D.3.1.1 Desk work on ICT for public transport and Intermodal solutions

WP3 Understanding mobility needs and trends

A.3.1 Understanding trends & scenarios on mobility services

AUTHOR: LP – ITL
Status: FINAL v.1
Distribution: public
Date: 7th January 2020

DISCLAIMER

This document reflects the author's views; the Programme authorities are not liable for any use that may be made of the information contained therein.

Table of Contents

1 Introduction

1.1 The ICARUS project

The goal of the Interreg Italy- Croatia ICARUS project is to create new intermodal solutions taking into consideration passengers' mobility needs and allowing the maximum level of flexibility for users. This goal will be achieved thanks to:

- Improvement of passengers intermodal connections in and between the territories of the Programme area;
- Foster of behavioural change of transport users and increasing the use of intermodal low carbon transport solutions;
- Creation of seamless multimodal and environmental friendly intermodal transport solutions
- Easing the sustainable transport integration of the coastal and hinterland areas
- Boost of existing or new maritime connections among the Italian and Croatian coasts by raising the level of service of ports land side.

To improve passenger intermodal connections and ease access to the coast for the hinterland population, mobility behavioural change the involved area will be promoted using the Mobility as a Service (MaaS), a concept which moves passenger needs from the transport means to the mobility service. MaaS and ICT are among ICARUS' three pillars, which also include Intermodal Mobility and behavioural change.

Thanks to ICARUS, partners will carry out and implement 8 pilot projects and a case study focusing on timetable harmonisation, car/bike sharing within transport nodes, ICT solutions for seamless flow of information, integrated intelligent multimodal payment systems, dynamic travel planning and cross-border intermodal services.

The planned activities will be tested in the regions of Emilia-Romagna, Abruzzo, Veneto, Friuli Venezia Giulia, Primorsko-Goranska, Istrian Region and throughout the Croatian railway area.

1.2 About this deliverable

Work Package 3 "Understanding mobility needs and trends" aims to build knowledge and define mobility needs in each partner location. The activities in WP3 will lay the foundations to understand the pillars of the project (ICT/Maas, Behavioural Change and Intermodal Mobility), and eventually to overcome barrier related to bottlenecks in multimodal connections and governance and lack of efficient multimodal networks (road, rail, air, water transport), as well as low connectivity and mobility of peripheral areas.

A.3.1. is designed to highlight which are the main activities and trends in Europe and worldwide, in relation to the three pillars of the project.

D.3.1.1 "Desk work on ICT for public transport and intermodal solutions" aims to analyse the current state of play in Europe and beyond of sustainable multimodal transport solutions supported by ICT. This includes trends and future scenarios in the private and public sector, selected good practices and case studies. The contents of this deliverable should support partners in the definition of mobility needs and gaps in their region, as well as future policy development.

2 The need for passenger multimodal transport

2.1 Evolution of transport mode

When we think of future trends, or even near-term prospects for the transport sector at global level, we must take into account two major variables that limit the ability to make robust projections: the uncertainty of the economic climate and the environment.

The fact that greenhouse gas (GHG) emissions from transport are a key contributor to climate change is well-known nowadays. CO_2 represents one of the largest proportion of the basket of greenhouse gas emissions, and over the past three decades CO_2 emissions from transport have risen faster than those from all other sectors and are projected to rise more rapidly in the future. In Europe, transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities. The transport sector has not seen the same gradual decline in emissions as other sectors: as shown in the graph below (*Figure 1*), emissions only started to decrease in 2007, remaining higher than in 1990. Within this sector, road transport is by far the biggest emitter accounting for more than 70% of all GHG emissions from transport in 2014 (European Commission, 2019).
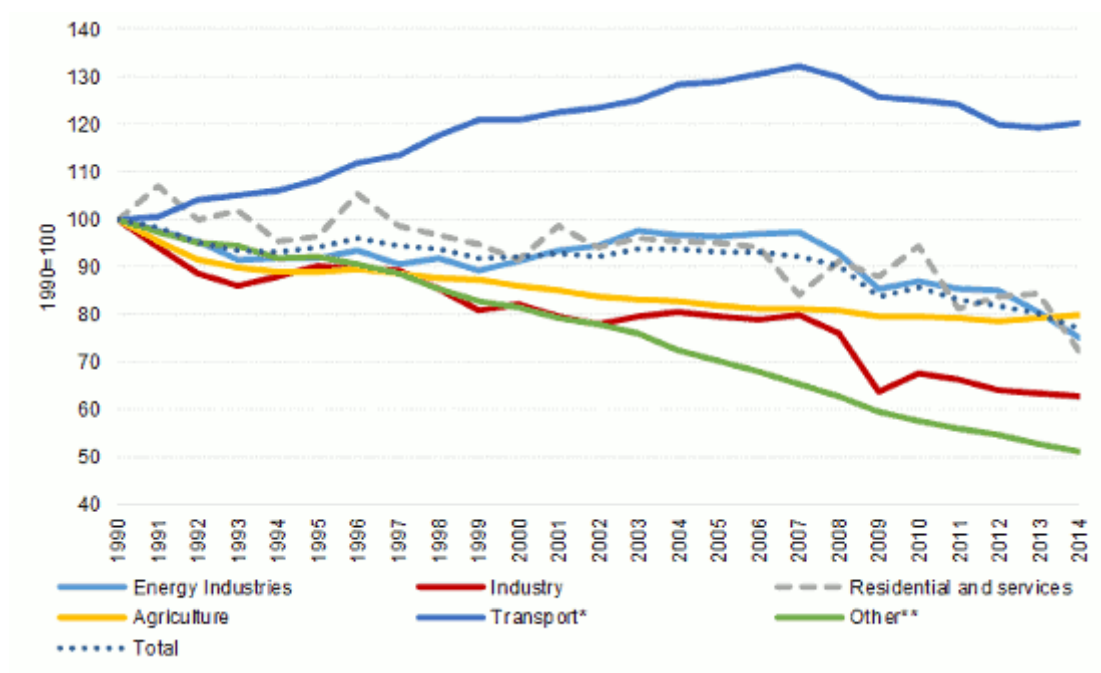

Figure 1 GHG Emission by sector over time, Source: EEA

At the same time, studies state quite confidently that, globally, demand for mobility will continue to grow over the next three decades. We must therefore be able to respond to the increasing mobility needs of people and goods and stay competitive, while answering to the emission reduction challenge in the transport sector. There are three primary ways to go towards emissions reduction:

- *Avoid* (i.e. avoid travel, or avoid traveling alone in your car and thus inefficiently)

- *Shift* (i.e. shift to more environmentally friendly modes)

- *Improve* (i.e. improve energy efficiency of transport modes and vehicle technology) (Dalkmann & Brannigan, 2007)

According to the ITF Transport Outlook 2019, passenger transport will increase nearly three-fold between 2015 and 2050, from 44 trillion to 122 trillion passenger-kilometers; private vehicles will remain the preferred mode of personal travel worldwide; travel in cities especially will shift towards public transport and shared mobility. By 2050, both these modes are projected to account for over 50% of total passenger-kilometers. Shared mobility in particular could halve the number of vehicle-kilometers travelled in urban areas if widely adopted. This could lead to a 30% decrease in CO_2 emissions from urban transport by 2050 relative to projections based on current ambitions. However, the widespread use of autonomous vehicles would likely increase the number of vehicle-kilometers travelled and tons of CO_2 emissions generated in most urban regions (International Transport Forum , 2019).

