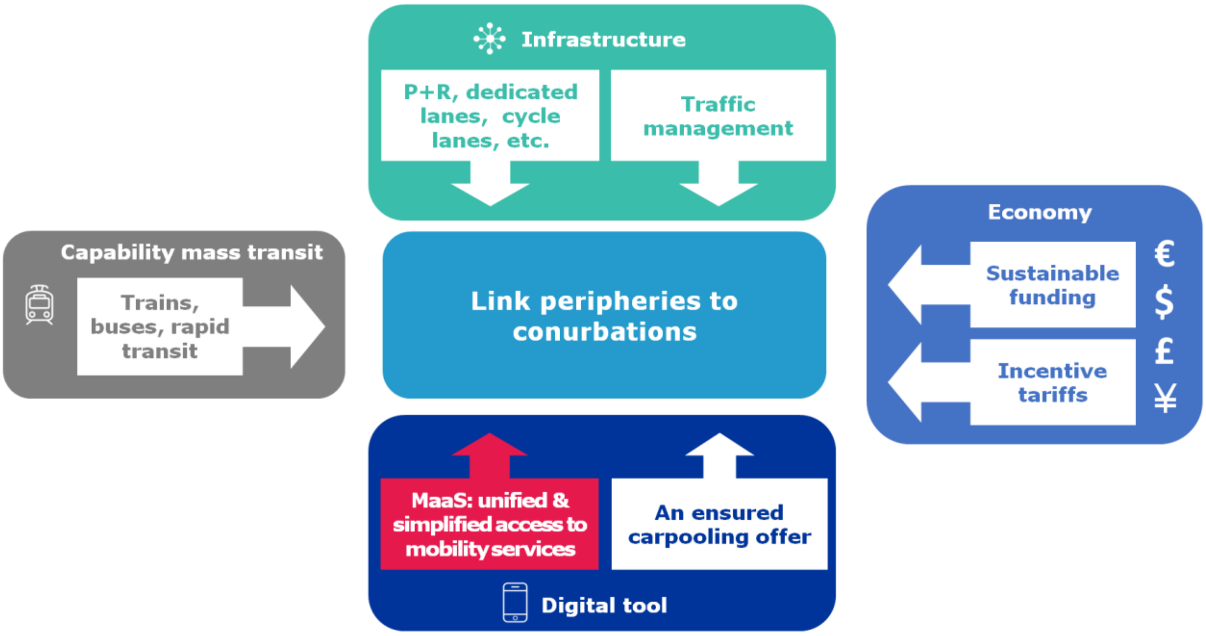
As we have seen, one of the main challenges of urban mobility is to build mass alternatives to private car usage. Ideally, those alternatives should include efficient public transport connecting peripheral areas between each other as well as to city centres, through an inter-modality approach including feeder services. In other words, this could be done with MaaS. At this stage, however, public transport offers around the world are mainly focused on the intra-peripheral and star-shaped zones around city centres. As already stated, there is an urgent need, not least given the environmental issues at stake, to come up with alternative, more efficient and more sustainable solutions.

To build these alternatives, it is necessary to act simultaneously on four elements: transport offerings (1), infrastructure (2), digitalisation (3), and funding and tariffs (4):

1. **Strengthen public transport offerings for long distance travels** mainly made by car: connect peripheries to the areas concentrating employment opportunities, with trains and high-frequency express buses during peak hours.
2. **Develop infrastructure for public transport and shared vehicles.** Depending on the model, a car can cost the user twice as much as public transport. It is therefore on travel time that action must be taken. Creating dedicated lanes on main roads is essential to ensure that those who use public transport and who carpool travel much faster than those in private cars. This requires the development of infrastructure like interchanges, but also 'park & ride' facilities where users can leave their car either to take a train or an express bus, or to carpool.
3. **Develop digital carpooling and all-pass solutions allowing access to all mobility services** ('park & ride' facilities, express coaches, trains and shared mobility options) **via a single support system** (smartphone app or contactless card), including comprehensive, real time information.
4. **Deploy an adequate pricing policy to finance the above mobility package and address the EU mobility objective** of reducing transport emissions by 60% by 2050 compared to 1990 levels. Progressively, we should move towards a payment of mobility depending on usage, whatever the transport mode.

For short distance travels (< 7 km) bicycles and electric bicycles are certainly the main solution. This requires dedicated lanes to ensure road safety for cyclists. Figure 5 hereunder summarises the four courses of actions detailed above.

Figure 5 – Four courses of action for sustainable and efficient mobility



2.2. Questioning the business model of MaaS

2.2.1. New mobility solutions: between rhetoric and reality

Some may think that digital innovations come with the promise of clean, inexpensive mobility, widely deployed in record time by private actors who will revolutionise mobility and disrupt existing players. It may also be tempting to believe that new mobility solutions will reduce our reliance on internal combustion vehicles.

Reality is however far from this overoptimistic rhetoric. Inhabitants of urban areas are still far from being able to detect in their daily lives the mere clues of the so-called digital mobility revolution's imminence. The modal share of cars has remained unchanged for almost 20 years, representing 80% of passenger kilometre. 75% of Europeans drive their car to work, with traffic jams in conurbations increasing year after year.

New technologies undeniably offer room for manoeuvre. But they will unlikely, just by themselves, trigger a change of model. Actual experience and urban mobility fundamentals urge us to be cautious in our assessment of what could actually be feasible and sustainable.

Just focusing on the experience of France, we see that **carpooling and car-sharing impact very small audiences.** For instance, the success of carpooling in the Île-de-France Region during the SNCF strikes in 2018 was quite limited. Despite the €2/trip incentive granted to passengers by regional authorities, only 2,000 journeys per day were made via carpooling, out of the 41 million journeys made daily in the Paris region. The generalisation of a carpooling allowance of up to €150/month, announced by the Île-de-France authorities, should have a total cost of several hundred million euros – and perhaps even more than a billion euros per year – to be borne by the public treasury. We may thus wonder whether the planned incentive scheme is really sustainable.

Furthermore, people who resort to car-sharing in France earn on average €3,700 monthly, which is twice as much as the median income (i.e. they are the richest 15%). 50% of them hold graduate degrees and the vehicles involved are mostly used during the week-ends, for average distances of 80 kilometres. Therefore, at this stage, the impact of car-sharing on daily mobility in France is negligible.

Still, it is regularly stated that technological developments concerning vehicles will be a major driver for the development of smart mobility.

Autonomous vehicles will, however, face considerable technological challenges related to: the deployment of the necessary road infrastructure, the possible use of dedicated lanes, their business models, their shared or private use, but also legal responsibilities. These challenges are still to be met and despite active lobbying on behalf of manufacturers, it is now recognised that there is still a long way to go before the promise of autonomous mobility becomes a reality.

Electric vehicles, which are mostly deployed in their hybrid version for the moment, will partially address the issue of pollution, depending on the energy mix of the country of deployment. In France (where 75% of electricity is derived from nuclear power), electric vehicles have a positive carbon balance, whereas the latter is very negative in Germany. They will, however, not solve the issue of public space use. Nor will individual autonomous vehicle.

New mobility services operators: a success story?

New mobility services are for now mainly geared for city centres – and for short distance trips – which are already largely equipped with alternatives to cars. They also face difficulties in finding sustainable business models. After the bankruptcies of Gobeebike and OFO, bike-sharing company Mobike has reported difficulties and a decrease of its activities in Europe (despite being the only significant free-floating actor). Business-to-Consumers (B2C) MaaS stakeholders, such as Whim, Moovel or Moovit, did not manage to find BtoC models and they have now turned to transport authorities for funding. Lyft lost 20% of its value shortly after its initial public offering. Uber's operations in Europe are still far from breaking-even and the company is now seeking partnerships with public mobility authorities or public transit (PT) operators. It has also become part of UITP, the International Association of Public Transport.

Most of these actors were initially set to disrupt the mobility ecosystem via self-financing from a single activity. They are now more and more looking for public subsidies or support. New mobility services operators live on an unprecedented availability of private money which they are eager to invest. Still, they often end up funding operating deficits while expecting unlikely virtual benefits. Here again, we may wonder if this model truly is sustainable.

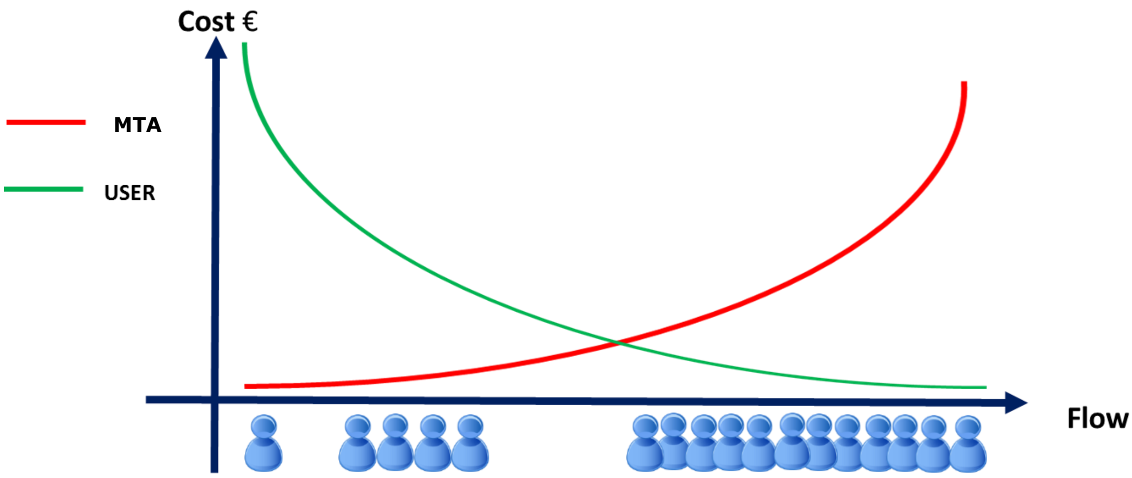
The message conveyed by some private operators is that regional or local authorities are unable to address mobility issues, and this is why the public sector ought to unconditionally open data and sales channels to the private sector. It is suggested that the private sector will achieve more, in a faster and cheaper way. This is unfortunately not applicable to daily mobility: the Booking.com and Airbnb models are not replicable in this sector of the economy, and 'business model for some' should not be confused with 'mobility for all'.

Complementarity and cooperation between new mobility services and public transit operators must on the contrary be sought, via sustainable business models addressing use cases where traditional modes alone (PT, Park & Ride combined with PT, cycling, etc.) cannot provide the right answer (e.g. at night time, etc.).

2.2.2. Flow, speed and cost: the key variables of urban mobility

There is a direct relationship between mobility flows, the costs borne by users and the amount of subsidies. At almost €2/km, Uber or taxis are in fact still luxury services carrying a very small number of passengers compared to urban public transport, which costs on average only €0.1/km to the user, with as much as 75% of costs paid by taxes (figures for Paris).