At European level, the negative consequences of transport such as pollution, climate change, noise, congestion and accidents pose problems to the economy, health and well-being of European citizens. Not only passenger transport but also freight transport continues to grow and road freight transport, in particular, is projected to increase by around 40% by 2030 and by little over 80% by 2050. The EU transport policy aims therefore at reducing road transport towards less polluting and more energy efficient modes of transport (European Commission , s.d.).

It is therefore quite clear that environmental concerns and priorities represent the biggest limit for robust projections as well as the major driver for investing in the transportation sector; however, it is not the only one. There are indeed other very important drivers that lead to the innovation of this industry, some of which are reported in the following list:

- People health
- Reduction of congestion
- Reduction of noise
- Improvement of passengers' wellness (convenience, comfort, etc.)

- Cutting of future maintenance costs
- Optimization of spaces and resources
- Minimization of accidents and thus safety improvement
- Improvement of accessibility

All these drivers are at the basis of a new concept of mobility: the Smart Mobility, highly technological, citizen friendly and with a low environmental impact. Smart mobility means technology, new transport infrastructures (parking lots, charging stations, road signs, vehicles) and new solutions for the mobility of vehicles (new mobility) and passengers. By switching to this new concept of smart mobility, we move towards the development of smart cities, made of a set of urban planning strategies aimed at improving the quality of life.

2.2 New modes of transport

In spite of the environmental emergency that the planet is facing, people will continue to increase their mobility needs and therefore the demand for transport will increase. One of the ways to face this situation is to develop new modes of transports that can cope with demand in an environmentally sustainable way. Mobility must shift towards options that are low or zero emissions, such as electrification and hybridization of all transport modes, use of alternative fuels, higher energy efficient vehicles, infrastructures and transport system as a whole. At the same time, these new modes of transports aim at improving the quality of service, reducing commuting time and overcoming the usage barriers.

Public transport will not be able to accommodate the need for mobility and flexibility of modern users. So, even though private vehicles are still widely used, next to public transportations there is a new wave of mobility modes growing and they belong to the ***sharing mobility***, a socio-economic phenomenon that affects the transport sector both on the demand and the supply side. On the demand side, sharing mobility demonstrates a transformation of individuals' behaviour, as they tend to prefer temporary access to mobility services rather than using their own means of transport. On the supply side, this phenomenon consists in the affirmation and diffusion of mobility services that use digital technologies to facilitate the sharing of vehicles and/or journeys, creating scalable, interactive and more efficient services.

Sharing mobility means ***bike sharing***, ***car sharing***, ***scooter sharing***, but it also means ***carpooling***, a mobility service based on the shared use of private vehicles between individuals who have to travel the same route, or part of it, and ***on-demand services***.

Car sharing is highly used nowadays; the graph below shows how this phenomenon increased in Europe in the last years, from less than 1 million users in 2011 to a projection of 15 million users in 2020.

Number of car sharing users in Europe in 2011 and 2020* (in millions)

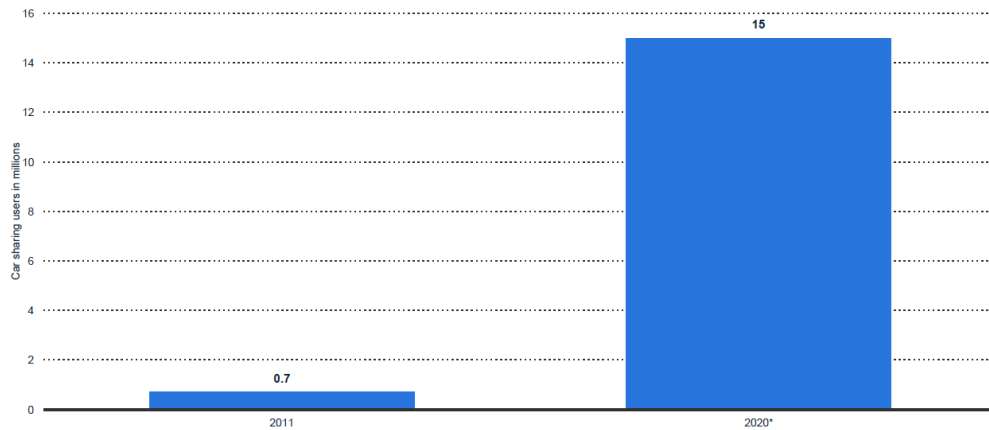Number of car sharing users in Europe 2011 and 2020

Figure 2 Number of car sharing users in Europe (source: Frost & Sullivan)

If we look at European countries, we can see that Germany, the United Kingdom and France are the countries with the highest number of car sharing users, followed by Italy with 130,000 users in 2014.

Number of car sharing users in Europe in 2014, by country
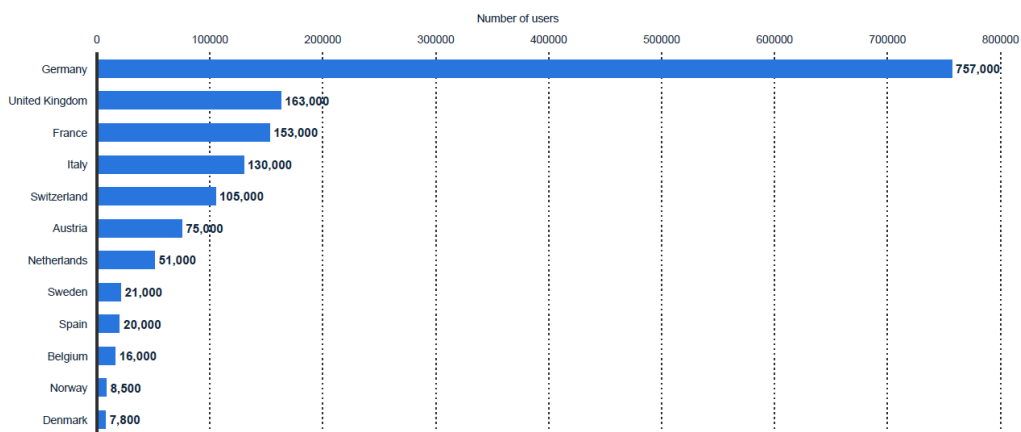
Car sharing users in Europe 2014, by country

Figure 3 Number of car sharing users in Europe (source: Frost & Sullivan)

There are then *support services* that facilitate the access to shared mobility services; ***journey planners*** are on-line tools assisting users in finding the best routes at a given time, ***MaaS platforms*** integrate also

different mobility services, and *mobility hubs* are physical exchange platforms that facilitate the integration of different shared mobility systems.

Combining technology with a need of more sustainable transports, another mode of transport arisen in the late 2010s is *micromobility*, made of light vehicles such as electric scooters, electric skateboards, shared bicycles and pedal assisted bicycle. Micromobility spread as a solution to the "last mile" of personal transportation, particularly in congested urban areas. Rather than use existing modes, a user would join a micromobility sharing network to be able to ride distances typically less than one mile.

However, there are also areas of low passengers' demand where regular bus services are not considered financially viable, such as the rural or peri-urban areas. These areas can today be reached by the so-called *demand-responsive transport (DRT)*, a form of transport where vehicles alter their routes based on particular transport demand rather than using a fixed route or timetable. These vehicles typically pick-up and drop-off passengers in locations according to passengers needs and can include taxis, buses or other vehicles. In the past, it has been used primarily for its social benefits, increasing opportunities for people with limited mobility, or those who are socially marginalized. However, DRT can also have significant environmental benefits through reducing the number of private vehicles on the road, and by supporting multimodal transport in cities, acting as the first/last mile solution for linking communities with broader transport networks (Interreg Europe, 2018).

All these new modes of transport can be offered either by private or public actors, and they can be incumbents or startups. It is worth considering that these different groups of players can have some peculiarities that affect their relationships, therefore they can cooperate but occasionally be competitors.

2.3 Trends and future of mobility

More than ever, the reform of mobility systems is one of the key challenges facing the world today. According to the study "The future of mobility 3.0", there are two key strategic paths that cities must take if they are to respond to environmental and capacity challenges. The first approach is the so-called "Rethink the system", i.e., work towards a more sustainable mobility system; and the second, "Network the system", i.e., work towards integrated mobility, with the customer at the center. In this context, all mobility solutions providers must master three key approaches simultaneously: Anticipate, Innovate and Transform (Arthur D. Little , 2018).

Our mobility systems are currently under increasing pressure, reaching high levels of congestion and excessive levels of car use, at a very high cost to the economy, the environment and the health of urban inhabitants. This challenge must be addressed by providing more public transport solutions, which must be improved, customer-driven and with citizens at the heart of transportation strategies. In urbanized

areas, the global demand for passenger mobility is foreseen to double by 2050, and meanwhile the number of individual journeys taken on a daily basis has massively grown since 2010. The technological advancements and innovations thrown up a range of new mobility options within the 4th industrial revolution, as represented in the figure below.
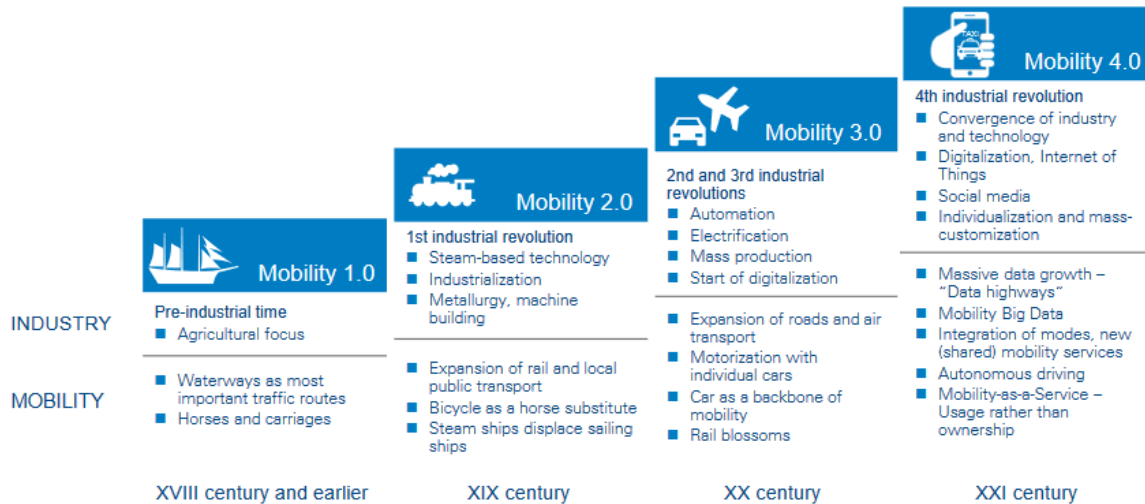

Figure 4 Source: Arthur D. Little

These major technological developments include big data, Artificial Intelligence (AI), the Internet of Things (IoT) and the emergence of new forms of energy. Internet of Things technologies are significantly influencing the future of mobility as they introduce a new, continuous communication channel between mobility stakeholders, increasing the ability to capture and share data. Also, the production on a massive scale of new, compact forms of energy, will allow for economies of scale and extended journey range, which will drive the adoption of electric mobility solutions.

2.4 Expectations and barriers

The EU Commission has already highlighted the importance of multimodality for the European transport system, where multimodal transport (i.e. the use of different modes/means of transport in the same journey) is a concept applied to both freight and passenger transport. In fact, given the importance of multimodality to help bring about a truly sustainable and integrated transport system, 2018 was the "Year of Multimodality". Expectations are therefore quite high, as multimodality would bring us towards a significant reduction of CO_2, congestion and air pollution.

The intermodal mobility for passengers derives from the concept of multimodal freight transportation, known also as combined transport, i.e. transportation of goods under a single contract but performed with at least two different modes of transport. In the same way, the intermodality paradigm gives to passengers the possibility to exploit two or more transportation means, combined together, to reach the destination. It is known also as *mixed-mode commuting* and it focuses on combining the strengths of various transportation options. Obviously, intermodality is really effective when the different transportation services are fully integrated among themselves and usually when they are accessible through a common platform and a unique payment system (integrated ticket): Mobility As A Service (MaaS) paradigm embodies this vision targeting a *seamless mobility*.

Usually the term "intermodal" refers to the matching of different solutions belonging to the same transportation player while the term "multimodal" addresses the combination of mobility solutions of different suppliers (which may be both private and public, startup or incumbent). It is important also to stress that this combination is increasingly composed by one or more main transportation system plus a first-mile or/and a last-mile solutions (e.g. Micromobility).

Expectations from these new kind of sustainable transportations are again related not only to the environment, but also to service improvement and effectiveness, accessibility, mobility costs and so on. Here is a list of goals/expectations related to multimodal and intermodal mobility:

- Push environment sustainability reducing carbon footprint;
- Reduce pollution to reduce impact on people health;
- Improve service effectiveness making transportation means integrated, flexible, comfortable and on-demand;
- Make traffic flows intelligent and without interruptions reducing waste of resources and time.
- Reduce mobility costs for passengers and future investments/maintenance costs for actors.

Before reaping these benefits, there are, however, some barriers that shall be overcome at European level. According to the study *"Challenges, opportunities and barriers to sustainable transport development in functional urban areas"*, the most common ones are the environmental/natural barriers; quite often, large-scale infrastructure projects are stalled or delayed for environmental reasons. Apart from these, there are also financial constraints. There are both internal and external funds for transportation development. Still, the need for partial financing by local and regional governments may lead to excessive burdens on their budgets. In spite of the threat of financial imbalance, municipalities, districts and provinces can raise funds or accept funds from EU Programs for transport development. Finally, the social

trends are not less important, as they influence lifestyles and habits that are strongly connected with transport mobility. Urban lifestyles are spreading; high levels of automobile ownership are associated with urban sprawl, and increasing level of automobile travel (Wolny, Ogryzek, & Źróbek, 2017).