Figure 6 – Metropolitan Transport Authorities (MTAs) and user mobility cost depending on flows



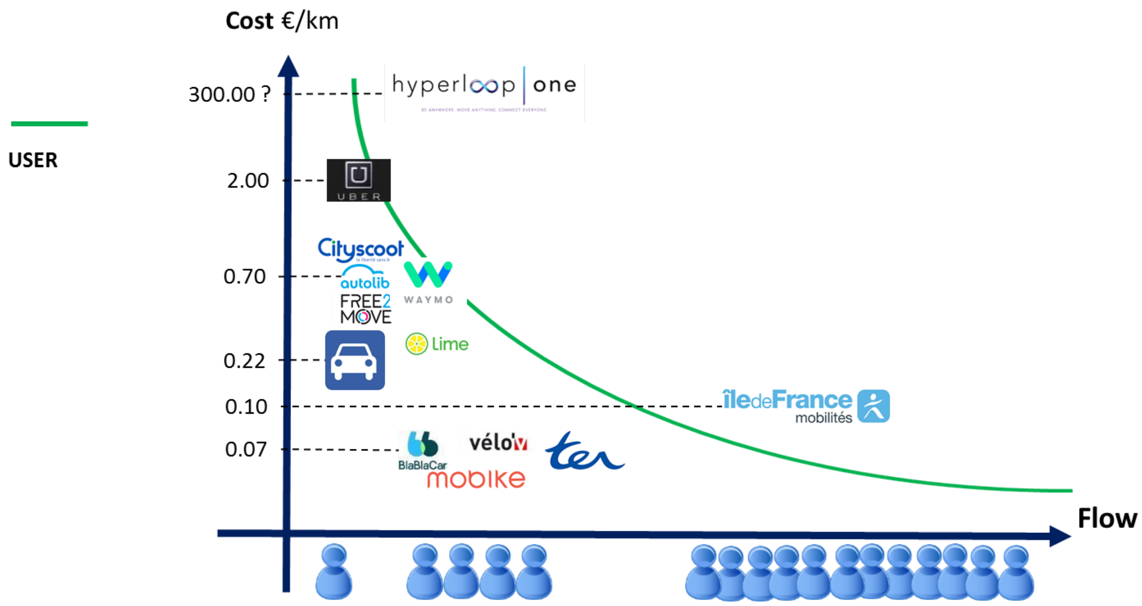
Flow is a major issue when it comes to mobility in conurbations: it is not a matter of transporting people faster, but of transporting many of them. Flying taxis and hyperloops can be solutions for the 0.1% of the population earning more than €10,000/month. They are, however, unable to ensure large flows of passengers. The Hyperloop between Orleans and Paris, with a forecasted travel time of 8 minutes, has a maximum hourly flow of 200 people (4 shuttles of 50 persons/h, to manage safety inter-distance between 2 shuttles), i.e. 10 times less than a single motorway lane, or 15 times less than trains operating every 10′. Such a solution is thus not relevant for everyday mobility.

Since public space is scarce in dense areas, the public sector must implement capacity-based transport solutions to avoid car invasion.

Just like the Hyperloop, new mobility services cannot accommodate the required flows: it is hard to imagine the daily 1,500,000 passengers of RER A (suburban train) in Paris riding electric scooters or bicycles. Accommodating such flows requires heavy infrastructure and public transport services. It is therefore necessary for the public sector to support these infrastructure costs with a public/user cost mix for services, the proportion of which varies depending on the country, region or city.

The costs of the various mobility services also show why it will be very difficult for new mobility solutions to scale up.

Figure 7 – User cost of mobility services in France

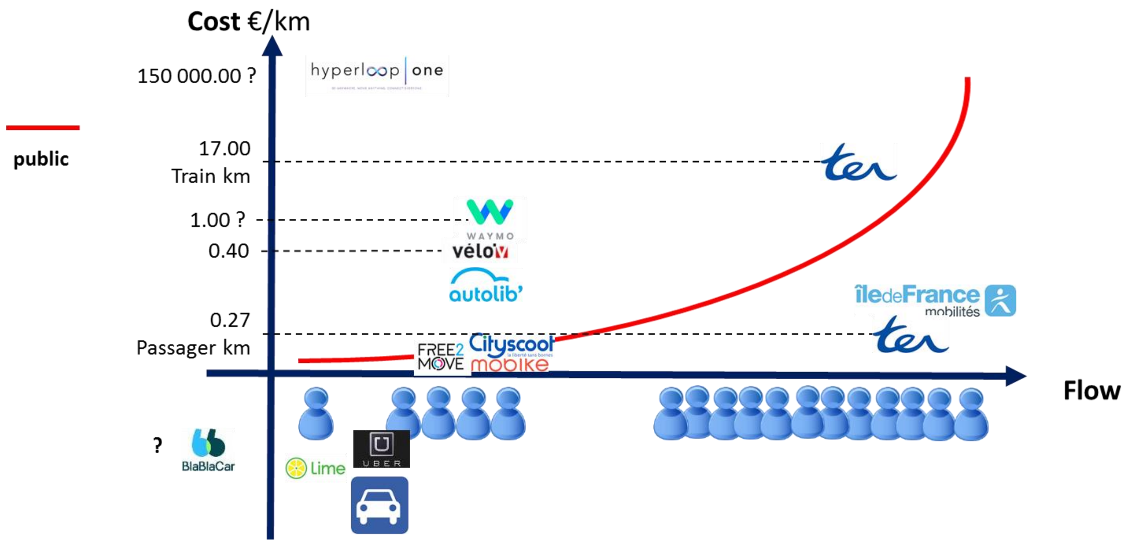


As shown in Figure 7 above, Lime scooters in Paris have a cost of €0.5/km i.e. 5 times higher than urban public transport, and 15 times higher than the local trains subscriber rate of €0.03/km. Electric scooters will never become a means of mass transportation. Similarly, podcars and Robot Taxis, when operational – and this will take a lot of time, if we ever get there[20] – will be twice cheaper than taxis[21] but 3 times more expensive than private cars and 10 times more than public transport. They will remain a luxury product and will therefore address a very small share of travels.[22]

In Paris, the cost of travelling by train varies greatly depending on whether you are a subscriber (in which case the cost is €0.03/km for a local train for instance) or an occasional traveller (in which case the cost is as high as that of a private car: around €0.22/km in 2nd class).

[20] See WAYMO, PSA and other car manufacturers' statements about the feasibility of level 5 autonomous vehicles.
[21] Refer to 2018 Cercle des transports study on Autonomous vehicles (France).
[22] The ITF - OCDE Lisbon study, based on modelling (always questionable), doesn't take into account the cost for the users.

Figure 8 – Public cost of mobility services in France



N.B. Short distance carpooling could go up in terms of public cost if MTAs decide to finance this solution

2.2.3. What business model for Maas?

While it is advisable to remain very cautious regarding B2C business models for digital and new mobility solutions for urban mobility (for the reasons we have exposed in Sections 2.2.1. and 2.2.2.), digital technology nevertheless brings undeniable advantages. Most importantly, digitalisation is the only tool that makes it possible to go beyond territorial, administrative and modal boundaries. Multimodal information can replace ten applications and thus simplify users' life, while also connecting modes and mobility services.

Lessons from the past

In Europe, the two decades from 1970 to 1990 saw the construction of a vast network of road infrastructure allowing land accessibility by car. In the absence of regulated urban planning, this increased road accessibility resulted in longer travelled distances – the travel time budget in developed countries remains constant at around 1h/person/day – and hence in urban sprawl. This has led to increased road congestion – and pollution – at peak hours in major European cities, due to the number of vehicles and the (already scarce) public space allocated to road transport in urban areas.

To address this situation, European decision makers committed to a modal shift policy in the 1990s, and encouraged the development of urban transport networks with dedicated lanes (either for metros for cities who could afford it, or for tramways or buses). This policy aimed at offering viable alternatives in terms of travel time and at restricting public space dedicated to car usage. This resulted in a significant evolution of the modal share in city centres, even if, as we have already seen, much remains to be done in peripheral areas. Following the implementation of modal shift policies, it became imperative to connect the various existing transport networks, in which led to the emergence of the concepts of inter-modality, multi-modality and co-modality in public policies. Park & ride (P+R) schemes, but also interchange stations, were thus developed to enable swift transition from one transport mode to another, and to limit car usage in the mobility chain.

Multimodality, intermodality and MaaS

In addition to existing infrastructure, and thanks to the emergence of ICT and multimodal information, users now have direct access to the entire range of available mobility services in their area. With MaaS, one should be able to access and pay for seamless services and thus easily switch from one mode to another. Digital technology therefore constitutes a key tool for multimodality and intermodality.

Against this background, the fundamental question is how to implement this latent potential, given:

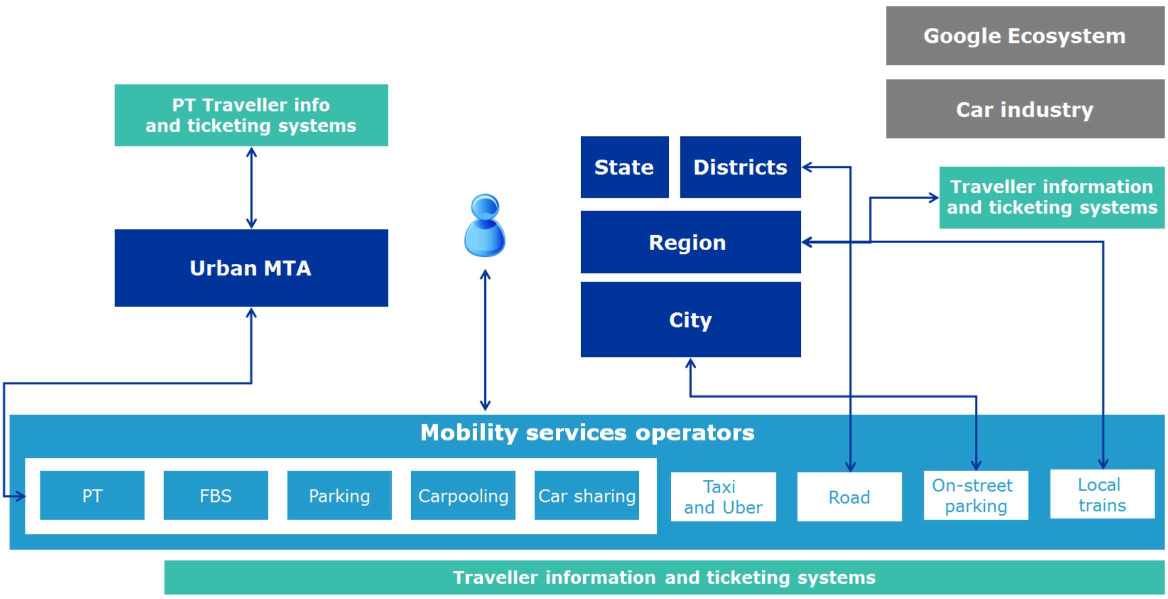
- that B2C business models are not realistic for daily mass mobility;
- the predominance of mobility service management by public authorities, either through funding or through allocation of public space;
- the significant cultural differences that exist between digital and mobility players.