Literature on this topic suggests also other common barriers to sustainable mobility (TRANSFORuM, 2014). In particular, if we think of urban transport the following barriers are the most common:

- Lack of knowledge/data about the potential and performance of alternative fuels and technologies;
- Lack of common definitions and easily accessible data for policy makers;
- Lack of standardized solutions for supply of new fuels;
- Limited availability of alternatively fuel vehicles on the market, low visibility and low public awareness;
- Lack of a common European standard for biofuels;
- On the regional/local level, new investments or policy measures to support certain fuels, vehicles and/or transport modes are related to investment costs for society;
- Public and stakeholder acceptance, as significant reductions of CO_2 emissions from transport in the EU is dependent upon behavioural change;
- Institutional conditions/organizational factors (regulatory frameworks, roles and responsibilities, how various policy fields are being integrated and coordinated, structures of financing and/or pricing, etc.);
- Urban and transport planning, as there is a need for more integrated strategies and a closer link between transport planning and management and urban design that manage to include both issues related to personal mobility and freight/supply chains;
- Lack of information, as potential customers may not always be aware of the access, the price, the performance and the potential long-term benefits of new fuels/vehicles or of innovative services.

Furthermore, the European multimodal transport faces a challenge in its integration due to an incompatible infrastructure. Many different actors are involved with different requirements, there is a lack of legislation at the European level and the difficulty to access the data is another big issue, as different stakeholders cannot get the information they need. Moreover, privacy and safety are two big issues that must also be considered. Solutions cannot be too fragmented or it will be hard to integrate them and to ensure public acceptance in the future. On social level, users should ideally be involved in the development of new systems and nobody should be left out or put at a great disadvantage, because he/she may have difficulties in using new integrated solutions.

We can therefore conclude that the main difficulties associated to sustainable urban transports are not about technology but about politics, institutional conditions and public acceptance, and the uncertainty about how to engage with the public and stakeholders to get them on board in the more fundamental transformation that is necessary in order to reach the goal.

Finally, it is worth highlighting that there are not only barriers to sustainable mobility solutions, but also enablers to the sustainable transport development as well as multimodal solution innovation, and these are:

- Indirect positive impact of city development pushes the investments on the transportation sector given its relevance for the urban and suburban growth;
- The large availability of internet connection (with respect to the past), also outside the city centre, open to the spreading of services that need access to data and information;
- The fast pace of development and diffusion of new technologies (IoT, Cloud, AI) enables mobility transformation that before were impossible;
- The policy-makers and institutions have the modernization of transportation infrastructure as one of the main agenda goals;
- The startups proliferation thrusts diffusion of new mobility concepts and ideas and indirectly increases the competition (with positive effect for both market and passengers) among market incumbents which have to adapt the traditional solution and to innovate their business models. The public mobility sector has to follow the market and purpose its sustainable solution to not lose its dominant position;
- The experimentation of new business model opens to new way of transportation and related services that before where impossible;
- The growing urbanization and thus the need for efficient transportation push the actual research for new and innovative way to move people, especially in developing countries;
- International agreements about increasing environmental sustainability (eg.: reducing carbon footprint) force a shift on transportation paradigms and local norms and rules.
- In all the industries the preference of customers are changing and are becoming more and more pretentious due to widespread service-quality improvements, thus expectations are in the transportation sector are similar. The new mobility solutions are pushed by the changes in passengers' behaviors and preferences (e.g. from private car to car sharing or pooling solutions)
- The medium/long term positive effects of efficient transportation modes in terms of lower risks and maintenance costs for the community push investment in new physical and digital infrastructures.

3 ICT and MaaS

3.1 Mobility as a Service (MaaS)

MaaS is the integration of various forms of transport services into a single mobility service accessible on demand. As described by Deloitte in its review "The rise of mobility as a service", MaaS relies on a digital platform that integrates end-to-end trip planning, booking, electronic ticketing, and payment services across all modes of transportation, public or private. Rather than having to locate, book, and pay for each mode of transportation separately, MaaS platforms let users plan and book door-to-door trips using a single app, moving us toward a more user-centered mobility paradigm (Deloitte, 2017). It is therefore pretty clear the bond between MaaS and ICT: MaaS is a data-driven, user-centered paradigm powered by the growth of smartphones; it requires high levels of connectivity, secure, dynamic, up-to-date information on travel options, schedules, and updates, and cashless payment systems. These services all refer to Information and Communication Technologies (ICT), as technology is behind their management, maintenance and improvement. ICT is what makes MaaS possible and is the key to its diffusion and improvement.

MaaS is considered to be both a physical service provision and a medium/digital platform for accessing this service. Its so-called ecosystem is made of agents (including vendors, transit agencies, other government stakeholders and consumers) and attributes (i.e. types of services or functionalities available and the technologies that enable these to be consumed) (Falconer, Zhou, & Felder, 2018).

In particular, four components characterize MaaS (Costantini, 2017):

(1) *Infrastructure.* There has to be an interconnected physical infrastructure enabling transfers between different transportation services. Moreover, a high level of connectivity is required. Indeed, since users gain access to the system through an app, a widespread use of smartphones is required.(2): *Data Providers.* Customers plan their trip selecting the route among different travel options thanks to the huge amount of data crowdsourced and real-time updated from public operators and other providers.

(3) *Transport Operators.* Transport operators are incumbent players in MaaS, yet their lack of flexibility has driven the growth of private providers offering specific services (e.g. carpooling).

(4) *Trusted mobility advisors.* As an intermediary, MaaS provides information, reservation, assistance and, in the near future, payment. This operator controls data and processes and, by that, is the main figure in the process.

The concept of MaaS is a natural consequence of current trends: people want cities to become more livable and less vehicle-centered, in other words they want them to become smart cities as previously described. As urban density continues to grow, MaaS provides an alternative way to move more people and goods in a way that is faster, cleaner, and less expensive than current options. In addition to that, consumers have increasingly embraced new mobility options and apps over the last decade, and journey planning apps helping users to identify and compare different modal options for getting to their destinations, have become commonplace. The natural next step will therefore be to bring all these options together on a common platform.

Also for MaaS, future projections show a massive increase of its market size; in the European Union, the MaaS market size in 2017 was estimated to be equal to 25 billion dollars, increasing to 198 billion dollars in 2025 and 451 billion dollars in 2030.
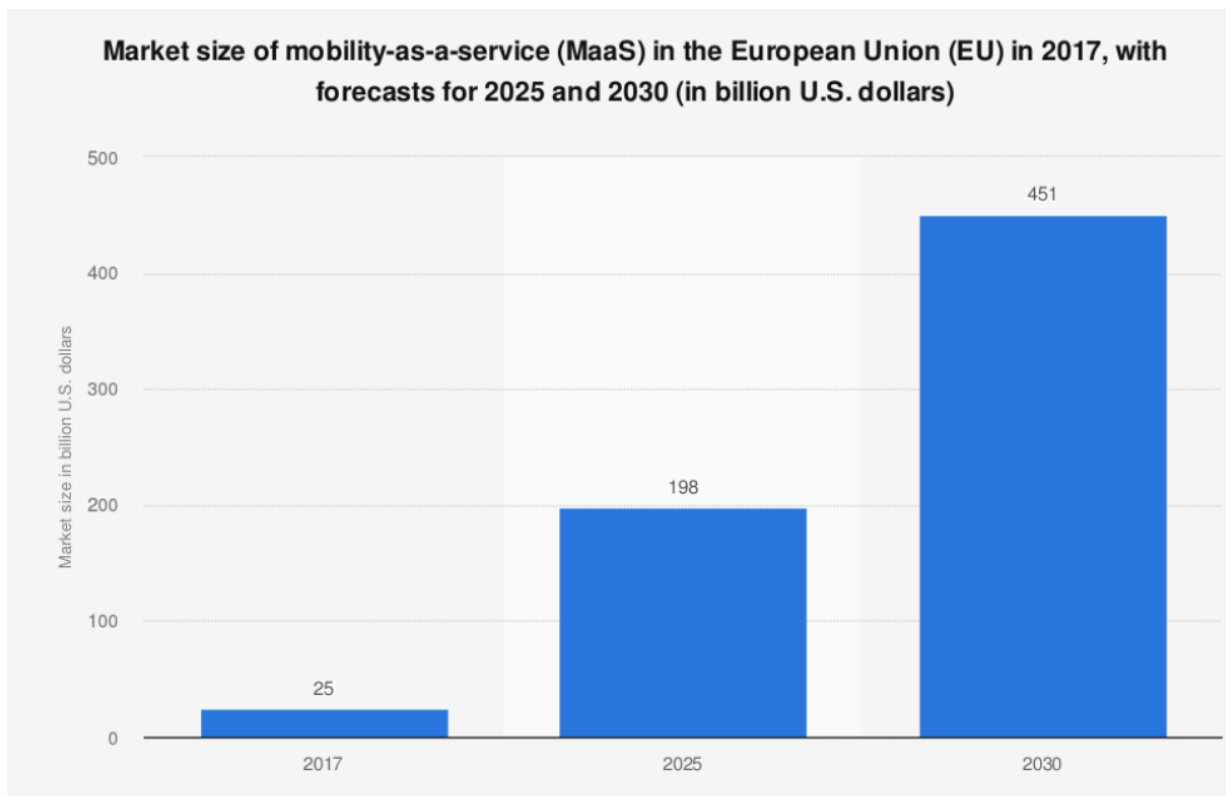

Figure 5 Market size of MaaS in the EU

MaaS platforms represent the technological realization of the concept of ecosystem paradigm for the transportation sector. The optimal solution for the mobility panorama is the one that shows all the

stakeholders perfectly integrated among themselves to create a strong value network, which aims at maximizing the satisfaction of the epicenter (represented by the costumer). Therefore, the scope of the MaaS systems is the possibility of fostering all the virtuous cycle that can be created among the different players. The value chain around the passengers are no more perfectly distinguished but instead they are mixed together to convey to the user a seamless experience. In the long term, the user satisfaction will reward the most effective ecosystems, also leveraging network effects: passengers will increasingly look for customized and flexible mobility solutions. At the same time they become active and directly interact with the other actors of the system to have an efficient, effective and interactive experience. Thus, to better understand the mechanism of the industry and how to innovate it, it is fundamental to study the relationships among the relevant stakeholders and between mobility players and users.

3.2   Evolution and trends of ICT

Over the last ten years, the evolution of ICT has radically changed people's lifestyles and firms' activities, leading to a condition where financial, economic and even social inclusion is strictly influenced by attitudes towards technological change (European Management Journal, 2019).

ICT access and use in Europe has steadily increased over the last years. ICT key indicators such as mobile-cellular/broadband subscriptions and others show that the European region as a whole is performing even above the global average. However, although most countries in Europe have high-income levels and correspondingly high levels of ICT development, there continue to be disparities correlated with geographical location and relative income levels. The countries in the regions which tend to perform well in terms of ICT access, use and skills also tend to be high-income countries in Northern and Western Europe, yet there appears to be increasing coverage in the level of ICT development within Europe. Given the cross-sectoral nature of ICT networks and online services, transparent, practical cooperation and communication between regulators and policy-makers as well as with other stakeholders is essential to ensuring that regulation is responsive to government policy decisions and the realities of the markets around the world. Moreover, cross-border harmonization of relevant regulatory policies as well as enhanced collaboration among national government agencies, regional and global organizations is essential for creating a global digital ecosystem while putting in place effective safeguards against fraud and abusive practices. Regulators have a role to play in building consumer trust and protecting security of services by appropriately addressing data protection, privacy issues and cyber security matters. Incorporating mechanisms to engage citizens, including disadvantaged and vulnerable groups, is also a key element of collaborative regulation (ITU, 2017).

Speaking of the future, given how fast technology evolves and how dramatically the opportunities for innovation rise, predicting the future trends of ICT is not an easy thing. Nowadays, info-communication

technologies are developed as centered on integration platforms with wide ranges of implemented services and applications. The primary goal of future info-communication integration platforms is in line with the paradigm of being connected anytime, anyplace, with anything and anyone. In this context, we shall speak of the Internet of Things (IoT), i.e. a generic platform where all objects play an active role in creating smart environments. It is a multidisciplinary ecosystem that encompasses a wide range of various scenarios and technologies, application domains, business strategies, industry stakeholders.

Innovation in IoT for mobility will boost the digital transportation of our transport networks, granting transport authorities and road users a substantially more comprehensive array of information about mobility conditions (e.g. having targeted traffic updates or suggestion on the routes that are least-congested). In addition, implementation costs are decreasing, performance and flexibility increasing and potential synergies of IoT infrastructures are pervasive. By harnessing IoT applications, transport actors will be able to collect and analyze an exponentially larger set of data, unlocking further improvements to network reliability. All these issues motivate the necessity to enter in detail with these technologies mapping, for example, the main features and solutions.

Thus, there is no doubt that the evolution of ICT towards creating integration platforms implies the significance of such vision and its impact on future societal, networking and communications landscape. In that manner, a smart world will become our reality, with a number of attractive applications: smart cities and environments, smart grids, industrial automation, traffic management and logistics, remote monitoring, healthcare and assisted living, agriculture, public safety and so on (Pejanović-Djurišić, Gavrilovska, & Fratu, 2016).

3.3 The key role of data

The ownership and access to data determines the market dominance in a digital economy, and in order to build real multi-player, multi-option market platforms, service providers should provide each other access to essential information in a computer-readable format. Information such as routes, timetables, stops, prices, ticketing and payment system interfaces should be accessible to/for other service providers. However, better access to travel planning data is not yet sufficient to make seamless multimodal transport a reality; third parties must indeed be able to establish a secure real-time data-connection to the vehicles and their fleets. With the ascendance of shared mobility services, for instance, mobility operators must have the ability to assess the status of the asset used (MaaS Alliance, 2017).

The development of this new mobility service market relies heavily on access to data and ticketing, open APIs (Application Programming Interface) and interoperability of the systems. Availability and access of relevant and high quality data and interoperability of systems are therefore fundamental preconditions of MaaS.