Business models

Given the contractual architecture of urban mobility (see Figure 9 hereunder) and the existing business models of the various mobility services available in cities, it is very difficult to implement a viable B2C MaaS model. Whether it is public transport, bike-sharing, car-sharing or carpooling, all these urban services work thanks to very large public subsidies. On another note, all mobility operators are keen to maintain a relationship with their customers.

Last but not least, overlapping contracts, as shown in the diagram below, place the Mobility and Transport Authorities (MTAs) in a *de facto* central role. Therefore, MaaS should probably be managed and deployed by the MTAs. MaaS should not be another source of public spending. Further reflection on business models is called for, especially on how to achieve a service accessible to the greatest number of users without triggering additional public costs (or conceivably with a gradual decrease in these costs).

Figure 9 – Urban mobility contractual architecture



N.B. Focus on traveller information and multimodal ticketing. The introduction of a MaaS operator requires major contractual changes.

Thus, when it comes to *daily mobility*, MaaS is not a national and even less so a global dimension market. It is a multi-local market and it will probably require public support for everyday mobility. The tariffs of mobility services and the categories of users (e.g. young or senior, single user or families, etc.) will differ from one service to another and from one region of the world to another. Nevertheless, standards can be organised to reduce deployment costs from one city to another.

This multi-local dimension makes MaaS unmanageable for a global stakeholder alone. Global companies offering new mobility services tend to focus on occasional travellers (representing at most 25% of the public transportation user-base) in very large cities such as Paris or London. For now at least, they operate mainly for people who can afford to pay a relatively high price for a mobility service (tourists and business travellers). Even if such offering is useful, it represents only 2% of trips. If we draw a parallel, we observe that Booking.com and Airbnb are successful in the hotel business because the room pricing and classification system (stars) are uniform categories throughout the world, and because customers are well-off citizens with a strong time value (business travellers and tourists). This business model is not applicable to everyday mobility.

Figure 9 above also shows that the scattered institutional field is a real barrier for long distance travels, which are for now mainly done by car. If the goal is to make people leave their car as far away as possible from city centres and use trains, PT or bicycles instead, more institutional cohesion is needed. MaaS certainly has a role to play here as well.

2.3. How to bring out the full potential of digital technology into mobility?

2.3.1. The main issues

In urban environments, which concentrate most mobility issues, digital mobility tools are particularly efficient in meeting the needs of local communities and inhabitants, and in enabling businesses in the sector to develop. On the one hand, those new tools allow the optimisation of existing infrastructure across time and space, the creation of new services improving quality of life, and a more reasonable use of private cars. On the other hand, they question the roles of public and private operators and their interrelations.

Data and MaaS

Digital technology makes it possible to overcome institutional and geographical boundaries and is always primarily aimed at private individuals. To address urban mobility issues, it is therefore necessary to provide comprehensive information services:

- at the geographic level, by targeting catchment areas (large urban areas) that usually go beyond city borders;
- on transport modes, by integrating all mobility solutions proposed by the various public authorities of the catchment area, and also by private operators;
- that are time-related, i.e. that include historic, scheduled, real-time and even predictive data.

This scheme would allow the provision of services with very high added value to the three main stakeholders involved in urban mobility as presented in Section 2.1.1.: users, public authorities and mobility services operators.

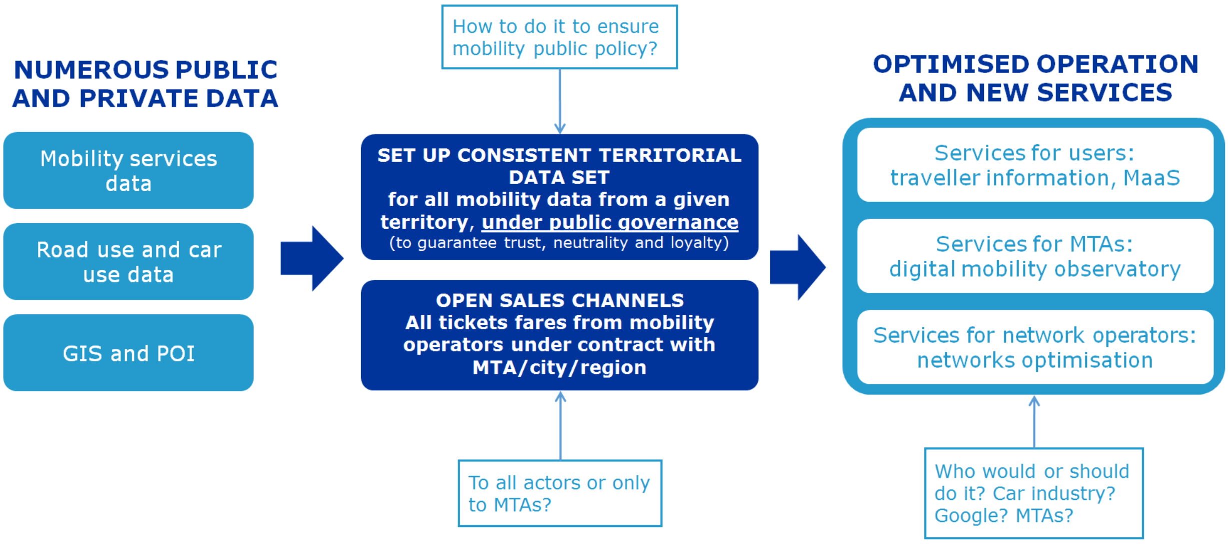
Figure 10 below presents the overall scheme and indicates the main questions to address to ensure public/private services complementarity and to harness the full potential of digital technology.

Those three questions are:

- What kind of governance is needed for territorial datasets that bring together all mobility offerings available in a given catchment area?
- How to open sales channels for mobility services so as to make MaaS a reality?
- Who will implement the services identified for the three mobility stakeholders:
    - MaaS for users,;
    - a digital mobility observatory for public authorities;
    - and network optimisation for operators?

We try to answer those questions in Sections 2.3.2. and 2.3.3.

Figure 10 – Overall scheme of data management and MaaS for urban mobility



2.3.2. Governance of the territorial dataset

The following comments are mostly based on earlier work, conducted particularly at the European level within the framework of the European Commission's Urban ITS (Intelligent Transport Systems) expert group.[23]

Why open data?

The European ITS Directive[24] includes regulatory provisions regarding the reuse of mobility data, provided it does not introduce anti-competitive and discriminatory clauses. As highlighted in the previous section, data is the fuel of mobility. Without data, apps cannot inform travellers about the schedules and availability of mobility services such as public transport, bike-sharing or free floating vehicles, carpooling, car-sharing and transport on demand. Without data, authorities and operators cannot either analyse mobility patterns to tailor mobility services to the real needs of citizens. Without data, it is impossible to optimise services and to reduce operating costs and, consequently,

[23] The guidelines for multimodal information are available at https://ec.europa.eu/transport/sites/transport/files/themes/its/road/action_plan/doc/2013-urban-its-expert_group-guidelines-on-multimodal-information.pdf

[24] Commission Delegated Regulation (EU) 2017/1926 of 31 May 2017 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services (C/2017/3574), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017R1926

the cost paid by users and MTAs. A long-asked question in the area of transport relates to the opening of mobility data. Indeed, if data is an essential component of mobility services, why should we share it?

This is so because, quite simply, users are increasingly looking for **multimodal solutions**. The same person may use a bike one day, the metro another day, and a car on others. People living in rural areas may use transport on demand when their car is down or if their driving license has been withdrawn. From the outskirts of cities, people drive their cars to Park & Ride (P+R) facilities before hopping on a train or a high-frequency express coach, and may end their journey by metro or shared-bike once they reach the city centres.

When it comes to data, strength lies in numbers, and collecting data collectively would allow for the provision of high added value mobility services for commuters and inhabitants of urban areas. To achieve this, the private sector needs a trusted third part. Otherwise, there is almost no chance of obtaining a comprehensive mobility dataset for a given territory with all mobility services included, both public and private. Still, the fear of disintermediation by large internet players is very high, for public and private stakeholders.

The only way to overcome this obstacle is to **open data to MTAs**, who are the obvious trusted third party: they are perceived as neutral and loyal by users, and guarantee, by nature, a general interest character.

Why open data to everyone? What are the issues?

As no single actor is currently able to master the whole value chain of urban mobility, extensive data opening is necessary. In doing so, the ultimate goal is to foster innovation by avoiding monopolies and rent-seeking situations that could emerge as a consequence of data possession.

However, prudence is needed here. Even though open data is a prerequisite for innovation and for the creation of new services and products, it has yet to generate successful business models. The economic outcome of open data is still particularly weak. In reality, the creation of private applications resulting from open data initiatives has hardly generated any significant business so far. Plus, the sustainability of such initiatives has proved very fragile once public seed funding dried up. The reason why is that **open data is certainly a necessary condition for the emergence of new services, but it is not a sufficient one.** Business models are key factors in their development.

Barriers to the development of innovative services differ depending on sectors, but the most important one in the area of mobility is the existence of dominant players who disrupt a rational economic logic. First, there are actors who rely on data monopoly and do not share it. Then, there are major stakeholders – especially Internet players – who offer high-performance services for free since their business model is based on advertising, collection of personal information, and commissions upon connecting individuals to multiple services. Some of them already hold significant monopoly positions (above 70% of audience) with regard to mobility information and to the digital services offered by public transport, for instance. Other companies in this ecosystem target buyouts by leading Internet giants who in turn will exploit their user data: this brings no added value to territories and countries. Instead, the 'everything-for-free' Internet culture is a tool serving the monopoly strategy of the largest tech players. Opening data without defining conditions would represent a real boon for those monopolies and a definite threat to other mobility actors. It is even likely to have the opposite effect than the one desired, by giving even more leverage to monopolistic actors and triggering the disappearance of emerging business models.

A possible solution is therefore to open all data to MTAs in a circumspect way, so that added-value data benefits territorial stakeholders without being captured by tech giants.

How to achieve the goal?

The vast majority of mobility data is not critical and opening data in the "pure open data" way should not be an issue. However, some specific data can be more sensitive when it comes to public mobility policies. It is therefore necessary to ensure, *a priori*, that their re-use is consistent with public policies. This consistency check could take the form of various questions to be answered. Depending on the answer, the data in question may be opened or not. For instance, can a service using public data divert road traffic towards school areas because the parallel street is congested? Could a provider purposely direct users to its mobility service at the expense of another? As the sole objective of private actors is to provide services without necessarily measuring the impact on the public interest (in terms of use of public space, safety, etc.), **adequate regulation (and not necessarily hyper regulation) of the reuse of public data is necessary.** From current experiences, we can say that the way forward surely lies in the cooperation between public and private actors, together with new, proportional forms of regulation.

Several public authorities have led the way over the past 6 years, with **smart licenses**. In 2012, the Metropolis of Lyon, using such a license system, established the most comprehensive set of open data in Europe with a record number of more than 100 re-users (see the box hereunder for more details).[25] This type of license identifies re-users for sensitive data only (5% of the data) and the dialogue between the MTA and the re-users results in regulation only in the case of non-compatibility with public policies. Thanks to this framework, many non-open data producers have made their data accessible. In the end, the opening of all mobility data reconciles user services with the general interest.

Moreover, data coming from vehicles is a particular issue. Within the next ten years, all cars in Europe will be equipped with a GPS chip and a SIM card (and already half of Europe's car fleet within the next 5 years). This follows the obligation to set up the e-call system in new car models that is in effect since 1 May 2018. While the big challenge in building alternatives to car travel lies in assessing users' needs (i.e. obtaining data on mobility flows), the generalisation of connected vehicles will potentially disrupt design tools and the evaluation of public mobility policies. For MTAs and mobility operators to build adequate offerings, it is necessary for them to have access to data from connected vehicles and driving assistants. A process to enable this is underway within the French "General Principles Act" on mobility framework, which will be a genuine step towards facilitating data processing while avoiding rent-seeking data possession.

To conclude, European regulation has cleverly paved the way for wide data opening. Public mobility authorities now have to build the framework of confidence needed to collect data at the relevant level. This will require smart licenses which will make rational regulation possible while maintaining a level of competition between operators.

[25] Google is not a signatory of the license agreement.

Open data the Lyon metropolis experience

Since 2012, the Greater Lyon metropolis has deployed an innovative open data policy. To date, almost all of the city's mobility data are gathered on the platform.[26]

This includes urban public transport time tables, public transit (PT) real time information about 4,000 stops, real time information on free bike services (more than 4,000 bikes), real time information and historical traffic data on more than 1,000 points in the area (3,000 km of road monitored), real time information on all parking lots, and a multimodal journey travel planner using real time and predictive data. Data about local trains (timetable and real time information) is available for Greater Lyon only. With the forthcoming new law on mobility (loi LOM), this data will eventually be available to all on the platform. This represents a dataset of 20 million data / day. It is the most comprehensive mobility dataset in France, and possibly in Europe.

This result was achieved thanks to a licensing policy for the most sensitive data, that specifies that re-users must comply with existing mobility policy goals (for example, operators must not divert traffic to secondary roads if public data indicates that the main roads are congested).One hundred re-users (SMEs, big IT players and research centres) have signed this license. This is the most important number of re-users in France for such a license.

As a side effect, this kind of licensing appears to be an effective way to steer the market towards fair competition. Indeed, such measures typically limit barriers to entry, as well as the strength of monopoly. This is due to the access conditions to a set of data that no one solely owns. Gathering all data under the umbrella of a mobility authority also ensures trust and fair competition. Nevertheless, the development of this kind of urban platforms is still in the infancy, and alternative tools might be used to ensure a fair competition. A CERRE study on market definition and market power in the platform economy[27] provides interesting tracks to adapt current regulations in this area.

Île-de-France Mobilités is following a similar strategy on the completeness of its platform, with more than 10 billion data available daily. The difference is that Île-de-France Mobilités is also integrating private data from various partners, thus aiming towards sustainable business models and the emergence of common interests between private and public stallholders. For instance, private stakeholders have access to the Île-de-France journey planner via a specific service-level agreement (SLA), and provide a reciprocal access to their own data. This is typically a win-win situation which aim is to combine public and private assets for a higher level of services.

[26] See https://data.grandlyon.com/

[27] CERRE, Peitz M., Franck J.-U., *Assessing the market power of digital platforms,* May 2019, https://www.cerre.eu/events/assessing-market-power-digital-platforms

Opening connected and personal GPS assistant data: the new French law on mobility

The French mobility law that is currently under discussion (Loi d'Orientation sur les Mobilités, or Loi LOM) should introduce a right for public mobility authorities to access connected vehicle data as well as GPS data (TomTom, Waze, Google Maps). Only the communication costs would be charged. This will result in a change from the current data business model, where a few stakeholders enjoy a data monopoly, to a model with competition on services using this data.

As there is currently very little data on travels made by cars, this measure will deeply change the way mobility policies are set up and assessed.

2.3.3. Opening sales channels

For MaaS to happen, it is necessary to open the sales channels of the various mobility services available in a given city. The question is then three-fold:

- What is the objective of opening sales channels?
- What exactly should be opened and to whom?
- What safeguards are needed to ensure consistency with the objective of avoiding monopolistic situations?

Meeting the EU objectives in terms of mobility decarbonisation implies targeting mobility in conurbations in particular. As stated in Section 2.1., MaaS is part of the solution.

Daily mobility accounts for 98% of trips and 75% of public transport users are regular ones. Consequently, MaaS must first target daily mobility. While we could also address long-distance travel, this is not the current political priority, nor the subject matter of this report.

When it comes to opening sales channels in a MaaS environment, several options are thus possible:

- Option 1: Open sales channels for the entire range of tariffs for all services.
- Option 2: Open sales channels for occasional users' tickets only, in order to limit the risk of disintermediation by the GAFA or other major actors (e.g. railway companies) in monopolistic situations. This option could prove useful, but it encompasses 2% of trips only.

It is therefore necessary to study the potential stakeholders to be involved in MaaS:

- Option 1: As stated in Section 2.2.3., MaaS for daily commuting is a multi-local market, not a national or global one, and B2C business models do not work for everyday MaaS. Operators who try launching B2C models usually fail to reach critical mass and/or profitability and eventually switch to Business-to-government (B2G) models, with partial funding from the public sector. This encourages the opening of sales channels for MTAs and for all services under public contracts (e.g. public service delegation contracts, procurement contracts, grant agreements, concession contracts, and public domain occupancy agreements). The advantage of this approach is that it transcends borders and the multiple layers of mobility, and promotes cooperation between stakeholders at the scale of catchment areas (e.g. conurbation/metropolis, region, community of municipalities).

- Option 2: Open sales channels for occasional users' tickets only, to everyone – and therefore to the private sector. This would be tantamount to confusing 'B2C business models for some' and 'mobility solutions for all', which is not a good option for everyday MaaS. However, this could work for long-distance trips, as well as in cities like Paris or London as these are world cities with a lot of occasional travellers (e.g. tourists and business travellers).
- Option 3: Open sales channels for the whole range of services a tariffs and to all, with safeguards to limit disintermediation of operators and to avoid services contradicting public policies. The necessity to regulate private mobility services is obvious, in particular given the constraints of public space use. Yet, it is important to note that this third option is to be assessed from a legal point of view. Regulation should ensure that such an opening of sales channels does not strengthen the monopoly position of giant tech companies and other dominant players (e.g. national railway companies) in major cities while providing little benefit for everyday mobility. The example of Paris – and this is probably true of other cities – shows that the risk is real and an actor from the tech or SNCF ecosystem (both entities have the same monopoly strategy) could very well build a MaaS offer by disintermediating the local MTA, Île-de-France Mobilités, and addressing a tourists and business user-base. While discussions around the taxation of tech players are in progress in France, it would be counterproductive to give the latter wide access to sales channels, considering that these companies capture the added value of territories without necessarily contributing to it. Nevertheless, this path necessitates deeper exploration to determine whether it is possible to couple the two different types of MaaS (i.e. daily and long distance) while maintaining a fair competition in the market. The solution identified in the new law on mobility in France (Loi LOM) may be a good track to follow (see box hereafter for more details).

The French mobility bill: an interesting track to follow?

The French government has recently had to tackle the above different options. In the mobility bill that was agreed by the Parliament on 18 June, Option 3 (opening the market as much as possible with some safeguard measures to avoid jeopardising public policy) was chosen. Hence, all sales channels for all services and tariffs will be opened to all MaaS providers, with the following conditions:

- MaaS providers must sell tickets and mobility services at the price offered by the original service provider or the MTA, except if an agreement is reached between them;
- MaaS providers for a given category of mobility services must integrate all mobility services providers available for this category and make them visible to users in a fair and non-discriminant way;
- All data collected for the operation of MaaS must be transferred to the public mobility authority for statistical reuse;
- In compliance with the provisions of the GDPR, a personal data management plan must be set up for each MaaS service in order to preserve privacy.

In parallel, a regulation authority will be set up. It will have wide competences to monitor and enforce the full respect and implementation of the new law.

Reusing MaaS user data: not that simple!

One of the interesting features of MaaS is that it could potentially improve the quality of user data owned by MTAs and other mobility services providers.

The GDPR and specific Member States legislation could, however, make the disclosure of such data complicated. For instance, the French CNIL (i.e. independent authority on personal data protection) is very cautious regarding the crossing of databases from one use or domain to another.

Information generated by MaaS operations will therefore need further legal research to identify which data may be reused, for which purpose and by whom. It is thus too early at this stage to say clearly whether the full potential of MaaS in the area of user data will ever be reached.

2.4. Conclusions

When it comes to fighting climate change, one of the European Union's objectives is to reduce transport emissions by 60% by 2050 compared to 1990 levels. As we have seen, efforts must be concentrated on urban areas and especially on decreasing road traffic induced by the use of private cars. In this regard, alternatives to access city centres from peripheries must be set up.

Digital technology can contribute greatly to achieving this goal, as it allows intermodality to become a reality across all modes of transport and all organisations providing mobility services.

To be clear, **digital services must be about public and private actors and their complementarity**. The public sector indeed cannot abandon mobility policy to the private sector, as it is not the role of private actors to define public policy. However, public stakeholders should enter into discussion with digital actors and new mobility services providers to define together how they can each bring part of the solution to their common mobility challenges.

Users' needs and public policies also need to be reconciled: the general interest is not the sum of individual interests, and regulation is necessary, especially in dense areas. It is necessary because public space is a scarce resource, though not a prime concern for most digital actors. It is necessary also because public actors control and/or organise most mobility services with strong public funding constraints.