If we observe[1] at the Italian data industry, we can see how its value is growing every year and is forecasted to continue growing until 2025. The value of the Italian big data analytics market has also grown from 2016 and 2018.
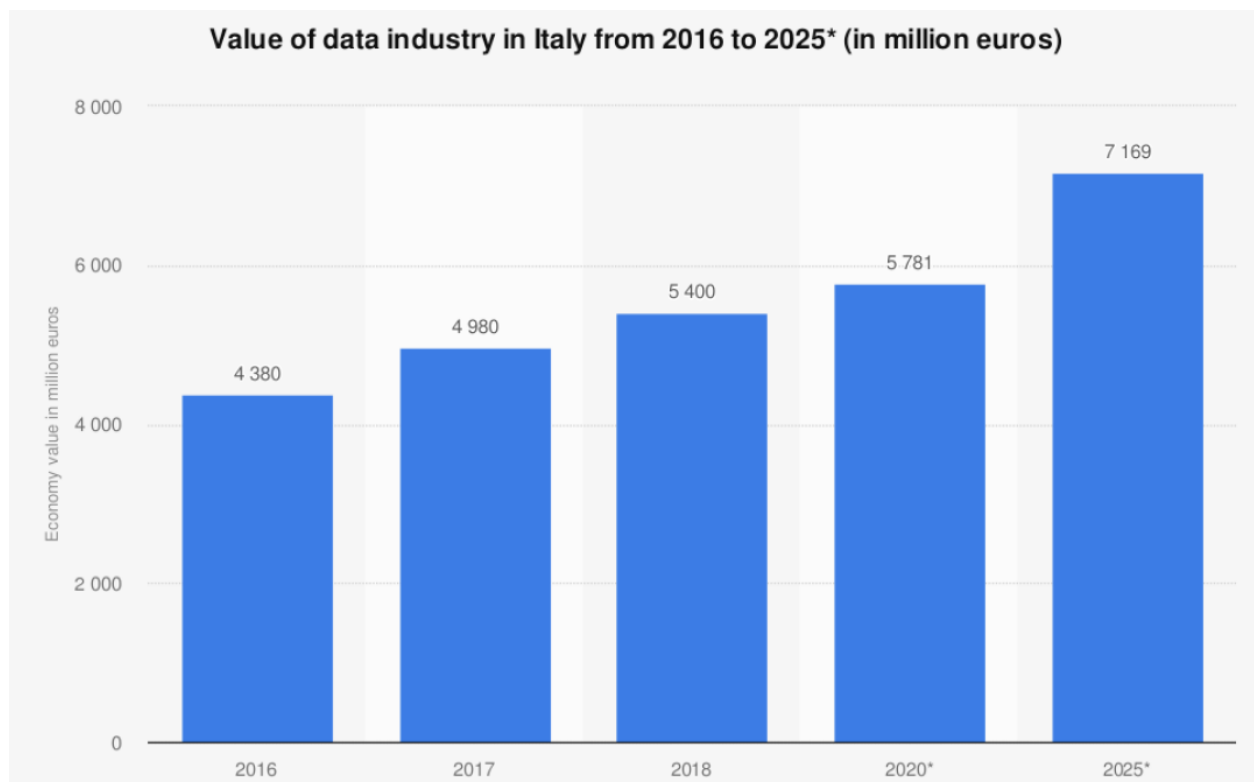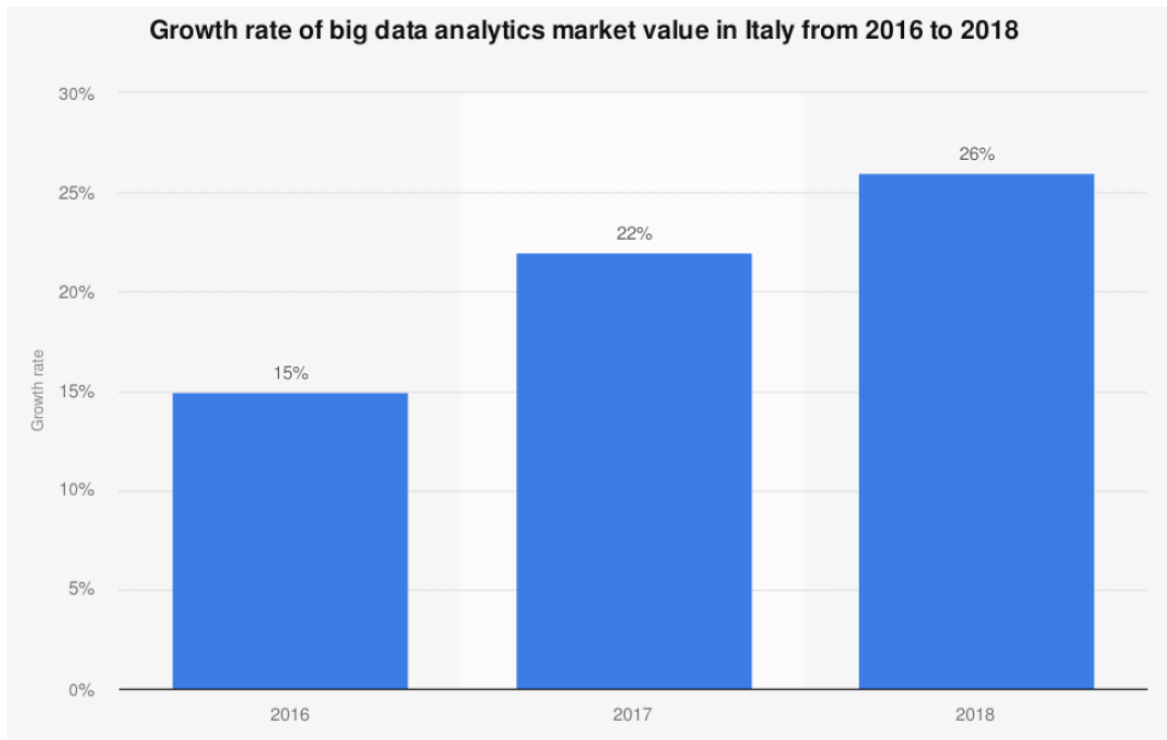

Figure 6 Value of data industry in Italy (source: European Commission)

---

[1] Not all countries can provide clear insights on ICT and data market. For the purpose of this study, we could only retrieve data from Italy, and no data about Croatia was found.

Figure 7 Growth rate of big data analytics market in Italy (source Osservatori Digital Innovation)

As explained by MaaS Alliance, there are however some relevant existing barriers:

- Poor quality and incomplete data;
- Lack of data standardization;
- Lack of interoperability by design;
- Data portability (lack of consumer/professional ability to switch between different service providers);
- Lack of economic incentives.

In general, some possible principles/business models for data sharing are: voluntarily; in collaboration; in reciprocity; based on commercial agreement; due to regulatory obligation (MaaS Alliance, 2018).

From a legal perspective, there are several questions concerning the control of information, and especially the security of the platforms where information are managed, the protection of personal data, the accuracy of data and the transparency and accountability of all processes involved. In MaaS this issue becomes particularly relevant as it offers "personal" mobility, targeting individual needs. For doing so, MaaS requires a larger amount of data and a stronger control of information.

Data represent the "intelligence" of the MaaS community's members, the synthesis of their strategies to overcome transport difficulties avoiding unnecessary costs and trying to take advantage of uncertainty, and therefore they are the core element of MaaS. Given their importance, establishing clear and fair rules for the control of information is crucial, and having the control of data gives a tremendous power which should be carefully controlled. The fact that such data have a huge economic value makes it important to establish if and how such information should be transferred or shared with other parties for commercial purposes. Based on some studies, considering the remarks strictly linked to GDPR, it is recommended that all operators draw a specific Code of Conduct concerning Data Protection (Article 40 GDPR) and propose a standard certification in this area (Article 42 GDPR). Indeed, both are needed in order to demonstrate compliance with the obligations concerning GDPR. Furthermore, this Code of Conduct could be very useful in order to solve or contain privacy issues, to create a framework of fair competition among companies, to encourage new businesses, and to set security measures against cyberattacks and unlawful accesses

3.4 MaaS in Europe: some case studies

There are already quite a few examples of European cities experimenting – or preparing themselves to – MaaS. The following cities represent some interesting case studies.