For efficient MaaS services to develop for daily mobility in urban areas, the key requirements are thus:

- **To gather mobility data under the umbrella of MTAs** who, as we have seen, are the only trusted party able to do so. Licensing to ensure compatibility with public policies is necessary and possible through the Intelligent Transport Systems (ITS) Directive.
- **To open sales channels for all mobility services and all tariffs**, with the prerequisite that reselling tariffs cannot be different from the MTAs tariffs, except if agreed by MTAs. This will strengthen cooperation between public entities (e.g. cities, regions, districts, MTAs) and also with private parties.
- **To set up new mobility offerings** (a combination of mobility services, with corresponding tariffs) **that will, in a financial sustainable way, ease users' life and foster alternatives to solo car use**. This will require significantly enhanced cooperation between the various public stakeholders involved and also between the public and private sectors.

MaaS is thus a tool that should help abolishing the barriers that exist between the various administrative layers of a given territory when it comes to organising mobility services. If implemented efficiently, it has the potential to foster public stakeholders' cooperation, and to combine the mobility services organised or funded with public money.

New mobility services should also be integrated in MaaS offerings, depending on:

- the suitability of the use cases;
- and possible business cases.

Overall, there is great untapped potential in the field of contractual and service innovation. Exploiting it could help achieve the goal of providing sustainable mobility for all as well as a better link between conurbations and their peripheries.

03

REGULATORY ISSUES

3. Regulatory issues

The process by which digitalisation is permeating the whole economy from public services such as health and education to monetised activities such as banking, trade and energy brings different regulatory regimes together in a number of new ways. The same applies to transport in general and urban mobility in particular. Yet, the implications of digitalisation in the area of urban mobility regulation are not self-evident. This is mainly due to the fact that, nowadays, a large part of mobility is generated through the use of private modes of transport (e.g. cars, motorbikes and bikes). Even in very large cities, public transport (PT) accounts for less than half of the mobility market and has to be supported by public subsidies. As explained in the first two sections of this report, it is not guaranteed that digitalisation and new mobility services will, per se, systematically lead commuters to leave their private vehicles behind and turn to shared mobility instead.

The limits encountered by shared mobility and the obstacles to the development of 'Mobility as a Service' (MaaS) should not, however, lead to considering these transformations as marginal. New mobility services still have to fully deploy and cannot be neglected by the public authorities in charge of urban mobility. To deal in an appropriate way with new mobility services such as shared cars or free-floating e-scooters, public authorities must develop new skills (see section 3.1. hereunder). In order to define those necessary new skills, it is first necessary to assess the potential impact of new mobility services on the urban mobility landscape. The question we will ask here is the following: with respect to 'traditional' mobility services (e.g. public transport), are new mobility services substitutable or complementary? Do they represent an additional offering (see section 3.2. below)? The answers vary depending on the type of services and the zones considered, but all lead to advocating for an extended and integrated approach to the regulation of urban mobility (see section 3.3.).

3.1. Urban mobility: the limits of a fragmented regulation

The regulation of urban mobility faces new challenges related to its very organisation. Urban mobility regulation is most often fragmented, reflecting the variety of mobility modes available. In addition, organisations in charge of public transport are often different from those managing roads and public space in general. The concept of MaaS calls into question this division of tasks resulting from the blurring of the lines between public and private transport. The result of this evolution is that the scarcity of urban space is becoming the central issue in the regulation of urban mobility.

3.1.1. Fragmented vs unified regulation of urban mobility

As mentioned in Section 2, the challenges of urban mobility can be tackled from different points of view: that of users, that of public authorities and, with the development of new mobility services, that of 'traditional' (e.g. public transport) and new mobility providers. In reality, each of these approaches is itself plural. Users are not duplicates, their individual interests vary, and the same goes for public authorities and companies providing mobility services. More specifically, there is a convergence of views between certain types of users, certain public entities and certain mobility providers. Thus, motorists and road managers share a common goal of fluidity of traffic, even though they may not agree on which solution to adopt to achieve it. Similarly, an improved quality of services benefits both users and operators of public transport.

This diversity of views on how to best organise urban mobility comes from **different conceptions of accessibility**. As it sheds light on the current fragmentation of the various modes of regulation of urban mobility, this notion deserves to be clarified.

From an analytical point of view, the key challenge of urban mobility is accessibility. If more and more people live in cities[28] and if the attractiveness of urban areas continues to grow, it is due to the high density of opportunities offered by the concentration of people and activities in city centres. But, as demonstrated 60 years ago (Hansen 1959), there is a cost to reaching these opportunities: a generalised cost directly linked to the monetary cost and to the time cost of mobility. From an individual as well as from a collective point of view, the objective is to reduce the cost of mobility in order to improve accessibility to urban amenities such as schools, shopping centres and leisure activities.

A first way to reduce the cost of mobility, and therefore to improve accessibility, is to improve the speed offered by road infrastructure. The accessible area, and hence the scope of choice in terms of housing and potential jobs, grows substantially with the provision of higher speed on the road network. In that sense, a new motorway or the widening of a trunk road represent a real step forward in terms of accessibility. Such reasoning implies that the objective function of policy makers be in line with the dream of car drivers: keeping car accessibility during peak hours at the same level as during off peak hours. But as explained in a lot of academic works (Downs; Mogridge, 1980; Goodwin), the more car accessibility is increased, the more road congestion there is.

Urban attractiveness cannot thus be reduced to the speed allowed on highway networks. It also depends on the city's ability to offer a combination of urban functions which are key to urban life. When the development of road networks encourages low density and single-purpose spaces, then the city breaks down. On the contrary, when the various purposes of a given space are maintained, the characteristics of the city are kept intact. It is thus not surprising to see that in Europe, elected representatives, and in particular representatives of city centres, who are attached to the historic role of the city, have reacted to the break-down threat by setting up public transport networks. This guarantees a high accessibility to the central part of cities, especially during peak hours.

The development of public transit is indeed another possibility to maintain, or even to improve urban accessibility and to reduce the travel time budget (TTB) of users. Speed remains an important issue – for instance for train or subway lines – but reliability, frequency and comfort of PT are other important variables. Even some relatively slow PT is useful. By developing slower modes of transport such as tramways, authorities in charge of PT have suggested that city dwellers reconsider how they view accessibility. Rather than focusing on speed and the distance it provides, urban residents are invited to make choices that reflect the advantages of density and, to some extent, proximity. As a result, we usually witness a move towards denser urbanisation in areas served by new tramway lines. When warranted by the size of the city, both in terms of the distance to be covered and the number of daily commuters, the chosen option will be forms of metros or trains, as those can move people faster than tramways. This usually involves a mix of underground and regional express trains, i.e. infrastructure requiring substantial investment in all of the world's major cities.

These two approaches to accessibility, one that focuses on car traffic, and another that focuses on public transport, have led to the fragmentation of public authorities in charge of mobility. As we have noted in three (i.e. Barcelona, Frankfurt and Paris) of the four city regions which, in addition to Uber, have partnered in this research project, road services are managed by a set of various local authorities (municipalities, departments, regions, etc.) whereas public transport is often operated by a different entity working at the conurbation or regional scale. Of course,

[28] It has is the case for more than 50% of the world population since 2007 and the proportion is still increasing.

cooperation exists between these various entities, especially when it comes to setting up reserved lanes for buses, or setting up transport options like trams on road sites.

Very few cities have developed a fully integrated approach to mobility management. Oslo has an integrated approach: public transit and roads are managed by the same vice mayor (political level) even if at a lower, administrative level, PT and roads are still managed by two separate administrative entities. The Norwegian capital has also set up a congestion charge which revenues cover about 20% of the costs of the city's public transport system. In addition, a number of traffic restrictions have been put in place, in particular to limit the circulation of vehicles equipped with internal combustion engines. There, the management of public space is made with the circulation of pedestrians, bicycles and public transit in mind above all. The result is that car traffic is particularly reduced in Oslo, compared to European conurbations of the same size.

By promoting walking, cycling and public transit, policy makers are putting forward another objective function of cities: **accessibility improvements can also be obtained by increasing the density of urban amenities.** With such reasoning, public authorities are no more focused on transport as a pure technical matter, but as a component of a system giving the priority to density and land-use optimisation. More and more, they have to take into account the complex interactions between land-use and transport, but also social conditions and the environmental challenges of sustainable development. In other words, the objective of public authorities is not the mere satisfaction of a given travel demand by additional transport supply without caring about related feedback mechanisms any more.

This new objective function calls for the regulation of urban mobility to be unified. Transport policy must be in harmony with existing priorities in terms of public space use, as well as with the form of urbanisation that public authorities wish to develop in their city. In this perspective, transport authorities are transforming and becoming true authorities organising mobility. This evolution is necessary but difficult to put in place. It requires institutional changes and the grouping of several skills in a single pair of hands, at the very moment when new mobility services are developed on the basis of private initiatives.

3.1.2. New mobility services and the blurring of frontiers between public and private transport

Mobility in urban areas is frequently based on a division of labour between public and private actors but also between public and individual transport: both are managed independently. Clear borders exist, for example, between public transport vehicles and individual cars, and cars are often opposed to softer modes like cycling and walking, with two-wheeled motorised vehicles occupying an intermediate position. Based on these well-defined categories, the role of each actor involved in urban mobility is clearly defined: public authorities deal with the organisation of public transport and the management of roads, while users of the latter, including motorists and cyclists, can use their own vehicle freely. With the development of shared mobility, the line between public and private transport is blurring, both in the denser parts of agglomerations and in their peripheries.

The emergence of new mobility services is directly linked to the digitalisation wave within the transport sector. Various innovations are challenging public policies which, sometimes, have existed for several decades. The development of connectivity in mobility services is changing the level-playing field for taxis, but also for operators of bicycles or cars fleets, and eventually for all actors of urban mobility.

The main challenge has come from the development of new apps on smartphones, which could lead to a radical transformation: **a more collective use of cars**. Within the new paradigm of **shared mobility,** fleets of connected (and autonomous?) cars have great untapped potential. As shown by studies conducted by the International Transport Forum in Lisbon, Helsinki and Dublin, a systematic sharing of connected vehicles could greatly reduce congestion, pollution and even travel time in European cities. Yet, this revolution is not easy to implement. It requires novel, unexpected forms of public-private partnerships.

New mobility services providers like Uber and Lyft have indeed disrupted the long-established organisation of public transport. With their apps, they question the traditional functioning of taxis, but also the way public transport is managed by public authorities. However, such services can only be deployed if both a new division of labour between new and traditional mobility providers and a new regulation of mobility services are put in place.

Defining the optimal division of labour is not an easy task for many reasons:

- The business models of new mobility services providers face serious challenges. Many new entrants have gone bankrupt and those who remain in business are hardly profitable. This raises a series of questions. Do public subsidies represent a necessary condition to achieve critical mass? If so, how should subsidies to traditional public transport be combined with those to new mobility services? What should be the share of private funding for new mobility services?
- The challenge of turning private cars into public transport raises the question of ownership of the vehicles. Who should buy vehicle fleets which, especially in urban and suburban areas, could provide a more effective service than that provided by private vehicles? Is direct intervention on behalf of public authorities advisable? Or should it rather be the role of private operators, who should receive incentives to engage in this activity? If so, what kind of incentives could be considered?
- The issue of data is also crucial: the new mobility actors are not just small start-up companies offering ridesharing or big innovative companies in taxi services. Major changes have emerged in terms of information for commuters, route calculation and even ticket sales. Thanks to real-time tracking of their customers, mobility operators relying on mobile phone applications now have more comprehensive databases than public transport authorities. Should MTAs then develop their own applications? How to organise data gathering and sharing so that anyone can access all the information on available mobility services? In this area, it is crucial to ensure a level-playing field in terms of requirements to provide data. The same rules must apply to public transport operators and to private providers of new mobility services.

These three sets of questions have important financial implications for public authorities. For now, the question remains whether innovative mobility solutions will ultimately result in an increase in the budgetary burden of public authorities. If car-pooling is to be subsidised, and if expensive investments are needed to build digital platforms and applications, how can we ensure that this will ultimately result in a better mobility system not only for users, but also from the point of view of community as a whole? This question can be answered by taking a look at the occupation of public space in cities.

3.1.3. MaaS and the scarcity of public space

A large number of new mobility services are leading to an increased use of public spaces such as roads. We have seen it in several US cities (see Section 1.2.3. of this report), where the development of new taxi-like services is suspected of increasing congestion. Even if such a phenomenon has not been observed significantly in Europe, the fact remains that public space is rare and its use must be optimised.

The main problem posed by cars in urban areas is that of space consumption. A car covers 2.5 times more space than a cyclist, 5 times more than a pedestrian and 10 times more than public transport at peak hours. If there is only one person per car, then there is an overconsumption of space. As a consequence, in recent decades, policies for public transport and soft modes like walking and cycling have been accompanied by a restriction of the public space dedicated to private cars. In order to make public transport more efficient, it was necessary to create exclusive right-of-way for public transport vehicles. It has thus become necessary to regulate more and more closely the use of roads, including by acting on the pricing of parking spaces and sometimes of the traffic (e.g. in London, and Stockholm). To protect cities from the overconsumption of space by cars, bike lanes have also been installed. The street space dedicated to private cars has also been reduced by the introduction of pedestrian streets for shoppers. Due to its impact in terms of pollution, congestion and accidents, the automobile is thus often presented as the 'enemy' of the city.

This situation could change with the development of shared mobility. If the number of passengers per car rises to 2.5 people, then the space consumption of a car becomes the same as that of a cyclist. Under this condition, cars are no longer a problem. They become part of the solution. To achieve this goal, incentives for shared mobility must not be focused on time savings for commuters, but rather on a better use of public space. The development of connected vehicles, even autonomous, is of interest to the community only if the load factor of automobiles increases, i.e. if cars become part of the public transit supply.

For this to happen, the various uses of the road network must be more closely controlled. Just like the development of public transport has necessitated the establishment of segregated lanes and right-of-way public transport, a large development of carpooling will require limiting access to roads for vehicles transporting one person only. If, at the same time, some lanes are reserved for carpooling vehicles, carpooling may develop. Until now, the weakness of the business models of carpooling platforms has been largely due to the small number of users. For critical mass to be reached, the main action of public authorities must be focused on roads. This questions the current fragmentation of urban mobility regulation.

In one way or another, organising authorities of public transport must regulate the various uses of roads and even sidewalks and pedestrian zones. This is all the more so as free floating e-bicycles and e-scooters are becoming more and more popular. By different means, public policies must favour modes of transport that optimise the use of public space, and not those that offer individual infinitesimal time savings to users.

Establishing public space as the rarest resource brings us back to the issue of urban tolls. A consequence of the development of shared mobility could be an unexpected revival of congestion charging, with urban tolls targeting empty vehicles. It would not be justified by the time savings offered to payers, but by their overconsumption of urban space. One hundred years after the pioneering work of Pigou, the congestion charge concept is more relevant than ever, not only as a better management tool for roads, but also as a component of a global urban mobility plan.

3.2. MaaS, new mobility services and the limits of the paradigm of substitution

Road pricing and congestion charging have been very hot research topics in transport economics. Thousands of scientific articles have been published to show that congestion charging is a solution to congestion problems. Yet, very few European cities have implemented urban tolling. While parking pricing is now widespread among cities, the same is not true for congestion pricing. Motorists, but also most local decision makers, are not in favour of it. It might be for bad reasons, but it might also be for good ones, e.g. because some car users may not have alternative options. A lot of studies have indeed shown that implementing congestion charges would be supported by a very little share of the population only, whereas other measures achieve higher support rates.

Plus, pricing of congestion is not beneficial for everyone: there are winners and losers. Implementing congestion charging requires questioning its acceptability by citizens, and acceptability is closely linked to accessibility. The main questions for car users to answer are thus the following: "how to access urban amenities if I can't use my car? Are there available, genuine substitutes to car driving I could resort to?"

3.2.1. The paradigm of substitution: principles and limits

Achieving a modal shift is a central objective of various EU White Papers on Transport, but also of many national, regional and local mobility policies. In urban areas, public transport is presented as a substitute for car use. More generally, the paradigm of substitution is at the heart of the concept of ecological and energy transition, as shown by the rhetoric that is often heard: public transport can replace private cars; electric vehicles must substitute for thermal vehicles; active modes (e.g. walking, cycling) can replace motorised modes. With the development of electric bikes, the line is blurring between active and motorised modes. Electric bikes could then replace private cars for many trips in urban areas.

The notion of shared mobility is also based on the paradigm of substitution. The idea is that shared vehicles will not only substitute for people driving their own car, but they will also question the mere utility of owning a car.

The omnipresence of this paradigm of substitution deserves to be questioned for two main reasons:

- The first reason is that substitution could happen in reverse of what was expected. As was mentioned in the first part with the examples of New York and San Francisco, it is possible that new mobility services will lead to replacing public transport with private cars and not the opposite. In the same vein, the development of self-service bicycles has mainly reduced walking and the use of public transport in some US cities. It has not had a visible impact on the use of car. The same is true today for self-service scooters.

  This challenges the logic behind new mobility services. If their development leads to reducing the cost of transport for users, in its monetary component and/or in its time component, it creates a substitution effect that is not in line with the development of public transport or even with that of shared mobility, as shown in Part 1 of this report with some of the 4 models.

- The second reason is that substitution could happen, but in low proportions because only a small part of mobility is concerned. It is true that public transport can replace private cars in city centres and on major highways connecting the periphery to Central Business Districts (CBDs). But concerning trips within the periphery of cities, the modal shift is much more difficult to implement. It is indeed a challenge to set up public transport lines addressing the diversity of origins and destinations of users. In such a situation, ride-hailing and other services can act as a first-mile or last-mile solution and connect underserved areas with public transport routes. Still, the volume of traffic would remain at a low level. Ride-sharing can easily be developed between colleagues from the same company, sharing the same working hours, but it remains marginal when people's schedules are not compatible. This incompatibility is further reinforced by the current trend of reduced costs of car mobility.

For substitution to occur on a large scale, the cost of the new modes of transport must not exceed that of the traditional ones. New mobility services providers thought they could achieve this goal. But as the fragility of their business models shows, their ambition is rarely achieved, despite the decrease in transaction costs generated by the digital revolution.

Still, what new mobility providers have failed to achieve, authorities organising mobility could do by accepting to take binding measures to reduce the use of private cars. The implementation of a congestion charge is a first way to go in this direction. But other measures are available, especially concerning the allocation of road space, for instance developing reserved lanes for vehicles carrying two or more people (i.e. 'high-occupancy vehicles' or HOVs). As suggested by the ITF-OECD studies already mentioned, another solution would be to totally ban cars from all or part of the urban road networks. This would, however, be a strong constraint on mobility, which would lead for many people to a degradation of their accessibility to urban amenities. This is not in line with the principles of MaaS.

3.2.2. From substitution to addition

The aim of MaaS projects is not to reduce but to broaden the mobility options available to the inhabitants of a city. To understand the logic behind new mobility services, we must therefore reason not in terms of substitution but in terms of addition.

Free-floating bicycles and scooters, car-sharing or carpooling services offer an extension of the range of available options for mobility. This is how 'smart card' projects are presented to the inhabitants of a city, providing them with a single information and payment medium for public transport, car-pooling or even taxis. The goal of MaaS initiatives is to enrich the universe of choice by unifying access to information and payment of travel for all modes of transport.

The logical consequence of MaaS is therefore a tendency to increase mobility. As more options are offered, it is highly likely that the number of trips will increase. This raises, however, a number of problems for transport authorities.

The first issue, which we have already mentioned, is the risk of developing mobility options that lead to increased congestion, pollution or other unintended negative effects. In that case, it becomes logical for public authorities to regulate certain mobility services. This is the case today with electric scooters, which create problems in various cities: anarchic occupation of public spaces, traffic accidents, etc. We can also mention here the development of new taxi-like services that introduce questions of social regulation. In many cities, the arrival of Uber has had the beneficial effect of stimulating traditional taxi services, both in terms of quality and price. But many cities have limited the implementation of services like UberPOP, considering that it led to situations not compliant with labour regulation.

The second problem is that transport authorities must make a strategic choice between two visions of future urban mobility:

- Either they consider that new mobility services will remain marginal and be limited to a few gadgets. They can then continue to focus solely on public transport in the traditional sense of the term, while striving to limit the space dedicated to private cars. This would be tantamount to prolonging the current situation characterised by a high modal share of passenger cars, particularly in the peripheral areas around cities.
- Or they consider that, despite its current limitations, MaaS will ultimately result in profound changes. As we saw in Sections 1 and 2, for now at least, the changes observed are more in terms of data collection, information for users and ticketing, than in terms of mobility services per se. These improvements may appear as secondary but they are instead central to a mobility orientation perspective. It is therefore crucial that mobility authorities also broaden their range of activities: if traditional and new mobility services are combined, then new responsibilities must be added to existing ones. On the one hand, this entails a resolute commitment to the digital revolution as indicated in the Part 2 of the report. On the other hand, it requires for mobility authorities to become aware of their central role in optimising mobility services.

Except if mobility authorities play the *status quo* card and choose the first option, the result is clear. Mobility authorities will have to show ambitions. In the old world of urban mobility, it is neither commuters nor mobility providers who planned the development of public transport. In the new world of MaaS, it is not them either, but the authorities, which must define the balance to be found between the various uses of roads.

3.2.3. Complementarity and the issue of public financing

The extension of the mission of public authorities presupposes the resolution of two major issues. These are respectively the complementarity between traditional and new mobility services, and financing.

Complementarity is a way of combining substitution and addition. We will focus on two examples.