- *Helsinki*: the capital of Finland not only gave its political support to MaaS Alliance when hosting the European ITS Congress in 2014, but it also first voiced its aim to make private car ownership obsolete by 2025 (The Guardian , 2014). Today, the Whim app in Helsinki brings public transport, taxi, bike share and car travel together under a single subscription model. The result is a solution that has led to increased usage of shared transport, helping Helsinki on its way to that 2025 target. Furthermore, the city is developing a completely open data platform that can be accessed by anyone to connect public and private transportation more seamlessly.
- *Lisbon*: further back in time the so-called Lisbon Study, completed in 2015, made a simulation of the impact of MaaS in the city and the data was clear: replacing cars, taxis and buses with autonomous vehicles could reduce congestion, improve mobility, and cut CO_2 emissions by 62% (Brecht, 2018). Bringing this simulation to life is a slow process, however Lisbon offers strong public transport with integrated ticketing, and also ride sharing services like Uber have very much grow. Given its uniquely hilly terrain, the city is also developing a new scheme for electric bike sharing.
- *London*: the capital of England is also embracing MaaS, indeed there are collaborations between government bodies. Transport for London and Transport for West Midlands are looking to share best practice from the potential impacts of major transport projects to MaaS and improving open data.

- *Berlin*: MOIA, Volkswagen Group's latest venture, offers on-demand ride-hailing and pooling services, invests in digital start-ups and collaborates with cities and transport providers.
- *Rome*: more than 1,600 citizens signed up to participate in the urban mobility plans, and shared transport is going very well (Witzel, 2018).
- *Turin*: one hundred citizens will get mobility coupons valid for a year to get around the city by using low-impact, sustainable and shared means of transport. These citizens have been recruited through a public call where specific parameters were considered, like their economic condition. Citizens who decided to scrap their own car without substituting it with a new one and citizens living in areas where there are specific policies aimed at discouraging the use of private cars were favored within the others.
- *Madrid*: the Municipal Transport Company (EMT) launched the shared mobility app MaaS Madrid, which combines public transport data and other transport service providers into a single app, with 1,000 new customers register daily (Modijefsky, 2018).
- *Amsterdam*: the capital of The Netherlands wants its public transport to be 100% powered by renewable energy by 2025 and citizens are already helping to reach this target. The report "Citizen in motion" demonstrates that people in Amsterdam would favor MaaS over their own private vehicle where ridesharing services were readily available and at a good price (Arcadis, 2018).

According to the study of the research group Juniper, when talking about cities ready to deploy MaaS, close behind Helsinki there is also Vienna, which claims that more than 2.3 billion private car journeys in cities will be replaced with multi-modal, on-demand transport services by 2023. Vienna also has a successful app, WienMobil, through which citizens have access to door-to-door transport via bus, tram and metro – including e-loading stations, parking garages, taxis, bike or car sharing, and car rentals. As well as real-time data on journeys, personalized plans, booking, and payment, it also provides details on energy and financial savings based on transport choice (Weitzel, 2018).

The UK has several examples of applied MaaS schemes, an interesting case is given by the Scottish NaviGoGo platform: a MaaS service for younger people of the Dundee and North East Fife regions of Scotland. The project was co-designed by young people, following extensive work with a team of 16-25 year old co-designers, and the service offers streamlined and personalized information, from walking, buses, trains, taxis and bike schemes – alongside concessions and discounts – in one single, optimized hub. Quixxit and Moovel are two more examples of technology solutions providers which help organizing a trip combining trains, buses and flights (The Transport Knowledge Hub, s.d.).

MaaS is a phenomenon widely studied and tested all over Europe. Examples are given also from international projects such as MaaS4EU, whose aim is to provide quantifiable evidence, frameworks and tools, to remove the barriers and enable a cooperative and interconnected EU single transport market for the MaaS concept.

4 Impacts and the future of mobility

4.1 Impacts of multimodality

An increase of multimodality leads towards more multimodal transportation infrastructures, a change of relationships between the different operators involved in the integrated system and a relevant development of digitalization and therefore of ICT solutions.

ICT functions like the nerve system of a multimodal transport chain and brings multiple benefits to organizations by providing real-time visibility, efficient data exchange, and better flexibility to react to unexpected changes during shipment (Harris, Wang, & Wang, 2015). At the same time, ICT solutions are also the basis of multimodal transport of passengers, for they need digital platforms/apps in support of their journeys' planning.

Given the importance of ICT and technology in general for the development of multimodality, it is reassuring seeing how the European market size of the Internet of Things is expected to grow by 2020:

Figure 8 IoT market size in Europe (sources: IDC; I-com; Foundation Astrid)

Multimodality will also have a positive impact on the environment, if the transportation industry and its customers and stakeholders will actually move from strategies based on regulatory compliance to those emphasizing proactive environmental management.

4.2 Impacts of MaaS

The fast proliferation of new business models in all the industries is similarly replicated by new business paradigms also in the mobility industries, activated mostly by digital and technological innovation and changes in customers' behaviors. The relationship among new business models and the MaaS development is bidirectional. On one side, different novel business models maximize their value and increase demand if integrated to other solutions (also thanks to data sharing) and if connected to different players of the network (otherwise they risk to remain too niche services or not to be able to entirely deliver value to the users). On the other side, an integration platform needs diverse services and alternatives to be attractive to the customer.

In addition, platforms require considerable network effects to gain momentum in adoption that in return drives service-quality improvements that attract new users. This loop consolidates dominant position in winner-takes all markets, thus platform business model should reduce any barrier adoption in order to be effective.

The most common innovative business models are, for examples, the ones that change the transportation mean ownership paradigm (like car sharing or bike sharing) or the exploitation of free seat on own vehicles (ridesharing like carpooling). The ones which implement subscription-pricing models in services that operated on one-shot purchases or the ones which move rigid scheduling mobility offering to flexible on-demand models.

As MaaS is still a new concept, there is a general lack of generally available information on actual impacts of MaaS and the same is true of MaaS-related services. Services which appear to have undergone more thorough evaluations include well-established mobility services, such as car-sharing and bicycling schemes, whereas other services have not been exposed to the same process. Moreover, evaluations that have been undertaken are generally focused on those impacts related to users' behavior. Overall, assessments suggest that a broader introduction of MaaS could result in overall positive impacts, in terms for instance of a modal shift and an increase in perceived accessibility to the transport system. However, some analyses of the feasibility of introducing MaaS in different contexts identified also some negative consequences, for instance increased accessibility to the transport system - a desired impact on an individual and societal level - may result in an increase in the number of trips made (possibly a desired impact on an individual level but an undesired impact on a societal level with negative implications for emissions as well as congestion).

In any case, the introduction of MaaS will require new business models, increased data sharing, and further collaboration between public and private service providers with possible implications also for legal and policy issues on a societal level. Without a functioning business model and without data sharing between service providers, the MaaS model and offer will not result in the expected positive impacts on an individual level, and hence not in the desired behavioral changes (MAASiFiE , 2017).

5 Conclusions

This desk work aimed to to analyse the current state of play in Europe and beyond of sustainable multimodal transport solutions supported by ICT. In this work, we provided a comprehensive overview of the drives and new transport modes that are taking over cities. Also, we explored the synergies between transport and technology, highlighting concepts such as MaaS, IoT and big data.

Passengers mobility is undergoing great change, driven by environmental concerns, new business opportunities, and social trends. In the past years, we have witnessed the advancement of new modes of mobility (sharing mobility, micromobility, on demand services, demand-responsive transport) responding to the need of moder users. As demand rises, in the future we are likely to see a completely different scenario compared to the one we experience today, in our daily lives.

Despite the evident technological advancements, to address future mobility challenges, cities and mobility solutions providers must first adopt more comprehensive and well-coordinated management of mobility supply and have more proactive approaches to mobility demand management in order to influence behaviors. The mobility systems of tomorrow should be intermodal, personalized, convenient and connected, and encourage the usage of more sustainable modes of transport (public transport, cycling, walking) while integrating new mobility solutions and autonomous vehicles.

Digitalization will be one of the main drivers for upgrading the mobility system to a completely new level and make it a "truly connected system". Means of transportation must develop into "mobility ecosystems" where customers will be able to get intuitive and continuous information about the travel chain. In this context, the rise of new paradigm, such as MaaS and IoT will represent the future of mobility.

The solution for the future is an interconnected multimodal mobility system, with increased convenience and efficiency, tailored to the city's growth project and balancing economic development and well-being.

From this desk work, it is also important to highlight that it appears the main difficulties associated to sustainable urban transports are not just about technology. In fact, they relate to the political situation, institutional conditions and public acceptance, and the uncertainty about how to engage with the public and stakeholders to get them on board in the more fundamental transformation that is necessary in order to reach the goal of sustainable transport.

List of figures

Bibliography

Arcadis. (2018). *Citizens in motion* . Retrieved from http://images.connect.arcadis.com/Web/Arcadis/%7B948a41be-0a78-4430-b48c-34ca7390aa39%7D_Arcadis_Report_Citizens_In_Motion.pdf

Arthur D. Little . (2018). *The Future of Mobility 3.0 - Reinventing mobility in the era of disruption and creativity* .

Arthur D. Little. (2017, August 10). Retrieved 2019, from https://www.adlittle.com/futuremobilitylab/assets/file/180330_Arthur_D.Little_&_UITP_Future_of_Mobility_3_study.pdf

Brecht, M. (2018). *Mobility as a service in Lisbon*. Retrieved from https://lastmile.zone/en/urban-concepts/mobility-as-a-service-in-lisbon/

Costantini, F. (2017). *MaaS and GDPR: an overview.* Retrieved from https://arxiv.org/ftp/arxiv/papers/1711/1711.02950.pdf

Dalkmann, H., & Brannigan, C. (2007). *Transport and Climate Change - Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities.* Retrieved from https://www.changing-transport.org/wp-content/uploads/2007_Dalkmann_Brannigan_TransportandClimateChange.pdf

Deloitte. (2017). *The rise of mobility as a service.* Retrieved from https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cb-ths-rise-of-mobility-as-a-service.pdf

European Commission . (n.d.). *Multimodal and combined transport*. Retrieved from Mobility and transport : https://ec.europa.eu/transport/themes/logistics-and-multimodal-transport/multimodal-and-combined-transport_lv

European Commission. (n.d.). *Transport emissions*. Retrieved from https://ec.europa.eu/clima/policies/transport_en

European Management Journal. (2019). *Call for papers: 'Technologies 4.0: Understanding the evolution of ICT and its role for business development*. Retrieved from https://www.journals.elsevier.com/european-management-journal/call-for-papers/technologies-40-understanding-evolution-ict

Falconer, R., Zhou, T., & Felder, M. (2018). *Mobility-as-a-service - The value proposition for the public and our urban systems.* Retrieved from https://www.marsdd.com/wp-content/uploads/2018/04/Mobility-as-a-Service-the-value-proposition-Mar18.pdf

Harris, I., Wang, Y., & Wang, H. (2015). ICT in multimodal transport and technological trends: Unleashing potential for the future. *International Journal of Production Economics* .

International Transport Forum . (2019). *ITF Transport Outlook 2019.* Retrieved from OECD iLibrary : https://www.oecd-ilibrary.org/transport/itf-transport-outlook_25202367

Interreg Europe. (2018, June). *Demand-Responsive Transport* . Retrieved from https://www.interregeurope.eu/fileadmin/user_upload/plp_uploads/policy_briefs/2018-06-27_Policy_Brief_Demand_Responsive_Transport.pdf

ITU. (2017). *ICT trends and developments in Europe* . Retrieved from https://www.anacom.pt/streaming/itu_ICTtrends_developments_Europe.pdf?contentId=1408835&field=ATTACHED_FILE

MaaS Alliance. (2017). *Guidelines and recommendations to create the foundations for a thriving MaaS ecosystem.* Retrieved from https://maas-alliance.eu/wp-content/uploads/sites/7/2017/09/MaaS-WhitePaper_final_040917-2.pdf

MaaS Alliance. (2018). *Data makes MaaS happen* . Retrieved from https://maas-alliance.eu/wp-content/uploads/sites/7/2018/11/Data-MaaS-FINAL-after-plenary-1.pdf

MAASiFiE . (2017). *Impact Assessment* . Retrieved from https://www.vtt.fi/sites/maasifie/PublishingImages/results/CEDR_Mobility_MAASIFIE_Deliverable_4_Revised_Final.pdf

Modijefsky, M. (2018). *Madrid launches its new mobile application for shared mobility, Maas Madrid.* Retrieved from Eltis The urban mobility observatory : https://www.eltis.org/discover/news/madrid-launches-its-new-mobile-application-shared-mobility-maas-madrid

Pejanović-Djurišić, M., Gavrilovska, L., & Fratu, O. (2016). *Special Issue: ICT Trends for Future Smart World.* Retrieved from https://rd.springer.com/article/10.1007/s11277-016-3886-4

The Guardian . (2014). Helsinki's ambitious plan to make car ownership pointless in 10 years . *The Guardian* .

The Transport Knowledge Hub. (n.d.). *Mobility as a Service in the West Midlands and elsewhere*. Retrieved 09 2019, from https://transportknowledgehub.org.uk/case-studies/mobility-service-west-midlands-elsewhere/

TRANSFORuM. (2014). *Challenges and barriers for a sustainable transport system – state of the art report.* Retrieved from http://www.rupprecht-consult.eu/uploads/tx_rupprecht/TRANSFORuM_D4-1_APPROVED_Challenges-and-barriers_State-of-the-art.pdf

Weitzel, S. (2018). *MaaS in Europe Part 3: Madrid, Amsterdam, Vienna.* Retrieved from https://skedgo.com/maas-in-europe-part-3-madrid-amsterdam-vienna/

Witzel, S. (2018). *MaaS in Europe Part 2: London, Berlin, Rome*. Retrieved from https://skedgo.com/maas-in-europe-london-berlin-rome/

Wolny, A., Ogryzek, M., & Źróbek, R. (2017). *Challenges, Opportunities and Barriers to Sustainable Transport Development in Functional Urban Areas.* Retrieved from https://www.researchgate.net/publication/319923631_Challenges_Opportunities_and_Barriers_to_Sustainable_Transport_Development_in_Functional_Urban_Areas