The first example is in the area of data, platforms and digital applications. It is clear that, in this respect, private operators have often taken a step ahead of authorities, particularly as regards cartography, road information and the optimisation of itineraries for motorists. On this basis, a number of operators intend to develop their business (for instance their mobile application) by providing information on public transport, but also on taxis and other services such as self-service bikes or carpooling. To do so, they must build partnerships with data holders and also with other platforms, including for online ticketing. Transport authorities must be careful here. For complementarity to be real, they must stay in charge of certain activities that are crucial to them. The important thing is that they do not end up on the wrong side of the value chain, by simply organising public transport. Transport authorities must value their own data as well as their brand name, which is well known by local users. They must therefore not refrain from developing their own platform or app, and in particular must continue to promote their online sale of season tickets. This being said, and to make life easier, individual tickets could be sold by other platforms for occasional public transit customers such as tourists.

The second example of a possible complementarity between traditional and new modes of transport concerns the times or areas where public transport is neither relevant nor necessary. This is for example the case of self-service bikes in the late hours of the night. Data shows a peak in the use of this type of services when public transport stops. It is not a question of large volumes, but of a useful and complementary offer. For this reason, self-service bicycles have been set up in many conurbations upon the decision of public authorities. The same rationale could be applied in areas where public transport is not very present. Taxi services can be used as a kind of on-demand transportation. For instance, a partnership on this model exists in Nice between the transport authority and Uber. Travellers can benefit from a single fare taxi service (6 euros) for the journey between the bus terminal and their home. This implies that such services be subsidised by the community.

Funding issues are central to the development of MaaS. The latter can only develop if more public funds are allocated to urban mobility. Such an assertion is based on two observations.

- The first one is the weakness of business models of new mobility services. As explained in the first two parts of this paper, a vast majority of new mobility providers are not profitable. If they adopt pure B2C models, their commercial revenues are not enough to cover their costs. This is the case of short-distance ride-sharing, which cannot reach the necessary critical mass for its development. It is also a known fact that companies like Lyft or Uber lose money every quarter, especially because they have to subsidise drivers so that they do not stop their activity. It is therefore not surprising to see a Business to government (BtoG) rationale develop. Local public authorities are invited to partially finance certain services that could not be provided by users alone. But the question is then: how to find the necessary funds?
- The second one is that funding for new mobility services is not difficult to find in the case of services of a limited scale. This has been observed in the case of self-service bikes. Their installation involves little initial investment and they often have been indirectly financed by advertising revenues. This type of financial package has been a solution for public authorities. Still, it cannot be reproduced identically if the goal is to embody the ambitions of MaaS, i.e. at the same time, the entry into the era of digitalisation, data collection, information and online sales; and the integration of new mobility services into the public offer.

This is all the more so true if we consider that the management of roads should be under the responsibility of the authorities organising mobility. We emphasise this point because, as we pointed out when referring to congestion charging, it is a potential source of revenue for the community.

3.3. Towards an integrated regulation of urban mobility: what does it mean?

The development of MaaS is the result of the multiplication of private innovations both in terms of transport services and information, and in terms of transaction costs of mobility, which are increasingly reduced.

As we have shown, this does not imply a weakening of the role of local public authorities. On the contrary, the latter must be more ambitious. The regulation of urban mobility must no longer be fragmented. But what does integrated regulation mean, and how can it be achieved?

3.3.1. Private initiatives and platforms as integrator: a bottom-up process

At first glance, MaaS can be presented as a bottom-up process. Innovations have been proposed locally by actors who were not initially part of the mobility world. Still, they hope to invest this area of the economy which, like others, will be disrupted by the digital revolution. It is indeed common to distinguish three main waves of diffusion of the Internet in the economy:

- The first digital revolution was that of mobile data, i.e. smartphone and tablet penetration empowering consumers by allowing constant access to the internet and apps, e-commerce, the media, etc. As a consequence, in less than a decade, the world of media and culture has been deeply disrupted. New firms have emerged (the famous GAFAN: Google, Amazon, Facebook, Apple, Netflix), playing the role of intermediary between producers and consumers of information and cultural products, and, for some of them, producing their own contents.
- The second wave started some years ago. It concerns mainly the service sector, with the digitalisation not of the services themselves, but of access to services, including mobility services. Such changes began with the emergence of new intermediaries (Booking.com for hotels, Opodo or Trainline for aircrafts and trains tickets, etc.). New mobility service producers (Uber, BlaBlaCar, etc.) then appeared, based on fully new business models.
- The third wave of digitalisation, i.e. that of the Internet of Things, is still in the infancy in the area of mobility. Still, a lot of companies (e.g. Google, Apple and Uber) are already spending a lot of money for research on topics like autonomous vehicles.

The new giants of the Internet and mobility services therefore have a clear objective: mastering the technologies corresponding to each of the three waves of the digital revolution. If they succeed in this project, they will be able to offer public authorities "turnkey" solutions. To do so, they must control the main building blocks of the urban mobility system. From their point of view, MaaS represents the culmination of this approach. Starting with the dissemination of information in real time (first wave of the digital revolution) and then positioning themselves on ticketing and transport services (second wave of the digital revolution), they present themselves as integrators. The aim is to eventually offer a complete range of urban mobility services. The development of autonomous vehicles (third wave of the digital revolution) is a central part of this strategy, as it would lead to a total rethinking of transport itself.

But we know today that fully autonomous vehicles (level 5), able to circulate on all networks and in any conditions, are still far from being operational. We have also already established that such vehicles will have potential only if they are shared, so as to avoid a worsening of traffic congestion.

If we add to this the observations we have recalled on the two key rarities of public space on the one hand and of public funds on the other, it goes without saying that the digital revolution alone cannot ensure the development of MaaS. To approach things solely from the point of view of technology leads to forget the collective dimensions of urban mobility. The business models of new mobility providers introduce new social and societal objectives for public policies. The question is not only one of technical progress stemming from the digital revolution; it is how to put this technological progress at the service of a collective urban project.

3.3.2. Public authority acting as an aggregator: a top-down process

The establishment of MaaS can also be considered not as a bottom-up process but rather as a top-down one. The key idea behind this is that transport authorities could present themselves as aggregators. As with the previous (bottom-up) model, it is important to integrate the different bricks of mobility systems by taking advantage of the progress made possible by the digital revolution. The difference here is that this integration is conditional to the achievement of societal objectives in terms of noise, pollution, security, use of space and public health.

The foundation of this approach is the idea that urban mobility does not fall into the same category as hotel or housing reservations. In this field, companies like Booking.com or Airbnb soon found themselves in a natural monopoly position as they were the first ones to reach a critical mass of suppliers and customers on their platforms. This is what is called the "superstar effect" (Sherwin Rosen) or the phenomenon of the "winner takes all". But when it comes to urban mobility, things do not happen in the same way. There is no global natural monopoly on urban mobility. Partial natural monopolies may exist for certain services such as public transport. It is for this very reason that they are under the supervision of public authorities. These monopolies can be challenged by the arrival of new players. This is for instance the case of self-service bicycles set up by public authorities and which are now in competition with private, free floating services of the same type. However, these private operators have encountered great difficulties, as illustrated by the resounding bankruptcy of OFO, an ephemeral bike-sharing giant.

Urban mobility is therefore composed of different bricks but no actor has a monopoly of assembly of these bricks, except perhaps public authorities of mobility because they must (1) control the use of space and (2) organise the financing of the system. In this top-down model, public authorities are therefore in the position of buyer of mobility services. Given the societal objectives they usually set for themselves, they must choose which mobility services must be provided primarily to the population. On this basis, public authorities decide which partners will be chosen, and under which conditions.

This is true for transportation services, both traditional and new. For this reason, the organising authority may allow competition in the market to operate between different operators, for example taxis. But it can also organise competition for the market by launching tenders for the provision of special services such as buses, subways or self-service bicycles. The same rationale must apply in terms of information, route calculations and ticketing. Market competition is an acceptable information solution, but that does not mean that all public data should be in open access when private data is not. In the same way, the opening of online sales to partners must be conditioned to data sharing.

Let's not forget that, in terms of access to information, MaaS' main goal is to bridge the gap between regular users of cars and those who use public transport. For now, the world of commuters is split in two, and this is reflected in the way people uses- digital mobility platforms and apps. One the one hand, we have motorists, who are always connected to real-time information via applications giving insight on congestion and the best routes to follow. On the other hand, we have public transit users, who instead use platforms dedicated to public transport. The merger of the two kinds of platforms does not constitute a strong social demand for now, because each category of users has its own routines. The aim of MaaS is to offer commuters the opportunity to escape their routines, by learning about other options for optimising their schedules.

It is mainly for this reason that mobility authorities must take over the management of road networks. This way, they could act more effectively on vehicle flows. Also, increasing constraints on the use of the automobile will be more easily accepted if alternative options are available and accessible online.

3.3.3. Regulation of urban mobility: the key variables

MaaS has various aspects and there are various 'versions' of MaaS. Until now, the full potential of MaaS has not been tapped, because MTAs haven't found a way to get to it yet. In order for MaaS to reach its full potential, urban mobility regulation must be transformed.

- The main required transformation stems from the increasing role that the management of databases, platforms and applications will play in the coming years. This is a relatively new field of action for authorities in charge of organising mobility. They must invest by improving their skills in this area. In the same way, they must integrate in their planning the new mobility services that will contribute to improving the services offered to the inhabitants of the area they control. Now is also the time to integrate new technologies, to open the scene to innovation and ambition.

- But if MaaS and shared mobility lead to extending the missions of public authorities, we can understand the issues at stake by applying to the new context the same key variables that have prevailed in previous years. Even if this is a rather reductive way of presenting things, or rather because of this, we can summarise to four basic questions the set of choices that organisations dedicated to the production of public transport services are facing. Each question underlines a key variable.

First variable: planning

As a network industry, public transport is characterised by increasing returns. It is therefore a local natural monopoly that requires public action upstream of the offer itself: e.g. on the design of the network, the type of service, the frequencies, etc.

Second variable: operating

The public transport sector has a long history of very diverse forms of public-private partnerships (PPPs). In order to reduce costs, direct public operators have very often been replaced by a competition for the market of transport within the category of public service obligation (PSO).

Third variable: financing

There are various ways to finance public transport (e.g. pricing, taxation, cross-subsidies, etc.). Public transport provides positive externalities to users, but also to employers and landowners. It is therefore logical to have those indirect beneficiaries of the transport system contribute.

Fourth variable: users

In smaller communities, public transport users are generally captive to this mode. These are people who do not own a car, e.g. teenagers, students and senior citizens. The user-base is much more diversified in big cities where public transit is the backbone of urban mobility.

These four variables are still relevant in the world of MaaS, and lead to giving an important role to public authorities.

To face the challenge of MaaS and new mobility services, mobility authorities must redefine their approach to each of the above key variables.

Planning

Even though shared mobility remains at a low level until now, its future requires a global supply plan including, in a long-term view, ride-sharing based on autonomous vehicles. This is a major design change, and it would be naïve to believe that it will be achieved by spontaneous generation. In fact, it will be necessary to define safety standards for vehicles, rules for the use of public space, regulations for stopping points, loading and unloading points, etc. Because shared mobility must become a component of public transit, only public authorities can perform these missions. Of course, they will have to do so in partnership with new and incumbent mobility providers. In addition, a careful and consistent planning of the system architecture will definitely be required.

Operating

Here again, new mobility services are changing the rules of the game, but not the fact that a large diversity of operators is desirable, and not only for taxis or ride-sharing. Public authorities must define the level-playing field for competition. They must eliminate barriers to entry when they exist, not only for transport services but also for data collecting, information and ticketing. The diversity of actors all along the chain of mobility services is an opportunity that should be seized to define a clear and fair level-playing field.

Financing

New mobility services were, at the origin, built on the basis of B2C models. This does not seem to be a realistic way forward, unless we consider that new mobility services will remain a niche activity. The development of MaaS and shared mobility will probably rather require a B2G model. As a consequence, public authorities possess a strong leverage power, in deciding what kind of services should be supported. If we consider that public transit will remain the backbone of urban mobility, it is necessary to continue investing in transport infrastructure. Even though most new mobility services are making use of the road network, the maintenance and development of infrastructure dedicated to public transit must remain a priority.

Users

If the objective is to increase the number of users of the various urban mobility services, the issues of platforms, information and ticketing are crucial, even though digitalisation is not a magic wand.

If the goal is to reduce congestion and pollution thanks to the massive development of MaaS and shared mobility, the regulation of access to cities must change dramatically. Until now, constraints have remained relatively low on the use of cars. As we have seen, urban tolls exist only in a few European cities. It therefore appears that, in order to give shared mobility every chance to succeed, it will be necessary to focus not only on vehicles (e.g. size, motorisation or ownership) but also on the different uses of public space that one wishes, or not, to develop.

The emphasis on individual needs is often misleading, as it considers as a top priority the resource which is for us the rarest, namely – **time**. The problem is that most transport users make the same choice. Thus, an approach promising individual time savings does not make it possible to understand what is at stake from the point of view of the collective interest. The latter involves reasoning about what is the rarest resource for the community, namely – **space**. On this basis, we can again draw parallels with public transport. The full development of shared mobility will only become a reality if the rules for the use of roads are oriented towards incentives to ridesharing and disincentives to the use of individual cars. As long as the latter can move freely and on the same roads and use services in the same conditions as shared vehicles, it is unlikely that MaaS and shared mobility will be successful.

Regulatory issues: main observations and recommendations

- To take into account the complex interactions between land-use and transport, and also social conditions and the environmental challenges of sustainable development, the regulation of urban mobility must be unified and integrated.

- Organising authorities of public transport must, in one way or another, intervene on the uses of roads and even sidewalks and pedestrian zones. It is the MTAs' role, and not that of commuters or mobility providers, to define the balance to be found achieved the different uses of roads. It is up to public transport organising authorities to take over the management of road networks. Still, it is important to note that this is mainly a matter of political discussion on how to organise responsibilities for road traffic and public transportation. Public transport authorities certainly influence these discussions, but they will not decide of their outcomes alone.

- MaaS has various aspects and there are various 'versions' of MaaS. For now, the full potential of MaaS has not been tapped, because MTAs haven't found a way to get to it yet.

- Public policies must favour transport modes that optimise the use of public space, and not those that offer individual infinitesimal time savings to users.

- Encouraging the development of carpooling will require limiting access to roads for vehicles transporting one person only and creating lanes reserved for high occupancy vehicles (HOVs).

- Transport authorities must value their own data as well as their brand name. They must not refrain from developing their own platforms and apps, and must continue promoting their online sale of season tickets. To be efficient, they must improve their skills in the area of database management, platforms and applications. Mobility data must be gathered under the umbrella of MTAs, who are the only trusted party able to do so. Licensing to ensure compatibility with public policies is necessary and possible through the Intelligent Transport Systems (ITS) Directive.

- MTAs have to integrate in their planning the new mobility services that could contribute to improving the services offered to their users. The digital revolution alone cannot ensure the development of MaaS. MaaS can only develop if more public funds are allocated to urban mobility but also if, at the same time, MTAs are open to the development of new technologies on the basis of partnerships with new mobility providers.

- In fine, mobility authorities must redefine their approach in terms of planning, operating, financing and users.

Conclusions

85% of the EU's GDP is generated in cities. The latter are the main source of economic growth and employment. However, European cities face a number of challenges including: achieving enhanced mobility, ensuring accessibility and providing high quality and efficient transport systems while, at the same time, reducing congestion, pollution, CO_2 emissions, noise and accidents, rank in high positions. Within this context, the mobility objectives of Metropolitan Transport Authorities (MTAs) in most cities and regions across Europe include reducing air pollution, CO_2 emissions and congestion, and increasing the share of active (i.e. walking and cycling) and of public transport, and making efficient use of the road network.

As a sub-product of the current wave of digitalisation impacting the whole economy, the concept of Mobility as a Service (MaaS) is today gaining momentum in a number of countries. At the same time, we observe the development of many new mobility services. Among them, some (though not all) forms of shared mobility appear to be the most promising from a collective point of view. This is the case when commuters abandon private vehicles and turn to public and/or active transport, and when they combine these modes, if and when necessary, with shared mobility options.

In this respect, the development of platforms and applications is a means to reduce the transaction costs of urban mobility. A lot of apps are now available, offering, for a given trip, information about the different available modes of transport, their costs, the route choice, etc. In addition, EU legislation recommends the opening of sales channels. As a consequence, private actors can play an important role in helping commuters to change their routines by discovering the variety of mobility services available.

However, this reduction of transaction costs alone is not enough. Public stakeholders must initiate discussions with digital actors and new mobility service providers, to define how each party can contribute to meeting their common mobility challenges. MaaS is thus a tool that should help abolish the barriers that exist between the various administrative layers of a given territory when it comes to organising mobility services.

Commuters' requirements and public policy goals need to be reconciled through new regulations, especially concerning public space, which is a scarce resource though not a prime concern for most digital actors.

The process by which digitalisation is permeating the whole economy, from public services such as health and education to monetised activities such as banking, trade and energy, brings different regulatory regimes together in a number of new ways. The same applies to transport in general and to urban mobility in particular. However, the implications of digitalisation in the area of urban mobility regulation are not self-evident. This is due to the fact that, today, a large part of mobility is generated through the use of private modes of transport, mainly individual cars. It is not guaranteed that MaaS and new mobility services will, per se, systematically lead commuters to leave their private vehicles behind and turn to shared mobility instead.

The limits encountered by shared mobility, and the obstacles to the development of MaaS should not, however, lead one to consider these transformations as marginal. New mobility services still have to fully deploy and cannot be neglected by the public authorities in charge of urban mobility. To deal in an appropriate way with new mobility services such as shared cars or free-floating e-scooters, public authorities must develop new skills, especially in the field of data production, exchange and management. They also have to take into account the complex interactions between land-use and transport, and also social conditions and the environmental challenges of sustainable development. As a consequence, the regulation of urban mobility must be unified and integrated. MTAs must, in one way or another, intervene in the use of roads. It is their role, and not that of commuters or mobility providers, to define the balance to be achieved between the different uses of roads. It is up to MTAs to take over the management of the main road networks in and around cities. Even if this should be the result of a political discussion, MTAs can certainly have an influence.

In order to achieve an efficient development of MaaS, MTAs have to be more ambitious and must address their new responsibilities by developing new skills in two key domains: data and platforms on the one hand, and the management of urban space on the other.

Appendix

Mobility indicators of the four partner cities (Barcelona, Frankfurt, Oslo and Paris)

The four partner agglomerations of this study (Barcelona, Frankfurt, Oslo and Paris) are of different sizes, but in each of them there is a public authority in charge of public transit. It is with these authorities that the CERRE's team has worked to study the potential developments of shared mobility and Mobility as a Service (MaaS). These new mobility services are presented throughout the report, with examples borrowed in particular from the partner cities.

To introduce this work, it is possible, using a few indicators, to draw up an inventory of mobility in the four above-mentioned urban regions.

⇒ First by recalling that for each one of them, it is necessary to distinguish the city centre on the one hand and the urban region on the other hand. Population density varies greatly from one city to another, often in relation to size, but density remains higher in the centre for all four cities.

Number of inhabitants

	Urban area	City
Barcelona	5 686 489	1 608 489
Frankfurt	2 338 8777	747 848
Oslo	1 305 126	681 071
Paris	12 200 000	2 200 000

Density: inhabitant/km^2

	Urban area	City
Barcelona	700.90	15,784.90
Frankfurt	951.50	3,015.50
Oslo	243.00	1,500.00
Paris	1,016.00	10,628.00

⇒ Then by noting that there is no direct relationship between density and the modal share of public transport on the one hand and of the automobile on the other hand. The smallest city, Oslo, is the one that – along with Barcelona – has the least modal share of private cars. In Oslo, the modal share of public transport is by far the highest of all four cities.

⇒ Barcelona and Frankfurt have in common an important presence of two-wheeled vehicles, with one difference however: in the case of Barcelona it is mainly motorised two-wheels (9% of the modal split), whereas in the case of Frankfurt it is mainly bicycles.

Modal split: city centre

	Walking	Public transit	2 wheels	Cars
Barcelona	42 %	34 %	11 % (9 + 2)	13 %
Frankfurt	30 %	22 %	13 %	35 %
Oslo	13 %	68 %	5 %	14 %
Paris	53 %	29 %	4 %	14 %

Modal split: urban area

	Walking	Public transit	2 wheels	Cars
Barcelona	39 %	23 %	6 % (4 + 2)	32 %
Frankfurt	27 %	11 %	11 % (2 + 9)	51 %
Oslo	32 %	26 %	5 %	37 %
Paris	34 %	19 %	2 %	45 %

⇒ In all four cities, the modal share of walking is important, especially in Paris.

⇒ The main differences between cities, revealing local specificities, relate to the modal share of private cars vs. the modal share of public transport. This ratio shows the important presence of private cars, including in the city centre for Frankfurt and to a lesser extent for Paris. By contrast, Oslo is the city where public transport is the most attractive in the city centre. The relatively small share of the automobile in Barcelona must be looked at while keeping in mind the importance of motorised two-wheelers there.

Car/public transit ratio

	Urban area	City
Barcelona	1.40	0.38
Frankfurt	4.60	1.60
Oslo	1.40	0.20
Paris	2.37	0.48

The specificity of Oslo is also obvious if we look at the below indicator of the number of trips made via public transport, per year and per capita.

Public transit: number of trips per year and per inhabitant

	Urban area
Barcelona	190
Frankfurt	-
Oslo	600
Paris	307

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